If for things good and noble thou wert yearning,
If to speak not baseness were thy tongue burning,

No load of shame would thine eyelids weigh;
What thou with honour wishest thou wouldst say.

My Lords, Ladies and Gentlemen, Gods and Godesses. I present to you, with no great deal of humility, and not a little pride, my work, untitled as it is, and sadly unfinished. I need your help to find the errors, for there will be many, and of that *alone* we can be sure. And also to continue the work, and to fill in some of the missing pieces. And make some general improvements; round the place. It may turn out to be a bit of an epic. That is something for which *I* will not be apologising.

But before we begin, I beg one thing of you, which is *never* to take these matters seriously. It *should*, and *must always be* a *comedy* of errors. For that is what She *will* always intend.

Scene I

[It is a few seconds before midnight. Elaisson sits at his desk, typing. He has to look at the keys to do this, and from time to time he looks up and peers into the screen as if trying to catch a glimpse of something lurking just out of sight in its depths. Every now and then, he takes a few coca leaves from a bowl by his side, and chews on them distractedly.

Aristotle sits perched on the window sill. He has thin white hair reaching down to his shoulders, and a thin white beard of similar length. He is wearing a loose white tunic with a sash thrown over the right shoulder. He is barefoot.]

Elaisson. Incredible!

Aristotle. That's the third such exclamation in half an hour. What is it?

E. You wrote almost two and a half millennia ago, and you seem to have prefigured some fundamental results of quantum mechanics. Here in 'On Prophesying from Dreams' you describe quite cogently a quantum superposition.

A. A little intuition goes a long way. Few would say my description is anything much more quantum mechanical than a youth pulling the petals off a daisy and saying 'she loves me, she loves me not . . . '.

E. But *they* draw these consequences from the atomic theory of matter.

A. Why is still called that, I wonder? I mean, it's not *atomic* as such, is it?

E. Not really when an interaction of two particles involves a whole infinity of virtual particles popping into existence momentarily to help it happen one way or another.

A. It might do better as a theory of knowledge than of physics.

E. Physicists I've tried to draw on the subject seem very reluctant to talk about knowledge, or meaning or intention or anything 'mental' for that matter.

A. Then how do they explain their intentions in doing experiments? Or even the purpose of their measurement apparatus or the meaning of the readings?

E. Well, rather awkwardly. There are some theories of psychology that explain a human being's sense of purpose as something which one uses to explain a subject's actions and from which explanation one can build a model of their beliefs. And the same holds of their measurement apparatus—vicariously as it were.

A. Would a *model* of their beliefs be something different from what you would learn by asking the subject what they believe?

E. Well, they themselves may not know what they actually believe. The beliefs and the conscious intention are not necessarily real, just 'convenient fictions' as it were.

A. What in the name of Socrates is convenient about fictions? That they cover up the otherwise apparent total absence of knowledge?! Surely a man believes what he knows.

E. Well, it's an attempt to get a working theory of human behaviour without first having to explain knowledge and meaning and what have you. There is even a hope that perhaps physics may one day be able to explain what these things *really* are.

E. Please don't look at me like that. I'm not making this up, you know.

A. Who *could* make this stuff up. I mean, if a man's beliefs are not based on his knowledge, then how can I believe this to be a scientific theory? It denies the very existence of scientific knowledge.

E. I suppose it must be a different sort of knowledge. Epistemologists probably have a name for it.

A. You mean *dialecticians*? Perhaps they would be generous enough to give it the dignity of the name *sophistry*. But sophistry is supposed to have the *appearance* of wisdom, and this does not qualify! Do you have a science of *scatology?* It may find a suitable classification there.

E. Now now. But do you see why there's no place for teleology in science?

A. No, I don't.

E. It's because saying something happens because it's *meant* to happen presupposes some sort of *being* who has this conscious intention.

A. Indeed it does.

E. But that could explain anything!

A. Is that how people plead in your law courts?

E. You mean claiming that something they did was not their intention, but that of god or their 'destiny'? Sometimes, but usually it is followed by a plea to diminished responsibility.

A. Would it not be a more effective diminution of responsibility if one were to call an expert witness to declare that according to modern science conscious intention is merely a convenient fiction?

E. As far as I know that has not yet been tried, but it's probably only a matter of time before it is.

A. But my *teleos* is not necessarily conscious intention in the sense of *deliberation*, you know.

E. Indeed it is not, but few seem to be able to draw a distinction between deliberation and some action being directed to some definite end.

A. So a biologist who explains a complex cellular metabolic reaction as being directed towards the definite end of maintaining the structure of the cell itself is making

an appeal to *deliberation*? I don't think so. The appeal is to *necessity* because the structure of the cell is essential to the very thing that is the subject of discourse: without a cell there is no cellular metabolism to study.

E. *We* know that. But how does the cell know that?

A. The cell doesn't need to know anything. The cell just has to *be*. The end to which the metabolism is directed is the *reason* for the metabolism being something worth speaking of in the first place: i.e. it is *necessarily* the metabolism of a *perfectly functioning cell*.

E. For an ancient Greek, you have a surprisingly good grasp of cellular biology. The biologists say that they are using the purposeful language as a convenient fiction. That in fact nothing happens for any reason other than that some molecules bang into each other.

A. But one cannot even understand a drop of dew like that, never mind a cell. The dew-drop is one whole because the matter being in the particular form it is creates conditions which are necessary for it to remain in that form. A drop has a minimal surface area and this limits the rate of evaporation. If it were a flat disk of water it would evaporate much faster. Other macroscopic properties of the whole are important too. For example the fact that it is translucent effects the rate at which is is warmed by sunlight. The whole is not a convenient fiction, it is actual *substance* and its properties *as a whole* have explanatory power, which is to say they are the first causes of things, and it is by knowing the first causes of things that we think we understand them.

E. But you said just now that if something's *meant* to happen then that presupposes a conscious being.

A. I did. Something *can* be meant to happen, and then the final cause is the corresponding conscious intention. But not all consciousnesses are rational. The vegetable consciousness of the cell for example is the aggregate of the final causes of the cellular metabolic processes.

E. The *vegetable consciousness*? We are going to need a term with fewer extraneous connotations.

A. Well, the modern sense of the word consciousness is what best fits with my sense of the world *soul*. What about *system* instead? You could call it a *somal* system if you don't like the term 'vegetable system', though *I* think the latter has a certain quaint charm.

E. Then the somal system is the final cause…

A. What about calling it the *perfection*.

E. The somal system is the *perfection* of the cellular metabolic processes. That doesn't sound too outlandish a claim. And the *animal* system is the perfection of the processes of sense-perception.

A. And the *rational* system is the perfection of the reasoning processes.

A. *Perfection* is a better term than *final cause*, because it makes the *potential* more apparent. *Final* has a very, well, *final* sense, and this belies the possibility that things could turn out otherwise.

E. That the cellular metabolism could break down completely.

A. Or that the processes of sense-perception could be interrupted.

E. By a drug or anaesthetic?

A. I was thinking of just sleep. It's rather late.

E. This idea of perfection though is intriguing. It's not too far from the notion of *fittest*.

A. If fitness implies *purpose*. So a giraffe is not fit for getting under rocks, and a mouse is not fit for browsing trees. Then the reason that a giraffe has a long neck is so the he can browse trees and the reason a mouse doesn't is so that he can better scurry around under rocks.

E. Fitness is not something taboo in evolutionary biology.

A. But how do they define it? Presumably not fitness for purpose.

E. In a completely general sense, yes. They say the fittest is the one best adapted to survival.

A. Then everything is to the same end, which is survival, so a mouse is as fit as a giraffe, because they both survive?

E. Yes, I suppose so. Fitness always refers to the individual animal of course. But if we consider typical specimens then yes, the giraffe and the mouse are fit for different activities. A mouse is fittest for mouse-like activities, and a giraffe for giraffe-like.

A. Aha, so *that's* why elephants aren't giraffes! I've often wondered. An elephant is not fitter than a giraffe for typical *giraffe* activities, but is just as fit as an elephant for typical *elephant* activities. But an elephant also browses, and often elephants live in the same places giraffe live. So they are both exactly as fit as the other, for browsing.

E. But elephants and giraffes browse in a different way. Whereas a giraffe just nibbles the tips of the branches the elephant sometimes uproots the entire tree.

A. And of course they're much fitter for those more elephantine pursuits.

E. It's not a very good explanation is it? It's more like a *definition* of the species.

A. The definition of an *ideal*. In other words the *boundary* of the species. Which is the *end* of evolution. These are all the same words.

E. Are they indeed!

A. It's not obvious, is it? This is where the English translators of our work have done you a slight disservice. Following Saussure they probably thought it wouldn't matter what word they used to translate a technical term, provided they were consistent. But consistency is one thing, and appropriateness is another. So in English you don't see that πεπερασμένος, or *finite*, shares a root πέρας with the word περαίνω, meaning 'to bring to an end.' Or that ὅρος is used in the sense of both a *definition* and a *boundary*. And they translate σύμμετρος as *commensurable* so you don't see immediately that it has common roots with both σύμπας meaning *whole* and μέτρον meaning *measure*. And when you see the word *species* it doesn't bring to mind any of *figure*, *form*, *shape* or *idea* in the way the Greek εἶδος does. Again, when you see *irrational* you are not likely to think of *unspeakable* or *illogical* as you would if the word was ἄλογος, which is the opposite of ἀνάλογος which means *proportional*, which is in turn the inverse of ἀντιπάσχω meaning reciprocally proportional, but which comes from the root πάσχω which means *to suffer*.

E. Ah, like the turtles! Yes I see, not having these clues then is really quite a handicap.

A. It means you have work harder to get the *sense* of the word.

E. Lewis Carroll was good on the distinction between sense and meaning. *Jabberwocky* produces the sense but hardly any of the meaning.

A. And it shows that if you choose the terms *appropriately* then the sense will be more clearly perceived. You see this in mathematics a lot.

E. Yes. I knew a lecturer who was so taken by the sense of the algebraic operators he used that he did not see the need to *define* the actions of those symbols as they applied to whole matrices, never mind prove the algebraic properties that he subsequently assumed of them.

A. He probably didn't even see that he was using them in a different way.

E. He didn't, because he refused to accept the need to prove these things, yet he had found the need to prove that the same identities held in the operators as applied to individual elements.

A. He was lucky then that the original multiplicative operator was not commutative, because then it didn't matter that the matrix operations were not commutative. It's important to preserve these similarities wherever possible because intuition is based *entirely* on sense.

E. But let's just quickly go back to modern physics before we stop for the night. What I started to say earlier was that if you think about relativistic quantum electrodynamics you seem to have material cause in the fundamental particles, formal cause in the relativistic structure of space-time, efficient cause in the initial conditions and final cause in the measurement operators.

A. It may *seem* like that. But if you look a little more carefully you'll see that in fact material cause and efficient cause are completely absent.

E. I suppose efficient cause is absent because we don't know what 'collapses the wave-function' and material cause is absent because we don't know what the probability density actually is, physically, and it is this that evolves.

A. Exactly.

E. For an ancient Greek, you seem to have a surprisingly good grasp of modern physics.

A. We try to keep up. But it is difficult when fully ninety percent of the things that are published seem to be no more than tentative speculation. Why publish these hypotheses before thinking through their consequences?

E. Academics have to compete for funding.

A. Academics now *compete* for *funding*? You mean they are *all* sophists?

E. Well, being paid to do research is not considered to be such a bad thing.

A. It is if they have to *compete* for it because then they cannot be doing their research for just the sake of knowledge. This explains a great deal. We were somewhat bewildered on the one hand by how *popular* the profession of philosophy seemed to be, and on the other hand by how *poor* was the standard.

E. The Lyceum was very generously funded by Alexander, wasn't it?

A. It was, and that is how we were able to do so much. It wasn't just money, he sent us specimens and took students with him on foreign campaigns.

E. Why was that not sophistry?

A. We were never *beholden* to do anything in return for the money, so we were free to learn in a completely unqualified sense of the verb.

E. That must've been nice.

A. Yes it was.

E. I thought perhaps you would say that a philosopher should always be prepared to put Truth before his own well-being and this is why a philosopher should never be paid for their work.

A. There's no harm in accepting reward for one's efforts, especially if it will aid in furthering the work. But should reward become the *end*, then all is lost. The necessity to maintain a physical form is somewhat irksome, but it cannot be ignored altogether because starting again from scratch inevitably involves some *overhead*.

E. Starting *again*?

A. Yes, the dead do not make good philosophers. Principally because it is hard to have definite thoughts when one is dead.

E. You seem to be doing well enough.

A. That's because I'm not dead. Have you read Parmenides?

E. Very little. He said he brought his philosophy back from 'the halls of Night'.

A. The land of the dead, yes. But it was not Parmenides' philosophy, it was a gift from the godess Night to man.

> And the godess received me kindly, and in her hand she took
> my right hand, and she spoke and addressed me thus:
> 'O young man, accompanied by immortal charioteers
> and mares who bear you as you arrive at our abode,
> welcome, since a fate by no means ill sent you ahead to travel
> this way (for surely it is far from the track of humans),
> but Right and Justice did.'

There is only this one true philosophy, and it belongs to all those who know it to be such. Each of us takes the philosophy a little further, building on what we inherited, fixing any errors we find. So we are a succession of individuals who share essentially the same mind.

E. So the gods gave philosophers a kind of immortality?

A. In a qualified sense, yes.

E. That can't be proved, can it?

E. No. But for a philosopher it's an *inductive inference*: you will be able to *see* it is true because it's no less certain than the fact that when you wake up in the morning you are the same person who went to sleep the night before. You *do* sleep, don't you?

E. I have to, from time to time. But how does this make one philosopher? I am one person because I share most of my attributes with the person I was the day before. What attributes do *you* share with Socrates, say?

A. Well, none of the accidental ones and, I hope, all of those essential to Socrates *qua* philosopher.

E. So the extent to which we are one *by reference* is the extent to which the minds of the individuals share the essence of Socrates?

A. Yes, *alêtheia*, in a word. It is the existence of this one Truth that gives the continuity to the enterprise and which allows us to find each other even though we are each born knowing nothing. The extent to which men in general share this knowledge is not so very great, I'm afraid.

E. But there could be *another* cult of philosophers with the same belief that *they* were the immortal torch-bearers of the Light of Truth. The Heraclitians, say.

A. The fact that we *die* is important. We forget everything and start again from nothing. So for any of us to find the end of the thread, the work of those before *must* be checked again and verified at each step. Now if there were *another* thread, and *that* were in fact the True Light, then we would all of us be found to be deluded. And that is a possibility, and it is always a *necessary* one, because if it is possible to truly know then it is necessarily possible to be mistaken. That was Socrates' characterisation of wisdom, and Plato refined it but his is essentially the same. So we can know, but we cannot know that we know. I refined it further and showed that there is still wisdom, even if our knowledge is not innate from the beginning. This was a problem for Plato's theory, because if a man knows anything then he must have known that all along. But it seems clear that some people are ignorant, and we couldn't explain why that was if everyone really knew everything. So in my view the knowledge, what I sometimes call the *order of being*, concerns the actual substantive things in the world in which it has a *potential* existence. We *realise* that potential in *speech* or *dialectic* which is the logical process of Socrates. Incidentally, many claim that I 'invented' logic, but this is not true, Socrates was the first to show that speech was a necessary and fundamental part of reason. And that, I mean dialectic, is what we usually mean by the term *logic*. My contribution was *formal logic*.

E. What if the cult of Heraclitians were in fact right and we were wrong?

A. We would know this through some dialectical *contradiction*. And we would then need to look at all our basic premisses and all our deductive reasoning and find the error in the deductions, or all those premisses which were involved in deducing the contradiction. Then we would need to resolve the remaining premisses with those of the Heraclitians and produce the new thread which would consist of both ours and all the Heraclitians' premisses.

E. So the two threads would turn out to have both been merely *potential*, and they were somehow *resolved* into one actual thread by choosing which premisses were good and which were not?

A. Yes. But since some of the Heraclitians' *premisses* are immediately contradictory, this is impossible.

E. Which brings us back to the question of how it is that modern physics was able to draw a conclusion that concurs with yours, though from premisses which you claimed were evidently false.

A. Well the first thing to point out, though I'm sure you know it already, is that there is nothing that prevents one drawing a true conclusion from false premisses. All the formal logic is is a constraint on the drawing of a false conclusion from true premisses. So that we have a logical explanation for something doesn't necesarily mean it is the true explanation.

E. I did know that, but I am sometimes a bit sloppy and confound the ideas of deduction and demonstration. A demonstration is a deduction from necessary truth, not just any truth, isn't it?

A. Yes, and the atomic hypothesis, in the sense in which I took it, was pretty much that of Democritus, and not a necessary truth, nor indeed even an evident one. The atomic hypothesis that is the material foundation of QED is something quite

different. It's a delight!

E. Did you know Feynman?

A. Alas no. He was a very talented mathematician, and he had no time for philosophers. I get the feeling he thought he should be able to do everything himself, and he almost managed.

E. Apparently his last words were something like 'I'd hate to die twice, it's so boring!'.

A. It's a good thing he wasn't a philosopher then because he would have been *very* bored.

E. He apparently cared deeply about *people*, and not just the obviously successful specimens. It is clear he regretted having worked so enthusiastically on the Manhattan Project. Perhaps he needed his thoughts to be occupied.

A. Philosophy was responsible for a lot of horrifying deaths of innocent people in the Second World War, mine included.

E. You died horribly in the second world war?

A. I was referring to my philosophy.

E. I don't understand.

A. The Nazis' rhetoric and their banners and what-not were very cheap, but that was strictly for the masses. The intellectual culture of the Austro-Hungarian empire was still very much alive, though not completely well, apparently. And being more classically-minded than the Americans, they were probably more interested in the long term potential than the mere expedient of ending a war; something they perhaps believed was inevitable, and which would be in their favour at any rate. I worry that perhaps someone may have equated my notion of perfection or end with *destiny*, and that of a particular type of people: pale complexion, fair hair, blue-eyes etc., and my work on mixing and division would then have been especially interesting to them. It seems they conducted a lot of 'human anatomical investigations', shall we say. I don't know exactly what they were looking for, and perhaps they didn't either, but I rather regret now that I didn't better obscure my advice as to how to prepare specimens for dissection. In truth I put it that way thinking it would *dissuade* people from trying to learn anatomy through dissection, but I underestimated some capacity in man.

E. Shamelessness.

A. Yes. But their collective behaviour was an interesting example of what could be achieved by people with a unified sense of a certain definite *potential*. Only the exact nature of the potential is something that one needs to give careful consideration to, because the consequences of getting this badly wrong can be dire, as we saw. I thought I made it clear that the potential is *happiness* and that this is realised in perfect reasoning. But perhaps this was misunderstood as *breeding*.

E. Perhaps confusing *genera* with *generation* in the same way modern evolutionary biology confuses the causes of species, i.e. the *genera*, with the substantials, the animals themselves, and calls this *genetics*. They called it *eugenics*.

A. Yes, a horrendous error! It is just mistaking the sense in which the genera are prior. They are prior in the order of being, but it is the animals themselves that are prior in sense-perception. But the actual things prior in sense-perception are never the causes of themselves, they are the causes of the knowledge we have about them.

It is the genera that are pror in the order of being, and they are the true causes of the species.

E. They had been made to suffer dreadfully after the First World War, and they clearly believed they were engaged in the pursuit of happiness. This is the *eu* in eugenics. Were they not pursuing knowledge for it's own sake then?

A. No. Happiness is not the *possession* of the knowledge nor indeed the attainment of any state or posession whatsoever. As I wrote more than once, we cannot tell when we truly know. How then could we know we had reached that state, or had that thing?

E. To my knowledge you only wrote it *once*.

A. Really only once? Well, I *think* it all the time, And my students would roll their eyes towards the heavens I said it so often. And we wrote it into the definition of a philosopher.

E. In Plato's *Republic*?

A. Yes. Now have we completed that little diversion?

E. Yes I think so. Please explain why the modern sense of the atomic hypothesis delights you so.

A. Because it's *elemental*.

E. You don't mean that quantum particles are the elements, I presume.

A. Heaven forbid! No, The particles are not substance at all. I mean the elements are contrary *types* like electrons and positrons, and that bodies are continuous and infinitely divisible ...

E. How so? Surely the elementary particles are not continuously divisible.

A. Indeed they aren't. However the elementary particles are not the bodies. The bodies are represented by *wave-functions*. These wave-functions are continuous and infinitely divisible. And they consist in like kinds of matter.

E. You mean *probability density* is *matter*?

A. I mean the complex probability amplitude is matter, yes. It is one element of matter.

E. What you call *ether*.

A. The very stuff. Its natural motion is circular and it has no opposite.

E. You presumably mean that the complex quantities $Ae^{i\theta}$ are all taken to have the same *sense* of the argument θ, and this is essentially arbitrary as far as we're concerned. Merely a matter of convention.

A. Yes. And these values are the constraint on the possible, but they say nothing at all about what is *actual*.

E. Then the actual boundary conditions are the *constraints* on the natural motion, so the matter and energy are... what?

A. What do you mean matter and energy *are*? What is there for them to be?

E. Bodies of some kind.

A. Exactly. *Definite* bodies. So if they *are* then they have *form*. What gives them their form?

E. I can't say, in general, but we *know* the form as a limit of some kind. A surface, say.

A. Quite right! So the boundary conditions are limits in two senses simultaneously. On the one hand they are limits of what they contain, and on the other they

are known as being themselves the *continent* within those self-same limits, but on the other side of the surfaces, as it were.

E. So the surfaces are the abstract forms realised in the matter. This then is a *definition*. The limits we call matter and energy are boundary conditions and what they contain is called the probability density.

A. If by that you mean the *potential*, yes. Logically speaking, what does not exist, yet is *not impossible*.

E. The sense many have now of the term *potential* is of some sort of well. So for example the Earth sits at the centre of a gravitational potential and all the objects fall down into the well.

A. That's wrong. The *surface* is not the potential, that's just the energy, a definite surface is a definite constraint on the motion and determines absolutely everything that can possibly happen, so there's no potential at all on that view. Why does any *particular* thing happen?

E. The things that happen are just the things that *can* happen *spontaneously*.

A. So the 'explanation' for everything we see around us is just that it all just happened by *chance*?

E. Well, no scientist I know would dare to suggest anything happened for a reason.

A. And this is considered a satisfactory explanation?

E. Not Universally. The Emperor, for example doesn't find it a satisfactory explanation because it places an onerous responsibility on the choice of initial conditions.

A. Initial conditions of the *Universe*?

E. Cosmologists nowadays claim to know the thermodynamic conditions of the Universe when it was only a minuscule fraction of a second old.

A. Dare I ask what they are supposed to have been like?

E. Hot. And very very cramped.

A. Like a *boiled egg* then?

E. Only hotter, and much smaller.

A. Then how did it grow?

E. Very rapidly. In fact it exploded.

A. Oh dear! How did all this structure come about then?

E. Spontaneously, during the process of cooling.

A. Is there empirical evidence for this sort of thing? I mean, eggs exploding and then as the resulting product cools, giving birth spontaneously to things like stars and plants and animals?

E. No. It's the root of the problem really. It seems the initial conditions of the explosion were somewhat implausibly unlikely to have given rise to a Universe with this distribution of matter.

A. It seems implausible that *any* explosion in an egg could give rise to anything except a mess.

E. Quite. That's really the problem, in an egg-shell, as it were.

A. The surface determines the movements by constraint, the potential is what is not necessarily impossible with respect to those constraints. So it's the contrary of a constraint. But the entire future of a system cannot be determined by constraint, because then what determines what those constraints are?

E. So it's just like the problem of how we can know anything when all knowledge depends on other prior knowledge.

A. It's not *like* that problem, it *is exactly* that problem.

E. Ah, so the initial conditions *are* the knowledge we have about the system. In other words, every physical theory concerns some actual state of affairs and of course that is a *known* actuality.

A. Exactly. And in this exploding boiled egg theory of the origin of the Universe, what is the end implicit in the putative initial conditions?

E. Heat death.

A. You mean death by suffocation?

E. I think you would call it death by exhaustion. It occurs when all the available energy has been used to do work.

A. Work?

E. Force times distance moved.

A. Force is a magnitude?

E. Measured in newtons. One newton is approximately the force due to the gravity of a moderately-sized apple at rest.

A. So force is just weight?

E. That's what it is sometimes called, though weight refers just to a force due to gravity. Other forces have other names like tension, compression and so forth.

A. Then when you say 'all the available energy has been used to do work' do you mean that there is no longer any force? So when a house is constructed, that is work being done, lifting the stones, but also when it falls down, that is work being done too, because the stone falls under the force of its weight?

E. Yes, I suppose so. All the forces are more or less in equilibrium, so nothing moves anymore.

A. And this so-called potential surface is then in some sense flat.

E. Uniform, I suppose one should say. It was not really right to describe it as a surface: in the Newtonian sense the potential is a scalar field.

A. So you call *work* any kind of locomotion under constraint, regardless of the end to which it moves?

E. Yes. Who is to know to what end these things happen?

A. The fellow who understands the reasons for things.

E. That view is sadly out of fashion, as I said. We do not on the whole believe that reason and meaning are real.

A. Then why do you *do* anything at all? What is the point?!

E. Many, many people ask themselves the same question.

A. And what is their answer.

E. Most never seem to find a satisfactory answer and give up, or they die wondering about it.

A. Yet you have accumulated this immense art. All this technology. Take the machine on your desk, for example. It took an extraordinary effort to create. If it is ultimately meaningless, and for no purpose, then *why do it*?

E. I have no idea why *they* made it, but it was probably a means to some other end, very likely involving money. But *I* make use of it in *my* own way, and that is not necessarily the way it was intended to be used.

A. No it isn't. That's what is wonderful about the machine. Within the limit, i.e. according to its definition as a manifold of energy and matter the machine is pure potential. It is a marvellous thing indeed.

E. I would not have thought of putting it that way. So a computation is a limit, within which some potential becomes actual?

A. Exactly. And I'm sure you *would* have thought of it eventually. By controlling the limits one can have the machine explore a logical space of possibility. With such a device you could calculate the porisms.

E. The missing proofs that Diophantus refers to?

A. And Euclid too. They were mechanically generated abstract proofs. You will read only vague hints about it in my work. For a given completely formal structure in the categories one can mechanically enumerate the consequences of collections of premisses. What one is looking for is a common structure for the appropriate basic truths of *two* or more *different* sciences.

E. For example, the analogy between the point in geometry and the unit in arithmetic?

A. That particular example is problematic. A straight line is defined as one lying evenly with the points on it. The analogous property is an *odd* number, because an odd number lies evenly with its units. What is the analogous property of an even number? Or is it that an *even* number lies evenly with the ratios in it? In other words, we take the boundary to be the point wbetween two units? An easier example is the one concerning proportionals which I gave in Posterior Analytics. There are isomorphic structures in arithmetic and geometry between which whole proofs commute, such as the one that proportionals alternate.

E. When you say these were mechanically generated, you mean there was some procedure someone could use to go through some routine series of steps and write out a deduction?

A. No, by mechanical I mean we had a machine that did it. All we had to do was to make sense of what it indicated.

E. Were these the wheels of bronze and steel which they dedicate in temples?

A. You seem quite well read.

E. I was just taking a wild guess that you referred to the Lyceum as a temple. It is described now as a public exercise ground and gymnasium.

A. These things were all in a grove of trees dedicated to Apollo Lukeios. It was a very pleasant place to work. It was just outside the eastern boundary of the city, near the river Ilissus, now it's several metres below ground level, about 200 yards down the road from the British Embassy, behind the War Museum. The Earth is a godess, and Apollo Λυκειος is the god of light. These two aspects of the place were what made it special. It was a special time too. It was like a twelve year long consummation of the marriage of Gaia and Apollo. Earth and Light.

E. What was the result of this union?

A. An egg, of course.

E. Of course. I was also taking a wild guess that the machine was a calculator, but I have no idea why the wheels would need to be made of two metals.

A. You need to read more. You'll find out sooner or later.

E. So it these isomorphisms which you refer to when you say the we do not know when the basic truths are appropriate?

A. Yes. The word *appropriate* means on the one hand belonging properly to the science, and on the other as having been appropriated from another science. This works in mathematics because we have an element of freedom in our choice of basic truths. It helps to choose those which make the structure one whole because then one can use geometric intuition to solve problems in arithmetic, for example.

E. What is called 'diagrammatic reasoning'. And I think is what Peirce called *abduction*.

A. Indeed. But this is most emphatically *not* what we do in geometry, and neither do we have complete freedom of what are the basic truths.

E. Because it's an empirical science.

A. Yes. The science of volumes and surfaces and therefore of *deduction*.

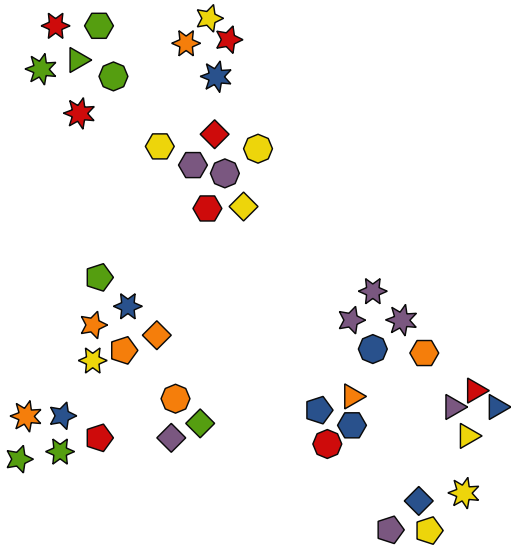
E. Deduction?

A. Sight is the only sense we have which can perceive of a collection of individuals as one whole. If we touch distinct things we are aware of them only serially in some order. Similarly if we taste distinct savours or smell distinct odours.

A. But this is not to say we don't perceive wholes with these other senses. My favourite little experiment shows that we perceive wholes immediately with our sense of touch, and furthermore it proves that sight is not necessary for this perception because as regards the plurality of the sense-experience, the evidence of the sense of touch of the crossed fingers is not bettered by the visual evidence that we are in fact touching just one whole surface.

E. But when we perceive a compound object by touch we perceive the parts serially, though we perceive them individually as wholes. And of course when we hear a word which is made up of distinct syllables we perceive it as one whole word, not a series of syllables. But what has this to do with deduction?

A. Look at that diagram on the wall, for example.



E. Did you do that? The bedder is going to have a fit!

A. I'm sure no body will mind, it's not permanent. It represents three genera, each divided into three or four specieses.

E. Specieses?

A. Lewis Carroll invented the term to avoid the Little Bo Peep problem.

E. Little Bo Peep who lost her sheep?

A. Yes. It's not clear whether it was just one or a whole flock. The steadfast refusal of the English to allow their children to use the word that every child instinctively invents to disambiguate one sheep from many sheeps is justified by the argument that 'it doesn't sound right', or 'it sounds childish'. Both of which are course true, but merely beg the question.

E. Such is the lot of the would-be language reformer. I doubt adults would fare any better.

A. Worse, I should think, because they should *know better*. Fortunately this didn't bother Carroll.

E. In this diagram the genera and the specieses are indicated by the clustering of the symbols. Am I to presume the symbols themselves are not individuals in any species, but *attributes* or *signs* attached to all typical individuals in the species?

A. Yes, and I hope that anyone who looked at this would agree on the genera and the specieses. There are just three different genera here, each containing a number of different specieses.

E. There are logical relationships visible too. For example, the genera are characterised by those colours which all their specieses share in common. There is a red genus, a green or orange genus and a blue one.

A. And deductions should be evident too. For example if I say that all specieses with green signs are not in the blue genus then this is immediately apparent. All we need to know to be able to judge the evident truth of propositions is what are the boundaries between wholes at both the level of the whole genera and that of the whole specieses within.

E. And some not-completely-obvious deductions are still verifiable. For example: if a species has neither blue regular polygons, nor both orange and green shapes then it has a red shape and exactly one sign with the same shape but a different colour.

A. That is actually a better characterisation of the different genera because it takes the form of universal and commensurate differentiæ of the specieses. The characterisation by colours which you first saw does not manage this because saying, e.g. 'this is the genus whose species all contain red signs' is not a definite *reason* why any particular species is in that genus. If the genera were defined that way an individual specimen would not include its genus within it; so it would not be possible to determine the genus from the specimen. The specieses must be defined in terms of their genera, not *vice versa*. But saying 'either this is a species with a blue regular polygon as a sign, or it is not. If not, then either it has both a green and an orange sign, or it doesn't, and if it doesn't then it has a red shape and exactly one sign with the same shape but a different colour' is a valid deduction, given these facts, so it makes the genera definite.

E. So the differentiæ in each case are a kind of boundary or division between the parts, and specieses are classes of things, not actual things?

A. Yes. A species—and a genus, because that is just a species of specieses—is something we know indirectly by deduction only, never directly by sense-perception.

E. But we perceive the specieses immediately in this diagram.

A. Yes, but only because I drew it like that. Nature does not present us with the specieses arranged this way in space, so we have to use deduction to infer their structure. What I am trying to show with this example is how we can co-opt the same faculty that perceives whole substances to perceive the validity of deductions. It is the same co-option of the same faculty of perception we use when we read a written word. Then we perceive at once the letters and the whole word.

E. However in these examples the whole is nothing more than the parts.

A. Well, in the case of words it's the parts *in their particular relation to each other*. For example the word 'cat' is not the same as the word 'act'.

E. The sense of this too seems to be captured by the notion of boundary.

A. You mean that in the word 'tab' there is a boundary between the 't' and the 'a' and another between the 'a' and the 'b'? And in the word 'bat' ...

E. Ah yes, I see. So we always need a convention of *which* is prior and posterior as well.

A. Or above and below or left and right, yes. And this holds for all definitions of actual substances in general. Just giving the divisions is not enough. We always need to know the *sense* as well as the meaning because in the category of substance it *always* the case that the whole is more than the collection of the parts that comprise it.

E. So in this way, by appropriating basic truths, it is possible to have a single explanation for the same phenomena in more than one science. If the basic truths of geometry could be appropriated into both formal logic and mechanics, say, then you could have a machine for for calculating formal deductions. This would be a correspondence between the circle, the balance and the lever, perhaps, and some structure in formal logic. The unifying science would be geometry which describes *both* the others. Then the machine would in a sense *be* logic.

A. Yes. You make it sound easy. There are subtleties, but broadly speaking this is what we did.

E. There's something in your explanation of left and right in *The Heaven* which I don't understand at all.

A. The point I make there is that the distinction between left and right is one that those we are calling *animal systems* can draw because they have that distinction as part of their whole being: the right side is the side from which locomotion begins.

E. But what an animal *knows* as one side or the other depends on what the others know it to be. In other words, if I were the only animal then I could not truly know which side of my body was left or right.

A. What we *call* left and right is a matter of convention and if there is no one else around then, by default, whatever we decide is according to convention. If there are only two animals then there is no knowing which side is which either, because if there is a disagreement, then there is just disagreement, they agree to differ in that they mean opposite sides by the same words and neither can know whether they have the right or the wrong sense. But when there are three then the symmetry is broken and the convention must be established as a matter of fact if the words are to have

any meaning. The only sense in which this sort of knowledge of *sense* can be said to be real is that in which it is knowledge *shared* between animals.

E. You mean that when there are three animals and they are trying to see that they understand the meaning of left and right, then either they will all agree, or two will agree and one will differ.

A. Yes, but the important thing to understand is that it must be something that they individually *sense*. The words left and right have no meaning without there being a corresponding distinction made actual in sense-perception. If the animals are all totally symmetric, then they cannot know what this means.

E. They couldn't refer to some external asymmetry. The direction the stars turn, for example?

A. No, that is subjective.

E. I don't understand that at all.

A. Well, if you swap an animal's eyes over, then that animal perceives left as right and *vice versa*, and it sees concave as convex and *vice versa*, and clockwise as anti-clockwise and *vice versa*.

E. You did advanced neurosurgery as well as dissection?

A. No, we had a machine that swaps animals' eyes over. It was made of bronze.

E. A mirror! Of course, a mirror swaps left and right, clockwise and anti-clockwise. But convex and concave?

A. This is what the mirror *actually* does. And the other more obvious effects are just consequences of that.

E. Let me try and figure this out. A mirror doesn't swap above and below, but it swaps left and right. Why *is* that?

A. Why don't you try it with a fish?

E. What!?

A. Think about what a fish would see in a mirror.

E. Well, if *I* were a fish looking in a mirror, I would see the same effect, wouldn't I? Ah, but I would have to look to one side, because I *can't* see forwards with both eyes. So I have my head pointing to what the man behind me calls the right, and the fish in the mirror also has his head pointing the same way. So the mirror doesn't swap left and right. It only *appears* to *me* to have done so because I'm symmetric in that direction. I *empathise* with the man in the mirror, but I don't empathise so naturally with the fish.

A. You were thinking of a mackerel. You will probably find you empathise more with sole and plaice.

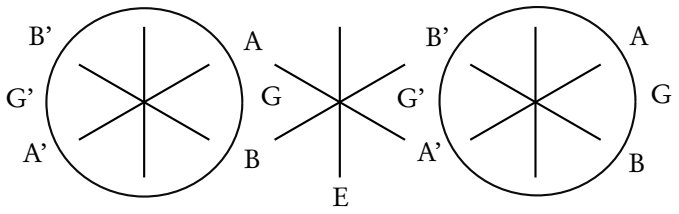
E. But for *them* the mirror swaps above and below!

A. It does that for us too.

E. Oh, wait. I don't see that at all.

A. You've established the mirror doesn't really swap left and right, any more than it swaps above and below. What then does it really do? Here, look at this diagram.

E. Oh no, not on the wall!



A. It's all right, it's just an image, no body minds. Now here the circle ΑΒΓ is your head, and the circle Α′Β′Γ′ is the head of your image, and Ε is the mirror. What has the mirror done?

E. It has turned my head inside-out!

A. That's all.

E. But I still don't understant then why I don't see above as below. The mirror swaps these too, doesn't it?

A. Yes it does, but you don't notice that because your eyes are *already* swapped over.

E. What!?

A. The veins from your left eye go to the right hemisphere of your brain, and those from the right eye go to the left.

E. But that's just accidental, it has nothing to do with physics.

A. It has everything to do with physics. It's why you see left-right symmetry but don't notice the symmetry of above and below.

E. There *is* no symmetry of above and below!

A. It's not just your head that the mirror turns inside-out, that would never work. Your head would be hollow, you would only be able to see what's inside, which is dark, and everyone else would only be able to see your brains. The mirror turns the Universe inside-out, so that everything that is *outside* your head ends up *inside*, but it's all back to front and upside-down. Now your eyes are swapped over, so it just seems to *you* that the mirror has swapped left and right.

E. What do you mean up-side-down? The image in the mirror *isn't* up-side-down.

A. It *is*, but it doesn't *appear* that way. We don't *see* images, what we call the images *are* the things we see and the images just *seem* to appear to us in peculiar ways, but that is not how it actually is. But the *actual* images *are* the images of the actual *things*. Don't worry, a lot of people seem to find this confusing at first.

E. You don't say!

A. No λεγο! I mean, I *do* say. But you will find things are even more confusing if you think it is otherwise than it is. If it's any consolation, you already understand it much better than Kant did.

E. You sat his window sill too?

A. I spent thirty years on that window sill trying to explain this to him, but he just couldn't get his modest little head around the idea. Eventually he died and I moved on. His mistake was thinking humility was his good.

E. Humility is not good?

A. It's *a* good, but not the good of *man*.

E. What is it the good of then?

A. Error, of course.

E. So *he* was right then? And he died humble and happy.

A. Yes, I suppose he did! However he was neither humble, nor happy, just in error, but he never realised it because of his lack of genuine humility. That's a rather pretty example of poetic justice, of the comedic rather than the tragic variety. But never you mind about Kant. Just carry on arguing from this basis now.

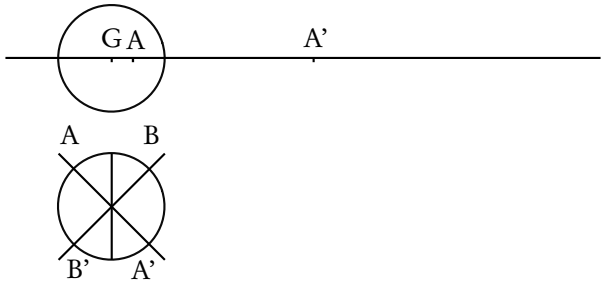
E. OK, so the mirror has turned the whole Universe inside-out, and my head is just a part of the whole universe. So everything that was outside *my* head, is now inside the head of my image, including the fish. But the fish is *not* inside-out, fortunately, so things aren't as messy as one might've expected.

A. Now what about the eyes of your image, are they the right way around?

E. My eyes were swapped over, so his are the right way round, yes.

A. Well, the two hemispheres of your brain will be where each of the two hemispheres of the Universe were before, but switched over. Your eyes are on the boundary between what's inside my head and what's outside, so yes, they are not swapped. Was that your reasoning?

E. No, I just guessed, actually. But I think what you're getting at is what in modern terms would be described as an inversion $(r,\theta,\phi)\mapsto(1/r,\theta,\phi)$ in the surface of the unit sphere, i.e. the head, followed by an inversion $(r,\theta,\phi)\mapsto(r,\pi+\theta,\pi+\phi)$ in the centre. The inversion in the surface doesn't change the orientation, but the inversion in the centre does. The inversion in the surface is the turning inside-out of the world, the inversion in the centre is the turning inside out of the surface.



A. Yes. Now when you look over the shoulder of your image, you see what *he sees* over *your shoulder*! This is because all the 'images' that he 'sees' inside his head are actually real things outside it. Isn't that amazing! Now of course *he* thinks just like *you* do, because he's just your image. So now you understand why it is that it appears to *you* that what *I* see is out there in the world. And that's how I can show you all these diagrams and things. In other words, it's a *proof* that 'I say what I mean' is the same as 'I mean what I say'. And this the basis for all true human understanding.

E. You mean we all understand each other because we're *actually* all inside each other's heads? That is a delightfully clever idea, but I'm afraid it just seems like magic to me. It's terribly, terribly clever; but it's just an *idea*, and it's actually all smoke and mirrors.

A. Absolutely not. It may not *seem* clear, but there's *no smoke*. Smoke obscures. This *is* one *kind* of magic though; it's what people think of as magic except with some of the darkness taken out. It's called *magic light* and that's just another word for *logic*,

which is *black light*. You could call it *white magic* if you like. Air is black, because it lets light pass through, and we Greeks are white because our skin is like that.

E. What?! Things only have colour when the light reflects from them. Air doesn't reflect light, it is *clear*.

A. All the light comes from the sun and the stars and it comes through the air and it is white, except when there's smoke and that makes it red.

E. If you say so. But after all this you *still* haven't explained why we don't see things upside down!

A. I have. The explanation is that when you think you see images, then you are confused. What you *call* images are *what* you see, you don't see the images themselves. What the images *themselves* are is actually abstract ideas: they are *parts of surfaces*, and which particular parts if the surface correspond to which objects depends on who is looking at what. The image you see in a mirror is a division of parts of the surface from other parts, and that division is affected by the passage of light through the mirror. This can only happen because the material of the mirror allows the light to pass into the matter of the substantive object where the image lies.

E. But then why are the books in the mirror written in mirror writing?

A. I *told* you, because your *eyes* are swapped over. Your image sees the books through swapped eyes, but you see what he sees through swapped eyes, so you *think* they're written in mirror writing. But if you *turn round* you'll see they aren't. In fact both you and your image see mirror writing upside-down, but it's the same for everyone, so we don't often speak about it. But philosophers *know* it to be actually the case.

E. I hope you don't mind me saying this, but you really are an *exasperating* little man.

A. I don't mind *you* saying that, no. You might be surprised at how *big* I actually am. But I understand your exasperation better than you think I do, and so I think you understand what I say better than you think you do.

E. I don't think I even understand *that*. There's more though! Then you say that the stars 'begin from the right and move round to the right', and I don't understand what the sense is here. If the motion begins from the right, they must move to the *left*, must they not?

A. Well you can see this for yourself. Stand up and a take a step forward.

E. OK. [Stands up and takes a step forward with his left foot leading.]

A. Now which way did you turn?

E. I didn't turn, I took a step *forward*.

A. You turned. I *saw* it. Do it again, and notice how your chest moves.

E. [Takes another step.] Ah, I see what you mean. As I moved my left foot forward I turned to the right to effect this. So the motion starts from the *right*, which is the leg that impels it, and it is effected by turning to the right. So when you say the stars turn to the right you mean they turn *clockwise*.

A. In the sense of rotation viewed from the *outside*, yes. But the heaven is only ever seen from within. So they turn *anti-clockwise* about the north pole.

E. And clockwise about the south, therefore the south pole is the uppermost. OK. But then you say something completely bizarre: you say 'they're up on the right, and we're down on the left'. How can there be a left and a right on a sphere?

A. There can't be a left and right *on* sphere, but there is one *in* a sphere provided it has both top/bottom and front/back asymmetries.

E. I don't see that at all, sorry. What is the front/back asymmetry of the Earth?

A. I'll give you a hint. It's a *very clear* distinction.

E. Oh, you mean it's Black and White, don't you? The front is black and the back is white. How did you know the people on the other side of the Earth from you were black?

A. Stories told by Chinese merchants, and it seemed probable since as you go further south in India, the people become darker-skinned. The Tamils are very dark. And it seemed *appropriate*. The Tamils had magic. *Never* upset a Tamil. The things thay can do with plants…

E. Make one's eyes water?

A. They can make each and every one of your known orifices, and few others you didn't even know about, all run a different colour at the same time, if they have a mind to. And you will probably feel a bit peculiar while this is happens.

E. Noted. And you thought that this was black magic, the opposite of logic?

A. No. It turns out it *is* just logic.

E. Where were we before we embarked on this little diversion?

A. The south pole is uppermost with respect to the heaven. But the *planets* counter-rotate to the heaven.

E. If one considers the Earth as being fixed, yes.

A. What do you mean '*if one considers* the Earth fixed'? The Earth *is* fixed. It is at the *centre* of motion of the Heaven, this is immediately evident. However I would be the last to deny the possibility that things may in fact be other than as they appear, so do please go ahead and explain to me *why* the Earth is *not* at the center.

E. Principally because we find we can put artificial satellites into orbit about Earth and though we can do this in any direction we please, we find we need far less fuel to put them into orbit in the direction the Earth turns.

A. You mean there are artificial *moons*?

E. Thousands.

A. Now that's interesting!

E. You know all about quantum mechanics but nothing about space-flight?

A. I had *heard* about it, but to tell you truth I didn't *believe* it!

E. I am flattered that you believe *me*.

A. As it happens I can't *help* but believe you.

E. Oh dear. That puts a great deal of responsibility on my shoulders.

A. No more than you usually bear. Now tell me, how long do these artificial satellites stay aloft?

E. It depends on the orbit. High orbits such as the geo-stationary ones hardly decay at all, but so-called Low Earth Orbits can decay in a matter of decades.

A. Then they 'shoot'?

E. Yes.

A. That must be exciting.

E. It is, especially if they contain nuclear reactors.

A. And you say that it takes much less fuel to launch a satellite into an orbit that is counter to that of the heaven?

E. Yes.

A. And the amount of fuel required is proportional to the work, but work is force times distance moved, so if the force is the same, then the distance moved must be greater in proportion to the extra fuel used?

E. Exactly.

A. And when its orbit decays and the satellite shoots, it presumably shoots much more spectacularly when it is in orbit with the heaven, rather than counter to it?

E. Yes.

A. We presumably agree that it is more spectacular because it is going faster, and you think this is because while it is in orbit it is going faster?

E. Many would claim to *know* this to be the case.

A. Well, we are all entitled to claim to know what we believe to be the case, and *I* believe that in fact the reason it is more spectacular is that it *weighs more*, and this is why it goes faster.

E. But the thing's mass is intrinsic to it, how can that change?

A. I didn't say the *mass* changed, I said that the thing *weighs* more. And weight is a force and not intrinsic to the substance.

E. Ah, so *this* is the reason why you say that heavier things fall faster than light things: you are combining the notions of speed and momentum?

A. I'm not combining notions, I am refraining from making a division which is not sensible.

E. It *seems* sensible enough. But you mean it is *literally* not sensible, don't you?

A. Yes. If you consider how it is we can *know* the weight of something, then it is always by comparison with another weight.

E. Even if we use a spring-balance?

A. Then we are not measuring the weight, we are measuring the force that the object exerts *at rest* and *under constraint*. We can't measure the weight of a moving object using a spring balance.

E. And if you move the spring-balance up and down as you are weighing the object the weight fluctuates because it's the inertial mass and the gravitational mass that are being weighed in different proportion depending on the movements.

A. I have no idea *what* you're talking about now. Let's take this a bit more slowly. Please tell me first what is a *gravitational mass*?

E. Did you know Newton?

A. Yes, I spent many very happy evenings sitting on the window sill of his third floor room in Trinity College.

E. Wasn't that a bit dangerous?

A. Not especially so.

E. He presumably never mentioned gravitational fields then.

A. Never. I presume they are the purported cause of the gravitational mass?

E. Yes.

A. It was clear to us that there could be no cause that acts at a distance as his law of gravitation assumes, and he was quite forthright about it himself.

E. Well, in the popular mind, Newton's law of gravity is supposed now to be caused by a gravitational field.

A. It's a vector field and it has units of acceleration, i.e. LT^{-2}.

E. Yes.

A. But in Newton's law the acceleration depends on the masses doesn't it? So this field doesn't exist in any sense: the force F acting at a certain point $\mathbf{r}$ must vary according to the mass of whatever object appears there, because it's the acceleration that's determined and $F = ma$.

E. But if the masses involved are all known, then the field is known at any instant when all the positions and velocities are determined, and if it is considered that gravitation is the only cause of their subsequent movements, then what is the difficulty?

A. That this is exactly the problem we found with the exploding boiled egg theory of the origin of the Universe. If everything that happens, happens only of *necessity* then nothing is possible.

E. Because what is possible is what is not necessarily impossible, and if something is possible then its contradictory is also possible and so the thing itself cannot be necessary. Thus there is no potential because potential is just that which is possible but not actual.

A. Exactly.

E. So we can solve the field equations, but only on the condition that everything that happens is inherent in the boundary conditions.

A. And thus we have the problem with the exploding boiled egg theory: initial conditions which result in a universe far from equilibrium seem implausibly improbable.

E. But this is the only way that an increase in complexity can come about spontaneously. For example, we can explain why a pot cools down when it's taken off the stove: it's because the heat flows spontaneously from hot to cold, and never spontaneously flows the other way. We can therefore only explain the spontaneous creation of structure in the world by reference to such a spontaneous process. So meaning and what have you is only something that can exist in these 'far from equilibrium' conditions where energy is flowing from a lower entropy 'source' to a higher entropy 'sink'.

A. This is a clear contradiction though. You cannot claim your theory explains an increase in complexity as being spontaneously produced in an energy flux from low to high entropy if your theory cannot discriminate between these two. Either you have a theory which allows random indefinite events, or it does not allow for anything spontaneous to happen at all, because everything must be a necessary consequence of the equations of motion. The choice is that simple. But you cannot pick and choose at will, depending on which suits what you are trying to explain, because that just means *you don't know*. The problem is the notion of *work*. One intuitively senses that the quality of the work of even a rather poor mason ought to be better than that work done as a house spontaneously collapses. But in Newton's mechanics it's considered the same.

E. This physics cannot distinguish between the two directions of time: towards the future or 'towards' the past. The equations are perfectly symmetric.

A. So it considers that the plans of the house are recorded in the pile of stones after it fell down?

E. Yes, I suppose so, if only we knew the right way to decode it.

A. But that's impossible: there is no *meaning* to be found in a random pile of stones because their positions are due to events that were entirely a matter of chance. For example, that the wind was blowing in a particular direction at a particular time as it fell down. All of this is just not known. The idea of decoding it is preposterous. It would be exactly like trying to foretell the future from the tea-leaves in the bottom of your cup on the basis that they will certainly affect the future somehow. But many other unknown things will affect the future too. Likewise, the past form of the house did indeed affect the shape of the pile of the stones, but so did a great many other facts that we do not consider part of the house because they are *accidental*.

E. So meaning is not something that physics could *ever* explain. The formalisms cannot distinguish between what is a random pile of bricks and what is in fact art.

A. But physics has no *business* explaining meaning. Physics has to *presume* it, as any science must, because when we demonstrate we have to presume certain things as self-evident, and this presumes meaning because if we don't know that then we can't know what the theory is about: it becomes completely abstract mathematics.

E. But Newton's theory, in so far as it is about anything, is mathematically, i.e. *logically* correct. Nothing that *happened* to fit the types of phenomena that it purports to be about could possibly happen in any other way than the theory describes. If it did so, then it would *have* to be because it was *not* in fact a phenomenon of that type. So Newton's theory is not empirical, it's a tautology!

A. If by *tautology* you mean it's not falsifiable, then I agree. Geometrically it is easy to see: the objects in any system orbit the centre of mass. The centre of mass is *defined* to be the average of the displacement vectors weighted in proportion to the masses. So of course they orbit the centre of mass. Then logic determines the necessary relation that the motion has with respect to the velocity and the positions of the objects. It *has to be* an inverse square law. The only things not determined are the units and the arbitrary constants of integration.

E. So in fact the centre of mass of the Solar System is *not* a 'perfectly well-defined point' at all.

A. No, because it moves whenever any animal moves. Every time you take a step, the centre of mass of the Solar System moves, so according to Newton's law, all the planets change their directions of movement in the same instant. So unless all animal movement is entirely the necessary consequence of purely gravitational interactions between bodies then Newton's law does not in fact hold. But Newton knew this himself.

E. Poor old Bertrand Russell, perhaps he really *did* need a holiday.

A. Who?

E. Never *you* mind. Did you know Lagrange?

A. Yes, very well, until he moved to Paris, then we lost touch somehow, I don't know what happened. That was such a beautiful geometric theory though! It *shows* that Newton's equations of motion arise immediately from the *constraints*. It didn't take us very long at all, and every step was a delight.

E. Is this how you earn your keep then, sitting on window sills helping people even out their thoughts?

A. Well, window sills, gates, fences. Any boundary is good.

E. So Newton's law is the *formal cause* of the gravitational field?

A. No. There's no cause of things that can't possibly exist.

E. Constrained motion exists though.

A. Yes, and Lagrange's mechanics describes it beautifully.

E. What about gravity though?

A. All this gravity is rather heavy-going. How about some *levity*?

E. By all means.

A. That balloon is neither rising nor falling, is it?

E. Where did *that* come from?

A. Never you mind. What do you notice about it?

E. It's a helium balloon and its hovering in mid-air. It *would* ascend, but it has the same weight as the air it displaces because you've apparently weighed it down with a blob of some amorphous substance.

A. That's sounds very *sophistical*. Do you mind explaining what you mean to a simple-minded old philosopher?

E. It's neutrally buoyant with respect to the air in the room.

A. It must be *ceiling* wax. And the ballon does not have helium inside, it has fire, otherwise it would't have levity with respect to air. By *removing* some ceiling wax, I un-weighed it *up*, and now it doesn't weigh anything at all.

E. I think most people would say it has more weight than it had before, irrespective of the type of wax used.

A. Most people are wrong about most things. When I came across it, it was on the floor.

E. Resting?

A. Yes, it was at rest on the floor. Then I removed some of the ceiling wax and it rose up and now it's resting nearer the ceiling.

E. Ah I see, so it waxed ceiling-wards.

A. Yes, as the ceiling wax *waned*. Do you agree that there are no forces acting on the thing?

E. I agree there is no *net* force on it. But there are two *components* to the vertical force and we can *resolve* them into the *gravitational* force and that due to the *buoyancy*. The gravitational force acts in the downward direction and the buoyancy in the upward. In this case they happen to balance out, so the net force is zero, but the balloon still has weight: it just happens to be equal to the weight of the air it displaces.

A. What is it exactly that you resolve into two components?

E. The vertical force.

A. But there *isn't* a vertical force. I sit here on the window sill and the net force on me is to nought. I can resolve it any way I please then. So I will say I actually have the weight of an elephant, but the air I displace is of a density such that it has less than the weight of an elephant, and this is proved by the fact that I don't levitate.

E. But if you sat on one side of the scales and an elephant on the other then you would find that the elephant in fact weighed much more than you do.

A. Quite possibly, but since my weight depends upon the mass of the air I displace, it changes as the barometric pressure changes. But how do we define the air I displace? Where is that air? We need to know, because my weight depends upon exactly what its mass is. But is the air I displace the air that was on this set of scales a week earlier or is the air that *would* be here tomorrow? These are all possibly different masses.

But my weight is *defined* in terms of them. It *can't* be the air that's on the scales *now* because *I'm* on the scales, and I displaced it! So the scale will *not* tell me *anything* about my weight *now*, will it?

E. Strictly speaking, no, but if we *assume* that it does not vary appreciably due to these accidental efects, then the theory *seems* to work well enough.

A. Why do you say they're accidental. They're *essential* to the definition of what is my weight, aren't they? And in what sense does the theory seem to work?

E. We could use it to calculate the load on the window sill and predict whether it will support you or not.

A. This argument is based on a notion of meaning, albeit one that has no sense to it at all. When you say we resolve the vertical components of no force at all into one which is my weight and the other which the equal and opposite force exerted by the window sill, you are referring to things which don't exist. When you balance one mass against another on a scale then you only know the weight because of the *potential* movement of the balance. If the balance cannot move both ways then the scale is useless. But when you balance these forces, then you are referring to something real, which is the potential. What is in the balance is equal and opposite potential, which is the true object of your knowledge. The deterministic theory of definite potentials doesn't tell you anything.

E. But the deterministic theory is *actually useful*. We can also use the theory to compute the orbits of the planets to quite impressive precision. We could tell you, to within an accuracy of a few hours, the times of the lunar eclipses that could have been seen from Athens in 350 BCE.

A. That surprises me greatly because what you call the year 350 BCE is not determinate to within even a decade.

E. But you know what I *mean*.

A. No, I really don't know what you mean.

E. I mean the year that was 2,361 years before this year!

A. That's what you *say*, but *I* still don't know what year you *mean*. Do you mean the year we wrote the Athenian constitution? Or the year before?

E. I don't know when you wrote the Athenian constitution, because you didn't date it!

A. Had we dated it, we would not have written 350 ΒΓΕ, I assure you. We didn't need to date it though because we *knew* what year it was written.

E. Then I know what year *I* mean when I say 350 BCE.

A. Do you? All you seem to be able say about is that it is the year 350 BCE. To know who Bill is, surely you need to know something else besides that he's called *Bill*. This is the case with all *data*, knowledge of data is actual *empirical fact*. So knowledge of the weight of something is to feel its force, and knowledge of an interval of time is to know what events ocurred within it.

E. What if I could tell you the exact days of that year on which lunar eclipses were observed?

A. That would be interesting, if it was a year in which we had those records. But a year is just a pair of boundaries that divide the events within from those without. Even if we had the records of eclipses for that particular year, we could only gauge the

equinoxes to within a week or thereabouts on either side, so it would not necessarily be certain that we were referring to the same year.

E. But given enough data points we could agree that we were probably referring to the same year.

A. And in the case of the weight of an elephant we can fairly easily come to an agreement that it is probably significantly greater than that of a philosopher, provided neither jumps about very much on the scales.

E. Provided the *elephant* doesn't jump about. It's unlikely the philosopher will be able to move the elephant just by jumping up and down.

A. Well, it depends how big his head is, I suppose. But some philosophers do have *very* big heads.

E. But you are saying that in the end we don't have any definite, absolute measurements.

A. I don't know about the *end*. But all knowledge of the natural world *begins* with empirical knowledge, and yes, when dealing with actual substance that knowledge is *never* definite.

E. And yet we are still justified in believing in definite Truth?

A. Yes. It's based on *rhetoric*.

E. I beg your pardon?!

A. Rhetoric. You know; dialectical argument—enthememe based on premises which are *examples* rather than truths.

E. But rhetoric is an *art*.

A. Indeed it is. It is the art of persuasion. Indefinite empirical facts are things we are persuaded are true because they are *probabilities*.

E. I.e. 'what men know to happen or not to happen, to be or not to be, for the most part thus and thus.'

A. I couldn't have put it better myself.

E. Apparently not.

A. [Frowning] As I was saying, indefinite knowledge consists in probabilities, which are those things of which we have persuasive arguments.

E. So because a probability is 'what we know to happen for the most part', i.e. a probability is the contrary of an improbability, all we need for a persuasive argument is things that we know happen slightly more often than they don't happen. And we can reason from *this* basis?

A. Yes. For example I know that philosophers are slightly more likely to fall off window sills on the side on which they hang their legs, so I always sit facing inwards, if I'm not on the ground floor.

E. But we can use *ratio* as a measure of probability and then we learn more.

A. Give me an example.

E. Well, if I know that the chances of throwing a six are 1:6 then I can calculate the chances of throwing three sixes with three throws are 1:216.

A. What does that tell you about the world? If you subsequently threw either three sixes or only two sixes, would you say in either case 'I knew that was going to happen!'?

E. No, because each of the possible outcomes of three consecutive throws are equally likely. But surely it tells me something about what the *expectation* is of my average score in the long run.

A. You mean that if you were to throw three dice at once, a thousand times, you would expect to throw 4.63 triple-sixes?

E. No, I would expect five.

A. Then you would be surprised if you only got four?

E. Not *very* surprised, no.

A. Think about what it *means* to say 'throw three sixes in three throws' and 'throw two sixes in three throws'. What do you *know* about *what is going to happen* when you throw the die once, then again, then again?

E. I know nothing at all about that, except that if the die lands with just one face up, it will be one of 1–6.

A. The knowledge that throwing three sixes is less probable than scoring a 1, a 2 and a 3 in some order is due to what?

E. Nothing more than what it *means* to say 'throw three sixes' and 'throw a 1, a 2 and a 3 in some order'. In other words, it is only because I know that three sixes can only be thrown one way, but the other can be thrown six ways. I see an expectation is just another distribution and it is indefinite if the original distribution is.

A. We know nothing about chance events. They are always as likely as they are not. A probability is what men know to be for the most part thus and thus. So throwing three different numbers with three throws is a probability, because we know it happens 35 times out of 36 when the outcome is a chance .

E. What we *know* doesn't *tell* us *anything* about the world, does it?

A. No, it's just what *it appears* to have told *us*.

E. So this is an art, not a science.

A. Strictly speaking it's a *faculty*.

E. Then what is natural *science*?

A. Demonstrated truth concerning natural phenomena.

E. So we can demonstrate on the basis of probability?

A. No. We only use probabilities as constraints on the possible alternatives we consider when we choose what are the appropriate basic truths for the science in question.

E. So we consider only the probabilities and disregard the improbabilities?

A. Yes.

E. That's just like *guessing* on which side of the window sill the philosopher will fall off next. It doesn't seem very reliable because there's only one *bit* per premiss.

A. On what basis do you say one bit? If it was one bit per premiss then the event would be as likely as not, but that is not a probability. The knowledge is not in the information, it's in the *meaning*. A probability is just which of two contradictory facts is most likely to be the true one.

E. So if we find that our theory deduces improbable consequences from probable conclusions . . .

A. Then we are probably in error.

E. But formally, that is the same as deducing a *false* consequence from *true* premisses.

A. In so-called *assertoric* logic, yes. But probable *possibilities* are not formally equivalent to anything in assertoric logic.

E. I think I *do* need to get some sleep now.

A. You look very tired.

E. I am. Let me just start this pendulum going before I go to sleep.

A. What's that for?

E. I like to know the world's still going round while I sleep.

A. Ah yes, what they call *Foucault's pendulum*.

E. You know about it?

A. Yes, we had one in the gymnasium at the Lyceum.

E. Well *that* will surprise some people. But they'll never believe me. Why didn't you write about it, it's a fascinating experiment?

A. Some things are sacred. It's not an *experiment*, it is one of our basic data. It is the intuitively observable *fact* that motion originates in the heaven.

E. We'd better talk about this in the morning! Will you be OK here on the window sill? You won't fall off?

A. Yes, I'll be fine. Goodnight.

E. Goodnight.

1 Scene II

[The next morning. Elaisson's room.]

A. Good morning. Did you sleep well.

E. Soundly, yes. But I had the most curious dream. And you?

A. I don't sleep. I watched the pendulum.

E. It hasn't turned!

A. Odd, isn't it?

E. You fiddled with it, didn't you.

A. Far be it from *me* to interfere with anything divine!

E. I don't know. Your name Ἀριστοτέλης…

A. Yes, from ἄριστος meaning *perfect* or something like that. Not an uncommon name for a Greek man. Parents hoping for the best, as they do. It doesn't mean divine or anything like that, it just means *the best*.

E. I am very impressed with the technology that you had in 350 BCE. These pendula, and apparently you could propel missiles so fast that they melted. How did you do that?

A. We used a military catapult.

E. And it could propel a ball of lead so fast it melted?

A. We reckoned it *could* melt a *small* lead ball. But they wouldn't let us try that because if you propel only a small weight the arm moves so quickly that the machine destroys itself. We made a hole in a missile and plugged it with wax and it melted. We know that it didn't just fall out because a wad of linen absorbed the melted wax.

E. Ingenious. And you built pendulums that could run for hours, yet you didn't think of using them for timing?

A. They are not that useful for timing.

E. They seem to work in clocks.

A. The clock is a complicated machine for counting the swings of the pendulum. We had such machines, but they were very expensive. If you don't have that machine then the pulse of a pendulum is not very useful because you have to count the pulses. It was much better for us to use water clocks.

E. But your water clocks drained faster at the beginning than at the end.

A. They drained twice as fast at the beginning as they did when they were half empty.

E. Of course, double the weight so double the speed.

A. As with the bob of a pendulum. A water clock measured a unit of time, and the unit could be adjusted to be longer or shorter according to the particular application. All we need to measure time is a means to determine the relative lengths of intervals. We were not as interested in chopping time as you seem to be. Why is that?

E. We are so good at it we can measure the speed of light.

A. We *knew* there was no point in trying to do that.

E. By measuring the relative speed of light in orthogonal directions Michaelson and Morley, it is said, *demonstrated* that there is no such thing as a *luminiferous ether*.

A. They measured the speed of light in a vacuum?

E. I believe so.

A. What is a vacuum, really?

E. Nothing, ideally.

A. So these fellows, by failing to find evidence of the ether in an apparently empty container, demonstrated that there is no such thing? Using exactly that experimental arrangement I think I could demonstrate that elephants don't exist either. Would that be interesting?

E. Well, the light travelled *through* the container. And the ether was presumed to be the medium through which light is transmitted as a mechanically propagated disturbance.

A. So what they demonstrated was that when nothing obstructs it, then light can travel through space. This is something I just had to assume because I could not see how to demonstrate that a space was in fact empty. It is not something that can be evident unless emptiness is nominally just an absence of evidence.

E. Parmenides' principle again?

A. The godess Night's, actually.

E. But assuming light is a wave, it must be propagated mechanically, so it must be a disturbance in *some* real substrate. What they proved was that substrate was not any kind of matter.

A. If not matter than what was it?

E. The consensus is that it is pure energy.

A. Pure energy moving through empty space, without any material medium?

E. Exactly. And the claim is that the experiment demonstratated that light can in fact travel through empty space like this, without supposing any material substrate of any kind, even a very strange absolutely motionless ether which pervades all space, whether apparently empty or not.

A. The assumption was that this ether, if it existed, would be stationary, and the earth would be moving through it?

E. It was assumed there would inevitably be a drift at some time, because the earth is moving through space as it orbits the Sun, and it is also turning on its axis as it does this.

A. With respect to the 'fixed stars', I presume?

E. Yes. And the purpose of the experiment was to detect the effects of the movement of the earth through this medium.

A. Did they not consider that in fact the ether may be an emanation from the earth itself, or from some kinds of animals, and that it would therefore be stationary around the whole surface of the earth?

E. Wow! Now that idea really is way out there. Even if they thought it, I don't think anyone would have dared to mention it for fear of losing their funding.

A. That's the problem with having to rely on sources of funding that are conditional in some way. It limits the possible areas of research in a way that may in fact prevent the truth from being discovered.

E. It puts a limit on the whackiness too. Many would claim this to be a beneficial effect.

A. Well, just because something *sounds* whacky, it isn't *necessarily* false. Apparently whacky theories based on sensible reasoning are to be preferred to only apparently sensible theories based on funky logic. But go on, tell me how the experiment worked.

E. As I recall, the apparatus consisted of two perpendicular arms, each involving a round-trip of some two meters or thereabouts. The two beams were combined in an *interferometer* and then any difference in effective path length would have shown up as a change in interference pattern. There were no observed changes as the experiment turned.

A. How did it turn? On some sort of turntable?

E. No, that would have been far too 'noisy' and would have given false results as the apparatus vibrated. They just used the fact that the earth turns through a full circle every 24 hours. The experiment would have been immovably fixed to a heavy concrete base.

A. And they did this on top of a mountain somewhere?

E. No, in a basement I think.

A. Let me summarise this: Michaelson and Morley looked for evidence of the earth's motion through the ether. They only looked in a box of nothing, in a basement. And, on the assumption that the contents of the box of nothing was in fact anisotropic with respect to the passage of light, they didn't find any evidence, so there is no ether?

E. Well, you are entitled to have your fun, because they are certainly going to have fun when they hear that you *still* insist the earth doesn't move or turn, despite all this evidence I have put before you.

A. Michaelson and Morley are still alive then?

E. Well, not *them*, but other physicists.

A. I should say that the artifice displayed by experimental physicists is truly astonishing, and far, far better than anything I could have imagined. Likewise the *mathematical* skill of theoretical physicists surpasses all reasonable expectations. But the logic is just *abysmal*.

E. We are much better at chopping things than we are putting them back together, I agree.

A. This *interference* is something we need to look into. How does that work, tell me?

E. Light is a wave, and waves interfere constructively and destructively. Constructive interference is when the peaks of two waves coincide and the height is the sum of the two amplitudes, and destructive interference is when the peak of one coincides with the trough of the other, then the height is the difference of the two amplitudes.

A. As these waves move though, they typically change their relation one with the other, as they pass through a region.

E. Yes, so it's easier to think about monochromatic light, then the relationship is fixed.

A. You call light *monochromatic*?

E. Yes. Really it amounts to just using the names of colours to identify parts of the spectrum of pure frequencies. We know that as a *psychological phenomenon* colour is not a property of light *per se*, because the same light can appear to have different colours depending on its juxtaposition with another colour. But in physics we abstract away this accidental property of human perception, and we quantify the colour precisely using the *wavelength*. So monochromatic light of a wavelength of around $1/1,650,000$ of a metre is a reddish-orange colour.

A. So it's merely a figure of speech, that's fine. Now you say that light is a wave of energy propagating through empty space. So it follows that these interference effects must only occur on the surfaces where the lite shines.

E. Why is that?

A. Because if we imagine two light sources A and B then at a certain point C on a screen where these two sources meet, there will be these waves of energy arriving from A and B. They will always have the same phase relationship, being from monochromatic sources at fixed distances from C. If they are exactly two right-angles out of phase, then the amount of energy arriving at C is constant in time. As the amount from one source increases, the amount from the other reduces, until one is at a maximum and the other a minimum, then the cycle returns. So there is no change in energy arriving in time. But when they are in phase, at a point D, say, then the energy is changing as rapidly as it possible. So there is more disturbance there. And this is obviously why the interference bands show. When the waves are in phase there is a violent pulsating of heat, and where they are exactly opposite phase there is no pulsation there, so no heat.

E. Err, that's *interesting*, but it's not how it's *supposed* to work.

A. No? How is it supposed to work then?

E. Well, the waves cancel out and no energy arrives at the dark parts of the fringes at all, and all the energy that would have to gone to those parts goes to the bright parts instead.

A. Well that is quite something to suppose! Why exactly do we suppose this then?

E. Because there is no energy at all arriving at the dark parts of the screen.

A. How do you know?

E. We can *see*.

A. What can you see?

E. That there's no light!

A. So you see nothing. What does nothing look like?

E. It doesn't look like anything.

A. Surely you see the screen, and it's black?

E. Well, yes, but that's just scattered light.

A. And it's not black light?

E. There's no such thing as black light! Black is just the absence of light!

A. When light passes through empty space, what colour is it.

E. It's whatever colour it is.

A. Alright, so when red-orange light passes through empty space what colour is it?

E. Red-orange, of course.

A. What if it were to be viewed from a rapidly receeding space-craft?

E. It would be more red.

A. But you just said that it's whatever colour it is? Which is that then, red or red-orange?

E. OK, it's not whatever colour it is.

A. If it could be various colours depending on how we look at it. Then how do you know it's not black when we look at it in a certain way? Say because we are mixing it with a light that is pulsing the wrong way?

E. What do you mean the wrong way?

A. The other way to the right way of course. Diametrically opposed.

E. But we find there's more energy in the bright fringes, than in the dark, and it's exactly in proportion in the sense that what should be in the dark fringes has turned up in the bright fringes. How can you explain that?

A. If you turn off one light source, A say, then you get exactly the even distribution of so-called energy. So it is obvious that it is arriving, but not having the expected effect because of being mixed with the light from B. Double the so-called energy arrives in the bright fringes because there are then two light sources and they have double the effect there where they are not in opposition.

E. Of course this explains *all* the features we observe about light because it's just QED in a different interpretation.

A. The interpretation that you offer of light being waves of energy travelling through empty space is not so convenient though, because of all the well known problems. It seems to involve negative and positive energy because otherwise the opposed waves cannot cancel out.

E. You have light travelling at infinite velocity. That's instantaneous action at a distance. It's not an explanation of anything.

A. No it's not action at a distance. In my theory light is not a substance it's an element. It's Fire. Only a substantive can act, and it always acts on some other substantive.

E. We don't see light itself then, we see colours or brightness, or something of that kind, but this is what *mean* when we say we see light.

A. I have no idea what you mean, sorry. You tell me now that you can see colours too? What do they look like?

E. We are trying to do *physics* here, not *philosophy*!

A. Do you do all your physics experiments in total darkness then?

E. No of course not!

A. *Could* you do them all in total darkness, in principle?

E. No, of course not. Most of them involve light.

A. Then if you don't want to do philosophy, you have to *assume* what is light, and base your science on that assumption. Because you cannot investigate the nature of light in physics, unless you restrict physical experiments to ones that do not involve light in any essential way.

E. Who says this?

A. I do.

E. What authority do you have over physicists?

A. Apparently I don't have any authority over them at all. And this is *not* to their advantage!

E. Then how can you tell them what they can and can't investigate?

A. They can investigate what they like, but if they want to investigate the nature of light they have to do philosophy, they can't do physics.

E. OK, so we have come full circle. *Why* do you say that?

A. Because you can't demonstrate knowledge of the nature of *anything* if you assume something about its nature in a premiss of that demonstration. If you try, you will end up with nonsense in very short order. Nonsense of the kind that we have repeatedly been running into. These things aren't profound mysteries, they are just the result of extreme incompetence. This is puerile, lazy reasoning. The idea that after two thousand four hundred years we have arrived at this paltry level of thought beggars belief. This is where we were with Heraclitus and Democritus. Your progress is not even *retarded*, it is not even progress, you have *regressed*! Humanity now knows *less* than we did in 390 BCE. Well done Johnny! But could try just a *tiny* bit harder, perhaps? Have a lovely holiday, and I look forward to seeing you next term. (And please would Johnny's mother explain to him that he's NOT *quite* the sharpest tool in the box just yet, and that if he continues to go around telling all the girls he is, and that they're stupid because they don't understand his nonsense then he'll never be able keep a girlfriend).

E. I see why you're angry. But this is actually *de rigeur* for physics now. It's not just women that think physics doesn't make sense, it's most people who think logically. *No* logician I know claims to understand physics. In physics it's considered *bold* to take a result from one set of assumptions and investigate it in another circumstance not consonant with those premisses. For example, one typically learns that the twin-paradox of special relativity is not a paradox because one twin undergoes acceleration. But there is no theory of special relativity in accelerated reference frames because intertial reference frames are one of the postulates. Nevertheless, it is considered to be a valid explanation why one twin experiences a longer interval of time than the other does.

A. I assumed that light could not be due to any kind of mechanical disturbance because it was so rapid; it seemed obvious to me that there would be no *question* of seeing it in motion. How did they manage to arrive the conclusion it's velocity is finite?

E. One doesn't need to see it in motion to judge its speed, one can infer the speed from knowing the distance it travels and how long it takes to travel that distance.

A. Have you ever watched a duck moving in a straight line on the water, parallel to the edge?

E. Yes, if the duck is going faster than the speed of waves in that water then the leading-edge of the duck's wake travels along the bank at the same speed as the duck travels along the river.

A. From which one might be tempted to infer that the speed of the disturbance through the water moves at the speed of the duck, because the disturbance moves along the bank at the same speed as the duck moves along.

E. But that is an error because in fact the disturbance at the bank is delayed by precisely the time it takes the wave to propagate naturally through the water from the duck to the bank.

A. Now if something travelled infinitely fast, we could never see it, we would just see mysterious *non-local correlations* between separate locations in space. Two points A and B on a line parallel to the path would be instantly correlated, but there would be no way *we* could tell that this was due to the wake of something travelling at infinite speed. But if there were someone else on the other side and further away from the line of travel, he would see similar instantaneously correlated effects, but somewhat later, depending on the speed with which the wake propagates through the medium.

E. And the effects would be perfectly correlated so the two of them could easily be convinced that this was due to a disturbance propagating at a certain finite speed *from* one *to* the other, albeit one which arose spontaneously at the origin.

A. When in fact it is nothing of the sort. So we need to be sure that nothing like this is going on when the speed of light is being measured.

E. It's very hard to imagine what it *could* be in reality.

A. But the fact that *we* can't think what the cause could be doesn't prove anything. As the godess said, we can never demonstrate that something which is not is. So if our demonstration of anything were based on the absence of a cause of a certain type then it is not scientific, because we could never have any empirical basis for this premiss: our theory would be founded on mere hypothesis. The characteristic of scientific knowledge is that it is based on premisses which are immediately observable.

E. This sounds *backwards* though. We can never demonstrate that we have true knowledge, all we can demonstrate is that some particular knowledge is *not* true knowledge, and we do that by *falsifying* it with an empirical observation.

A. What you say is perfectly correct. What I say is that we cannot base a demonstration on the absence of *knowledge*. The fact that we don't know how something could be brought about does not make it impossible. It is only impossible if it is *necessary* that it doesn't happen.

E. Ah, so when we demonstrate something *per impossible* we demonstrate that *in principle* we could *never* know a cause for it, because such so-called 'knowledge' would contradict basic premisses known intuitively to be true.

A. Yes. Otherwise that cause could be the actual cause and an actual contradiction of our theory, but unknown to us. So the theory would appear to us to stand, but one of its legs would be our own ignorance.

E. This is how solipsistic idealism seems to hold itself up.

A. Yes, the empirical foundation is the one point of fact that the subject cannot conceive how it could be otherwise than that he imagines all that he sees around him.

E. And so-called naive materialism is the *dual* of this, because it takes the physical world to be the only real thing, and the mind to be an *epiphenomenon*, completely determined by the physical events. Then what appears to be thought is in fact just the whole universe.

A. In both cases the failure is the inability to see that knowledge could be *real*: that the logical reasons why a thing must be so, are potentially the *actual* reasons why it is so. In other words, the *logical argument* is one and the same with the *abstract mechanism* in the world which makes it so.

E. But this sounds like it is confusing what is in the mind with what is out there in the world. Our subjective knowledge with reality.

A. Confusion is when what is in the mind is other than what is out there in the world. When we think clearly, what is in the mind is one with what is in the world. When we experience a difference between what is in the mind and what is in the world then we are confused.

E. Very Zen.

A. That's a Greek word, you know. But to get back to this question of the measurement of the finite velocity of light: presumably this is done by measuring the delay in two beams of light, one making a round trip and the other not?

E. Yes. We time the interval between the arrival times of the two beams. We can do this so accurately that we prefer to use a clock to measure the speed of light than to use any sort of unit to measure length.

A. Then you are not measuring the speed of light, you're measuring *length*.

E. Technically, yes, because the so-called *realisation* of the SI unit of *metre* is just the distance light travels in a vacuum in $1/299,792,458$ of a second.

A. And there are sixty seconds in a minute, and 60 minutes in an hour, and 24 hours in a day, so there are $84,600$ seconds in a day.

E. There *used* to be that many, but . . . You're not going to like this.

A. The day is not constant?

E. No, the rotation of the Earth is slowing down.

A. The Earth *doesn't* rotate, the *heaven* does, and I can assure you it is not slowing down. But go on, explain how we 'know' that the rotation of the earth is slowing down. I'm intrigued.

E. Because we have these superb atomic clocks that can measure tiny fractions of a second.

A. And you're convinced they are not speeding up?

E. Yes. Because there's no *reason* why they would. But there is *every reason* to think that earth is slowing down.

A. There is *no* reason to think that something that is at rest is slowing down, because it is *impossible* that something at rest could slow down. But the fact the we don't know any reason why the atomic clocks are not slowing down is not something we can use as a premiss in a demonstration because it is not an observation. It is not an observation because it is not a positive affection of anything, so there is no definite course of action I could take which could potentially refute this premiss. It is no

good to claim 'you could find a reason why the atomic clocks are not slowing down' because in the absence of any such kowledge that action is completely indefinite. But go on, explain why you think there's every reason the orbits of the sun and moon are slowing down.

E. Because of friction due to tidal forces.

A. So you mean that all the 'work' being done hauling the tides in and out is tiring the earth? When you get tired, you slow down, but do you also breathe slower?

E. No I breathe faster if anything, but this is the tides, not breathing!

A. It's the water being pulled by the non-existent gravitational field of the sun and the moon, you'll say. But we have ascertained that we don't know from where the energy comes for this constrained motion. In other words, we don't know the cause of the tides.

E. Well, the crust of the earth moves too. And the motion of the sun and moon is not constrained motion, it's spontaneous: it's *free fall* in empty space and would be eternal if it weren't for the slowing down due to friction.

A. Firstly a minor point: it's not *empty space* if there's something falling through it. More importantly though the path of a missile is a mixture of constrained and natural motion.

E. Do you still believe the impregnating the air theory?

A. Of course I do, it's what I *know* to be the case, so I believe it. The initial impetus, the *thrust*, if you like ...

E. Oh please, no! You can't expect anyone to take this seriously.

A. I assure you, I am always deadly serious. I say the initial thrust *impregnates the air*. Do you know what I mean by that?

E. Yes, you mean it actualises a potential.

A. It is the *efficient cause* that *starts* the movement from the potential to the actual. The air at rest is completely symmetrical, like the unfertilised egg. It is pure potential with no seed of the actual. The initial thrust of the movement breaks the symmetry in the air and sets parts moving in a definite direction. This is what the sperm does in animal fertilisation and these days you can actually *see* this symmetry breaking happening in the first few cell-divisions of the development of the embryo, it's quite something to watch for the first time. In the air, this resulting actual movement carries the missile up and then lowers it back down again. Throughout the upward motion the missile is constrained and the motion of the air is natural because the air is master of the upward motion. Then throughout the downward motion the missile moves naturally and the air undergoes constrained motion as the earth in the missile has mastery, and so the air has to flow around it as it descends, because the air below must move above if the missile is move down.

E. As an *analogy*, this has a certain plausible sound, but it is quantitatively extremely doubtful. For instance, the momentum of the air in motion as a ball is thrown up is far less than the momentum of the ball, so to say that it is the upward motion of the air carrying the ball seems quite absurd. The motion the air undoubtedly affects that of the ball, and *vice versa*, but we don't know precisely how because that depends on a lot of unknown detail. Newton's law is accurate because it abstracts away these contingent affectations like the surrounding air, and so it is a

universal law: it applies to any and all of a certain class of situations. How can one get accurate quantitative theories if one doesn't abstract?

A. I am not particularly interested in accurate quantitative theories, especially if they are only accurate in the absence of contingent causes; because all actual events are contingent on their causes and as we have seen, this abstraction just pushes the contingency back up the causal chain, so to speak, and eventually we end up positing that the whole Universe is not only an accident, but one that was extremely unlikely, and by rights there should be nothing here at all. I am a philosopher though. I want just to know the *Truth*, not some ideal approximation, however good the latter may be for practical purposes. So I am much more interested in the reason *why* this theory of work and energy has these apparent problems than I am in how accurately one can predict eclipses or program space flights. I understand why many *are* interested in quantitative science, because has immense *practical* value, but nothing practical and no particular knowledge is of any value to me whatsoever.

But I am very glad you made this criticism, because it has shown that there are clearly some misapprehensions on your part, and I think now I can probably explain to you much better what I mean. Now by your mentioning momentum and the fact that the momentum of the air would not be enough to impel the ball upwards from the hand, it is clear that you have in mind a purely material and energetic notion of cause, where the mass of particles is effecting the motion by contact. Is that not so?

E. Yes, I admit that. I know that it is surely not what you were thinking, but I honestly cannot conceive of any other way that the air could impel a ball.

A. It's because you've been so well-drilled in Newtonian theory. But remember that there is this problem with Newtonian potential which is actually part of what we are trying to understand. Now I *don't* claim that the air is the sole cause of the ball rising. There are *four* causes for that. (i) The *efficient cause* is the motion of the hand, because that is the limit of the constrained motion of the ball at the start of its flight. (ii) The final cause or the *perfection* of the motion is the intention of the thrower to achieve some mark, and possibly that of others to divert it. (iii) The *material cause* is the air through which the ball will fly. Finally there is (iv), the *formal cause* which is the form of the body of the air. This will ultimately be something rather complicated, involving a mixture of all the potential forms that are in the process of being actualised. There will typically be numerous and various eddies, vortexes and streams of many different sizes and shapes, on a vast range of scales. Many, if we could only see them, would appear to interact and fold together. But in fact it is their potentials which interact and these are what determine the actual motions of the parts of the body of air. But they do this by constraining the natural motions of the parts of the body of air to just those that are possible. Thus *all* of the actual motions will be due to chance, not necessity, because what is potential is neither necessary nor actual.

Now into this minutely choreographed dance of the air, the hand suddenly lets fly the ball. This very definite act instantaneously changes the potential form in the air. This is not an affectation limited in extent however, it covers the whole body of the air over the whole earth and out into space, reaching to the sun and beyond, and it does so instantaneously. But this change of the potential is strongly asymmetrical: the axis of the asymmetry is in the direction of movement of the hand. The air in

this region of the whole body of air is primed, as it were, and will very likely take the form of upwards motion along that line. But the actual form it takes depends upon the combination of *all* the potentials. Now it is these potentials that are the natural movement of the air. The movement of the ball is constrained by them, so that should there be a crosswind, say, then the ball will be diverted by it.

But imagine there was an archer a hundred meters away, and a fraction of a second after the ball left the hand, the archer let fly an arrow. At that instant a new potential from the point of the arrow would suddenly come into being and this would have a strong asymmetry along the straight line extending in the direction of the arrow. This potential too would mix instantaneously with the other potentials; and as the forms of the parts of the body of air fold together and become actual, the whole potential would evolve, always constraining the natural motion of the body of air to the possible. Within these constraints, nothing is determined until it becomes actual, but then what happens is entirely due to chance. The decision, as it were, is taken at the instant the potential becomes actual, and it is always the efficient cause that triggers it. So the efficient cause propagates the spread of the actual through the potential; in fact it is nothing more than this. It these *actual* movements of the parts of the body of the air that constrain the motion of the objects, and they do this by direct contact with its surface. So during the time of the flight there may always be a possibility that the arrow will hit the ball, or it may be that from the instant the arrow was let fly it was determined to be impossible for it ever to hit the ball. But it is hard to know about these things unless we abstract away all the contingent events and constrain the potential to a hard surface whose form we can describe quantitatively. But even if the archer is so skilled that the arrow as it is let fly could not fail to hit the ball, the potential could yet change. Someone could sneeze, for example, and it may then become possible for the arrow to miss.

If we consider a less symmetrically shaped projectile, such as a cube, say, then the turning motions of the projectile will perhaps be more constrained, because the potential forms in the body of air will interact with the potential turning motion of the shape as it flies upwards, and these together will result in some particular tumbling, but which will be due entirely to chance. So if the cube happens to have distinguishable faces then which of these is uppermost when the cube comes to rest is random if the die tumbled more than a few times.

Now is it any more clear?

E. Yes. I had no idea at all of the depth of it. I must apologise: I was expecting something trivial and that's what I saw.

A. Your reaction is not uncommon, because knowledge depends on other knowledge, and if all the scientific theories one has ever seen amount to little more than calculation then one naturally expects this in any scientific theory, so one does not look much beyond the superficial and immediately apparent features. But one must look beyond these if one wants to know the true causes of even the most mundane things, because the true causes are *never* superficial, they are always profound.

E. Now I see it properly it's beautiful and subtle. The potential is instantaneous throughout the whole, it is definite as soon as the efficient cause is.

A. Because in a sense this becoming definite *is* the efficient cause.

E. But then the potential can change at any time, and it *continues* to evolve during

the process of its being actualised. It gets added to by other potentials, and limited by what has thus far become actualised, so it's like a process of crystallization.

A. According to some definite rules …

E. Which we don't know. But what about the final cause? The archer may *hope* to hit the mark, and he may hit it by *chance* …

A. He *will* hit it by chance unless he is skilled enough to know how to constrain the potential in such a way that it is impossible for the arrow to miss. The *perfection* of this skill is what I call the *good* of the archer.

E. Then exactly when and where he hits the target is due to chance, but *that* he hits it is certain.

A. Yes. And if he is very skilled, the arrow will be as good as in the target the instant he releases the bow-string. And that is how any skilled artisan feels about his work: the potential does not seem like mere potential, it seems *actual*.

E. As you described the thought of the geometer.

A. Yes, the geometer brings about the actual construction via the potential, but this is because he *starts* with the whole and he produces the problem by a process of division, which is analysis. In his intuition, he can *see* the result of the construction before he starts describing the process of synthesising it from the elements.

E. So the rules of the 'crystallisation process' in the case of geometry are just *logic*.

A. And in the case of the physics, you don't think they're known? What we said about the skilled archer, is that just an impossible fantasy?

E. It *sounds* like one, because who could know all those contingent potentials in the air?

A. Archery though is an *art*. All the physicist needs to do is demonstrate that the perfect archer is a potential. In other words, that in principle there are logical relations that determine all the potentials and so that it *is* meaningful to speak of the possibility of knowing them.

E. And that's how we can demonstrate physical knowledge even though all our physical experience is merely of probabilities.

A. And my description of ejaculation of sperm should make more sense now too.

E. It does yes, and it's messier than I thought it was.

A. Potentially, yes. Consider the ejaculation that brought Gengis Khan into existence. But we need to be careful what we say, for someone of his time he has a disproportionately large number of living relatives.

E. I now see that I have badly misinterpreted your sense in which you use the terms *elements*. Air is not an element in the sense that we call Oxygen an element, nor in the sense we refer to molecules of H_2O as elements of water.

A. No, those things in so far as they exist are types of bodies, or *specieses* of substance. The elements Earth and Fire though are perhaps closest to what are nowadays called *mass* and *energy*. This analogy is not especially good one, but it may serve just to enable us get to a point of understanding them better. These two elements have absolute gravity, in the case of Earth, and absolute levity in the case of Fire. They are contraries, and the elements Air and Water are intermediate mixtures of them. Air and water have relative gravity and levity, so a part of a body which part is a mixture of air and water may be lighter or heavier than another part which is a mixture in different proportion. Elements change from one to other via the two principles

of hot/cold and moist/dry. Earth is hot-and-moist, Water is cold-and-moist, Air is cold-and-dry, Fire is hot-and-dry. Water and Air are a mixture according to which of the contraries moist/dry dominate. In Water it is the moisture of the earth that dominates, in Air it is the dry of the fire. In modern terms, this is like the two principles of *entropy* and *phase*, the former being the thermodynamic state and latter being the phase state of some substance: solid/liquid/gas/plasma. The difference though is that I believe these are the *actual principles* of all natural motion.

E. In other words, these principles are the ultimate explanation of natural motion because they are the cause of it. Whereas in modern physics the cause is always pushed back to the initial conditions?

A. These are the actual causes of *natural* motion, because these principles account for the motion which occurs naturally as things come to rest. But there is also a first cause of constrained motion, otherwise everything would be at rest.

E. Isn't that very similar to the idea of the initial conditions of the gravitational Universe which we're trying to explain? There we have an initial cause, and a final state where there is no motion because all things have come to rest as it were. In that case because there is no longer sopontaneous change, all the energy and matter having been dissipated completely?

A. It sounds similar, but there is a drastic difference ...

E. It's eternal.

A. Yes. I don't need to explain all constrained motion as spontaneous change from a state of low entropy to one of higher entropy, because I don't abstract away all the contingent effects and attribute motion to position and momentum. I consider the contingent effects to be essential because together they are the sole efficient cause of the phenomena of motion.

E. So your Universe is a perpetual motion machine.

A. If you mean by that that I don't believe the second law of thermodynamics, then yes.

E. The second law is so fundamental that sometimes people don't bother even saying that it's the second law of thermodynamics they're referring to. It is used as a kind of selection principle: if your theory violates the second law then its not a physical theory.

A. I agree that my theory of the eternal Universe is not a physical theory, but I don't think the second law of thermodynamics is a physical theory either.

E. But it states that the entropy in a closed system tends to increase to a *maximum* and this is almost just a theorem of arithmetic: if you consider all changes to a series of digits 1—9, say, where each element is equally likely to be changed to any other, then the strings with peaked distributions are less likely than others. For example 999999999 is extremely unlikely and those strings which have approximately as many of any one digit as any other are much more likely.

A. I have three responses which I will say summarily now, but which we can go into in depth later. Firstly, this is not true: the string 999999999 is no more or less likely than the string 246454653. Secondly, what people nowadays consider 'order' in the physical sense is *not* what they think of as information, which encodes *meaning*, but in fact it is the reverse, which is 'redundancy'. And thirdly, in consequence of this, the closer a system is to this maximum the *more* likely are the spontaneous changes

to be away from that maximum, so that towards the 'end' the appearance of order from disorder will be a regular, inevitable, and apaprently spontaneous ocurrence.

E. You're right as to the first point. I'm *ashamed* to say that I made the foolish error of confusing the idea of the probability of a single particular value with the likelihood of a *type* of distribution. Though the distributions which are peaked are less likely than those which are flat, in the limit, all particular strings are in fact equally improbable.

A. This is a common error, because we encode information in redundant physical systems and so we tend to think of meaning as being encoded in redundancy. But we do this just because the world is so *hot* that we need to make allowances for the spontaneous increase of entropy in the form of heat or shot noise or what have you which tends to erase any information in time.

E. But we also *compress* information by *increasing* its entropy, principally because we have these really *cool* mass-storage systems that have so much redundancy that they are nearly perfect memories, so we do not need any redundancy in the symbols with which we record the meaning: we simply presume that they are preserved perfectly.

A. This is why it is so hard to find advanced intelligence when you don't know where to look: if advanced intelligence only uses as much redundancy in communication as it expects to need to get the message through reliably then it will be practically undetectable at any distance away from where it actually is.

E. So the search for alien intelligence would probably not have found any alien intelligence unless it actually wanted to be found. I wonder if *we* would *want* an alien intelligence to find us?

A. I was thinking about feminine, or ancient Greek intelligence actually, but this probably seems alien too. On the basis that it is better to be safe than sorry, I would say we would probably not want one that was so stupid as to look only for reduntant transmissions as a sign of intelligence.

E. But our spoken and written languages are highly redundant. But I suppose *because* of this we use the spoken words as a medium to carry other meaning.

A. And we do. It's natural in human communication and is used to carry the *sense*. There are choices of synonymous words, and in the spoken word there is a great deal of scope for this.

E. Which is what I thought the subject of rhetoric was all about.

A. I would call that *oratory*, but oratory is a part of rhetoric, which includes more than just the sense, but also the meaning of speech.

E. Why does a philosopher need to know about oratory? Just because there is something to know and a philosopher wants to know everything?

A. Well, the philosopher chooses what to learn first, because the individual has a limited life in which to pursue knowledge. He chooses the most important things, and it turns out that oratory *is* important, and you might be able to analyse this if you think about it in terms of coding systems and noise.

E. OK, I'll try. Philosophical 'noise' is what we call sophistry. It is not wisdom, but it has the appearance of wisdom. The philosopher needs to make the end of the thread such that it stands out against this background noise. The only way to do that is to use oratory because the person whose attention he is trying to catch may not

even be aware yet what philosophy actually is. So in fact the philosopher must dress up his philosophy respectively to look as good as the most attractive sophistry of the age, otherwise it will be considered strange and wrong. How am I doing?

A. That's good, as far as it goes. But some sophistical ideas which are widely believed are actually wrong, so inevitably the philosopher will find he has to contradict them, and then what he writes *will* seem strange and wrong. For example, if he says the second law of thermodynamics is false, or that men have more teeth than women, or that the earth is the centre and does not move.

E. Assuming he *must* say these things, it would be better to use the sense of the words to carry them, so that the philosopher's ideas would appear 'sensible' at first, but on knowledgeable and thoughtful consideration they would be found to have a hidden sense which was in fact the true sense, but not obvious to the casual reading.

A. Yes, that's what we are forced to do. We have to write two texts at the same time. The *exoteric* text, which is for public consumption, and the *esoteric* one, which is for initiates. And the esoteric text is carried by the sense of the words used to express the exoteric.

E. But that can be damaged in translation can't it?

A. Yes it can. So the sense needs to be restored from time to time. And also as the ideas of times change, some things that were once widely accepted, such as the earth being at rest, become widely refuted. These present more of a problem.

E. That men have more teeth than women is something that is even harder to deal with. Why did you write that?

A. One cannot expect an intelligent man to look for an esoteric meaning in every text he reads. One needs to provide clues, which are small things which will catch the attention of a careful reader. They should be signs that all may not be quite as it seems.

E. That one doesn't seem particularly subtle to me.

A. It wasn't meant to be. It was intended to be a very clear signal so that anyone who was in the least disposed to look more carefully for the sense would be convinced that there was one to be found.

E. People could become frustrated when they read things like this because if the actual meaning remains obscure they will tend to feel that they're being cheated, and this will seem more likely to be because we are making a deliberate attempt to mislead them.

A. I submit that most of those would be more profitably engaged in other pursuits.

E. But the most obvious clue to the sense is intuition. I mean the perception of the whole. This is explicit in the text, and with this one can find the true sense quickly. Why do you need the esoteric sense at all?

A. Because the esoteric sense is of things that are very far from obvious deductions that one would be likely to make even if one did have a good intuitive sense of the whole.

E. Now I realise that I don't have a clue what you are talking about!

A. Take Euclid's *Elements* for example. The ultimate purpose of this whole text is to prove Proposition 18 of Book XIII which is a collection of rather esoteric facts

about Platonic solids. Who would have considered these things to be obvious consequences of the fact that the world is a whole volume, divided by surfaces which are divided by lines and which lines are divided by points?

E. So 'seeing the whole' is the first step, the next is analysing it by definition to discover the elements: lines, surfaces and volumes?

A. And the species of relations between them such as angles and areas. Then the next step is building it back up from the elements.

E. But then you say there is *something else* inherent in the basic premisses which was not apparent to the unaided perception.

A. My favourite example is incommensurable magnitude. Who would have thought it possible that some definite length could be constructed and described explicitly, but which was not expressible by any unit of measure, however small? But this characteristic of magnitudes turns out to be what we call the *first infimæ species* of the Platonic solids. That is, referring to the lengths of the sides and that of the diameter of the enclosing sphere, the pyramid, the cube and the octahedron are the rational solids, and the icosahedron and the dodecahedron are the irrational ones. This is far from apparent to the unaided intuition which perceives space as a whole volume divided by surfaces etc., even one which can perceive the Platonic solids as the only regular elements of volume. What should make one pair of them findamentally different from the other three?

E. It's thought people knew these five shapes a thousand years before Plato spoke about them, so it seems likely they had an intuitive sense of them, though very few people today could even describe them, never mind feel they could 'see them' intuitively.

A. We have made clear the distinction between eternal motion of the heavens and the heat death of the universe?

E. Yes, it is that the original source of movement is eternally present and involved in all animal movements, whereas the the thermodynamic origin of animal movement is back at the beginning of time.

A. Yes, time has a beginning, but the original source of motion cannot have.

E. Time has a beginning because time is just memory, and depends on deduction. So as we are able to deduce more we see the beginning of time move further back. In Laplace's day is was some 4,000 years because that was the limit of historical records, but now we have archaeological records and paeleontological and geological records and we can trace the beginning of the earth back to around 5 billion years ago. And then we have astrophysical records in the stars which seems to suggest an age of 10 billion years or so for the whole Universe.

A. Yes, the order of events is always a logical deduction and that is of course according to their meaning or *significance*.

E. The oldest thing in the Universe is supposed now to be the *cosmic microwave background*.

A. How far out is that?

E. It's supposed to come from the very fabric of space-time itself. But that which arrives with us now is from the most distant points in space that it could possibly have come from. I.e. those points which are around 10 billion light-years away from the earth.

A. And this is light of course, so it is very high-entropy radiation being uniformly distributed as it is?

E. It's supposed to be the radiation from the initial boiled egg explosion, called the Big Bang, by the way.

A. But that would have been very *low* entropy, a bright intense light radiating from one central point would it not?

E. The big bang was supposed not to be an explosion *in* space, but one of the entire space-time itself. So it was not something that took place at one point or on particular instant of time, but actually happened everywhere at once, as it were, at no particular time.

A. But what is the sense in which one can know the conditions in the first few fractions of a second of its existence then?

E. This seems to be with respect to the 'natural time' where the fixed stars are taken as the datum defining an inertial frame of reference. With respect to *this* frame, time has a beginning.10 billion years ago and the centre of the big bang appears to be a point right at the center of the earth from which all the surrounding stars appear to recede with a velocity proportional to the distance from which they are from the centre.

A. So by the *fixed stars* we mean just those which do not *appear* to move with respect to one another, but in fact are all receeding radially from the center of the earth?

E. Geometrically it's the only way they could in fact be moving relative to each other and to a fixed point, yet appear from that fixed point not to be moving at all.

A. But they are turning 360 degrees every 24 hours!

E. If you say so.

A. And if *you* look, then you will see that this is a fact. But let's not digress again just yet. How do we know they are receeding?

E. Edwin Hubble did a survey in the early part of the 20th century and found that the red-shift of distant galaxies was proportional to their distance. The distance was gauged by *parallax*, using the apaprent relative positions of the galaxies and fixed stars as they appear at opposite sides of the earth's orbit about the sun, i.e. observations made six months apart.

A. So as the earth 'moves' the different lines of sight give a measure of the distance of the objects. That's quite ingenious. Presumably though the most distant don't appear to move because of this?

E. Indeed they don't and this is the sense in which they are called the fixed stars. It is thought they *would* appear to move, but just that they are so distant we can't detect the apparent movement.

A. We can't detect the *apparent* movement? Let's assume then just that they don't apparently move. So this red-shift evidence for the recession velocity of the galaxies is only something that applies to the very nearest galaxies, the ones that apparently move?

E. I suppose it's the best evidence, because for objects further away we have only indirect evidence of their distance.

A. And the red-shift?

E. That's an experiment where one measures the wavelengths of the chracteristic lines in the spectrum of the radiation emitted from atoms of a particular element. For example hydrogen is seen in the laboratory to have characteristic lines of certain definite wavelengths. Hydrogen and Helium are known to be the principle elements involved in the emission of light from stars. These emission lines are *Doppler shifted* when the light source is receeding and the shift is proportional to the recession velocity. The effect of a receeding source is to shift the wavelengths *up* so that the light appears at a longer wavelength. Hence the term red-shift because red light has the longest wavelength of the visible 'colours.'

A. And this is not obviously caused by the fact that the further away the glaxies the more air between them and the eye so the more red the light appears?

E. No. This is the way you explain the red sunset, but I don't think it can be the case here because it is not that they actually appear redder, but that the characteristic spectral lines are shifted. In the case of the sunset the light appears redder because it is effectively *filtered*, but the emission lines are not shifted, except perhaps by gravitational effects.

A. How does gravitation affect the emission lines?

E. Well, a clock in a strong gravitational field runs slow. So I presume that an atom emitting radiation would emit radiation of a slightly lower energy. But I am a bit out of my depth here. I am not current with the experimental results, but it *seems to me* that since an atom is best understood as a quantum mechanical system, and a very strong gravitational field as a *classical* system, there are *no* good theories about this. But there are presumably experimental results, and I presume they are nothing unexpected, and so I would suppose that an energy quantum emitted as an electron changes down to a lower energy orbit is lower than it would be in normal circumstances. But I have to admit that I cannot see *why* this would be.

A. Well, let's first get clear on what is supposed to happen in a strong gravitational field. You say 'a clock slows down' meaning what precisely? It seems to me that if you mean 'a typical clock' then how could anyone *know* that it slowed down? And if you *didn't* mean a typical clock, then I am completely flummoxed.

E. Well, *time* slows down. So *all* physical processes slow down with respect to those which go on where the field is not so strong. And we know this because... well I suppose principally because of the shift of emission spectra from sources which are supposed to be in strong gravitational fields. Which sounds a bit circular ...

A. That's OK, as long as there is a real measurement in the loop somewhere. These measurements then all tie up with other data inter-related by theory, so although there is no *absolute* reference for the 'proper rate of time' there is a way to check that results are coherent? That sounds like a sort of gauge transformation.

E. You seem to know more about these things than I do. Why are *you* asking *me* these questions?

A. It's good to have someone else's interpretation to compare with mine. The last theoretical physicist I spoke to in person was Lagrange. All the rest I know was just through snatches of overheard conversation and hearsay.

E. What did you mean as long as there's a *real* measurement?

A. I mean, as long as you really measure something. For example, if you claim to have experimentally verified that the speed of light is constant, you had better have

made a physical measurement that has the dimensions LT^{-1} otherwise you have just calibrated your instruments with themselves and not done any experiment at all.

E. And if you measure the speed of light, how can you *not* have done a measurement with the dimensions LT^{-1}?

A. Well, using SI units, which are almost universal, velocity is m/s and the metre is defined as ...

E. Ah, of course. The metre is the distance light travels in a vacuum in $1/299,792,458$ of a second which just happens to correspond to the time light is *supposed* to take to travel a distance of exactly one metre. So if your apparatus is the very best, it will consist of just a caesium fountain atomic clock because the second is defined as $9,192,631,770$ oscillations of the radiation emitted by a caesium-133 atom at a certain frequency corresponding to particular chracteristic line in the emission spectrum?

A. So, suppose we calculate how many of these oscillations should have taken place as light travels one metre.

E. It's $9,192,631,770/299,792,458$ which is about 31.

A. We need only watch the clock count to 31 and the experiment is done.

E. And if the clock fails to do this for some reason, well it could only be because it is defective in some way. So we would fix it. But the clocks are actually a worldwide network which are synchronised and calibrated against each other. So they all work, by definition. But to be *doubly* sure, we could watch it count to 62 and thereby measure its speed over *two* meters in a *separate* independent experiment.

A. You may laugh, but I have heard it said that there has been a suggestion that the unit of mass also be realized as a time measurement. And when that happy day comes, philosophers need not wade through any more physics literature, because theoretical physics will have become a branch of mathematics, and experimental physics would have become just a branch of digital electronics, because there will be no need for any empirical measurements at all.

E. But what about experiments which measure dimensionless constants? For example the experiments that just count proportions of events. For a concrete example, take one which demonstrates that photons interfere when passing through two slits?

A. It's not an empirical experiment because it doesn't measure anything.

E. Surely it measures light intensity in different places in the interference pattern?

A. Not light intensity as such, no. It measures the number of detector events, and a detector event is a defined thing, not something that represents something else.

E. You mean because a detector event is 'one off' so to speak, it's not a masurement?

A. It can't be, because you can only *measure* a *magnitude*. A detector event is just a point in space-time: it doesn't represent any actual thing except itself.

E. Doesn't it represent what it's *meant* to represent? I.e. a photon in this case?

A. Nothing does that *necessarily*, otherwise it couldn't *possibly* work, I mean as an empirical faculty of sense-perception.

E. You mean a measurement is only meaningful if it is corellated with another independent measurement. This is just a deduction from *logic*, isn't it?

A. Yes, I explained it in *Prior Analytics*. I said that no deduction proceeds from only one premiss. And if there is only one physical measurement in a demonstration

then we can't deduce anything from the result. So in particular we can't demonstrate anything from the results of the measurement.

E. And what you're saying now, is that the measurements need to be *essentially* different, because otherwise we end up just checking the measuring equipment calibration, because the only thing that can change are the scale factors by which we relate the different dimensions?

A. Yes. But if you do that *a lot* then you get a lot of practice and you become very skilled at it and you end up with superb technology.

E. And extremely accurate quantitative science . . .

A. Which is ultimately completely devoid of significance.

E. But many claim that this is just a fact about the universe, sad but true, and they claim that science *proves* it.

A. Sophistically, yes. Do you begin to see what sort of a battle we're fighting?

E. Yes. They're not playing fairly, are they?

A. The sophists? They never have played by the rules. They don't understand them.

E. What are they, exactly?

A. One can't be sure.

E. We don't know what the rules are either?

A. We know what the rule is, yes. It's just that: One can't be sure. Socrates' rule.

E. Doesn't sound very *definite* to me.

A. It's very definite. It questions its own validity, yes, but that does not make it any less definite. This is a widespread misapprehension, that if something is definite it is certain. Something can be definite and merely *potential*, rather than necessary or actual.

E. So is this the real reason why quantum mechanics is a successful quantitative theory? It is a tautology? I can't believe it. And I don't think anyone else will either. Why has no one else noticed this? It's important. Many, many people believe modern science is the gospel truth.

A. You don't get much more gospel truth than a tautology. They're irrefutable.

E. So it's because people are calculating, not thinking.

A. Calculating is thinking of a sort. It's the sense-perception that's absent. Intuition. You have to convince people to take their *own* experience seriously and reason from *that*, not what they read about which has always been interpreted by someone else.

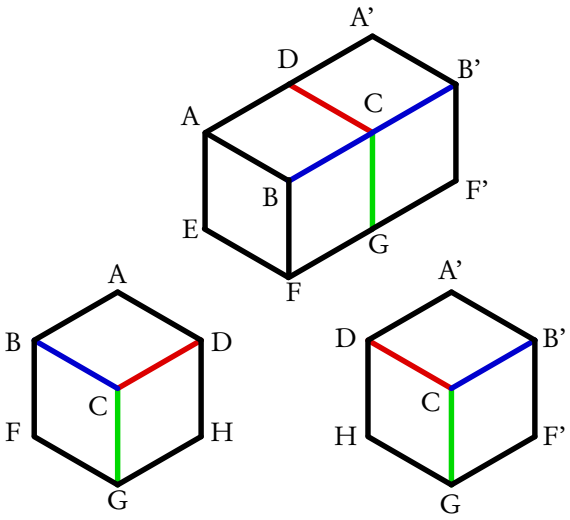
E. But if you point someone at something and say 'look' then why should they perceive anything different to what they usually perceive?

A. Show them this trick. Point out that it is one whole oblong cut into two parts. The whole has no inherent 'handedness' but the two parts do. They have the same parts, arranged in the same relation, which is what the labelling of the vertices is meant to show, but the wholes are *essentially different* because one is right-handed, as it were and the other is left-handed. And that this is what it means to see a whole as something more than the collection of its parts.

E. That's rather good. Why is it a trick?

A. Because they are not wholes, they are just images of wholes.

E. But if they *made* identical cubes out of wood or something and painted the edges, they would have wholes, wouldn't they? But the sort of people who believe the only validity any statement can have derives from its being calculated and formally verified are likely to consider anything that *can't* be calculated as being a merely trivial question of representation which can settled by adopting a convention of some kind.



A. The same sorts of people are mystified by quantum entanglement. You could explain that to them.

E. Really? I don't see how because I don't understand it myself.

A. Start with just a simple correllated spin measurement. The wavefunction is what?

E. For some particles, electrons, say with spin axes $\mathbf{r}_i$ and spins $\sigma_i = \pm\hbar/2$ it is something like $\Psi(\ldots,\mathbf{r}_i,\sigma_i,\ldots,\mathbf{r}_j,\sigma_j,\ldots)$ and there is a complicated expression that lets you calculate this and produces a complex number called the *probability amplitude* for each so-called phase space point, which is an axis vector and a spin for each electron.

A. And Pauli's exclusion principle is what exactly?

E. That if you exchange fermions i and j then because the particles are indistinguishable you have the so-called *Fermi* statistics, and the wavefunction must be *antisymmetrical*, so $\Psi(\ldots,\mathbf{r}_i,\sigma_i,\ldots,\mathbf{r}_j,\sigma_j,\ldots) = -\Psi(\ldots,\mathbf{r}_j,\sigma_j,\ldots,\mathbf{r}_i,\sigma_i,\ldots)$, all other things being equal.

A. And what's the physical reason for this?

E. It's so that the degenerate solutions of the wavefunction are not included. Because the wavefunction describes a state space it is susceptible to *reinterpretation*. This is when there are physically distinguishable solutions which are derived just by interchanging the indices of the particles: i.e. they are *accidentally* distinguishable solutions, arising from the symmetries of the particular form of the wavefunction. It is just a *coincidence* that they are solutions, because exchanging particles makes them go

away! But if the particles are *Bosons* then they *are* distinguishable, so these accidental solutions are real, and then the wavefunction is *symmetric*. Fermions have spins which are odd multiples of one half, and Bosons have spins which are even multiples of one half.

A. Pretty, isn't it? Odd and even elements. Now if there are two entangled electrons, one spin-up, one spin-down in some axis, and we separate them and if we do two measurements, one on each part, and each orthogonal to this axis, and if these two measurements happen to be in the same axis, then they will agree, is that not so?

E. Yes, quite mysteriously, because there is in fact no way in which the 'answers' to all the possible measurements could have been determined at the instant the particles were separated. Yet somehow they are found always to agree, and that cannot be my any means of ordinary communication by light, say.

A. So what is really going on here then?

E. Well, I suppose *you* would say that what we have is a simple system, not a compound system; because if we cannot distinguish the two parts, they are not proper parts; that each so-called part must in fact be the one whole system. So when we make the separate measurements we do not in fact make *distinguishable* measurements either. We are making just one measurement and that is of the whole system. But I am at a loss to say what this *means*.

A. Imagine the oblong is spinning on a gymbal about the axes GD and CH, both at the same period, and is undergoing *inversion*, this also at the same period as the rotation. That is to say that it is turning inside-out, with the diagonally opposite vertices being exchanged. So the pairs B'E, A,F', BE', A'F, DG and CH are being exchanged, with the same coloured edges still connecting the different vertices. This exchange is occurring *twice* with each full turn of the rotation. The different combinations of the possible sense of spin about the two axes GD and CH result in the effective rotation being about just one of the axes passing through the centres of opposite long faces in one or other sense. Then we wouldn't actually notice the combined net effect of one full cycle of rotation and inversion, because with the edges coloured like this the shape as a whole has no particular handedness. In other words, without the labels on the vertices, a mirror image looks like the same shape turned around. So we can, if we like, think of the oblong is being in some definite, but unknown one of two indistinguishable states. Then at some definite instant the oblong spontaneously separates into two pieces, one of which gets sent to each of two observers A and B.

E. Oh, I see. If A gets a left-handed cube, he knows instantly that, if B does indeed have the other half of that very same oblong that was earlier spinning whole about its axis, then B *must* have a right-handed cube. But neither could ever know whether they have the left-hand half of an oblong in one state or the right-hand half of one in the other state, nor *verca vise*, the the right-hand half of an oblong in one state or the left-hand half of one in the other state.

A. And this flipping between states of the whole system is what is expressed by the identification of the two parts of the whole phase space described the wavefunction. So everything is definite, but some things are in principle unknowable because they are physically indistinguishable, as in the case of the electron. But there is a necessary condition on the knoweldge that one observer has of the other's state. How are we supposed to know what we measured? I mean, how do we know that we measured

two separate things, which both came from the same whole?

E. Well, as you explained, it can't just be because that's what we *meant* to measure: there *necessarily* must be a possibility of the measurement being in error. So we must have a means to detect spurious results such as one detector detecting a particle and the other not detecting anything. Then after pairing off the remaining detector events we may have results that are contrary to the expectation. They of course *could* be the results merely of coincidence, where the particles measured did not in fact come from entangled pairs. If that were to happen in a significant proportion of cases, we would have to have a means of filtering these out otherwise we would not have any claim to an experimental verification of the result. But we would *not* have any means to decide which of the pairs of spin measurements which agree with the expected result were also *in fact* just coincidences that happened to go the right way.

A. Would we not just claim a statistically significant result, within a certain probable error bound? After all, we are dealing with what we believe is an inherently stochastic process.

E. I think that is what is commonly done, yes. No detector is assumed 100% accurate. And there is *no reason* why a pair of detectors would be biased one way more than another in the sense that it would spuriously detect more correllated than anti-correllated measurements, especially since it is only one of a pair of identical detectors. A well-designed experiment would swap over the detectors to eliminate any chance of a systematic error of this sort.

A. What then would constitute a *negative* result for the experiment as a whole? In other words, what would we have to observe to become convinced that it offers no evidence of spin entanglement in pairs of electrons?

E. The observed degree of measurement correlations would have to be no more likely than those expected by chance when in fact there were no actual correllations. And this is what is observed, consistently. There is no plausible way a set of truly random events could have this degree of correllation by chance. And that is what means this is not a tautology but a real falsifiable experiment.

A. You mean it is impossible that such a degree of correllation could arise by chance? Why?

E. It's not impossible, but it's so extremely unlikely as to be *practically* impossible. But that's not demonstrated proof then, is it? It's merely a probability.

A. And in itself, a probability tells you nothing whatsoever about the reason why the thing happens. And given the *empirical fact* instanced by this example, that the world actually does include whole systems, the properties of whose parts are not reducible to those of their parts, what do we learn from the sample distributions that these experiments yield?

E. Nothing. This experiment is actually not nature telling *us* something, it's *us* testing what we *know* about nature. I.e. we are testing our skill at manipulating the physical world in predictable ways.

A. It's a faculty of perception in other words. But what we want from a science is *demonstration* of our knowledge. We want a proof that what we know explains the phenomena we see. Now this wavefunction is just the expression of the possible, in so far as it's *not* actual. Because when it becomes actual then so-called unitary evolution stops and the new actual state becomes the constraint for the subsequent

evolution of the potential. So the question is just when does the potential become actual?

E. When it becomes the efficient cause of something else. But we do not usually know these things immediately, we just infer their times and locations from the evidence we have of the event.

A. And who does the knowing?

E. In this case, some one who understands quantum mechanics, because otherwise the experiment will not have any significance for them.

A. I agree, because electron spin is not a matter of sense-perception, but of inference from sense-perception. It would be impossible for someone to know the spin of an electron if he did not understand what it actually means.

E. Even if he looked at a screen that said 'Spin up'?

A. At the very *least* he would have to know to which electron that reading referred. How would he know that?

E. But how does *anyone* know which electron it was? They are all *indistinguishable* one from the other.

A. How do we even know which pair it came from then?

E. Well, if individual electrons are indistinguishable, then pairs are too. We mean just the pair that were known to have been prepared in the actual entangled state. I see now, that is only something we know *after the two measurements have been interpreted together* because that is when the event comes to be known as an actual event rather than a spurious detector event.

A. Could we not *then* refer this knowledge of the actuality of the events *back* to the time the measurement was made? So that we later come to know that the potential became actual at that earlier time, even though the experimenters did not realise this until later?

E. So only when the two events have been interpreted as a meaningful measurement of the whole system can we consider the measurement to *have been* a real one, and therefore we can infer that the events represented by the individual measurements were in fact real events. So the inference is a necessary part of the knowledge, but that is to be expected of anything that is not something we directly perceive.

A. When we make this inference, we make it in the inertial frame where the two events have been brought together, so there is a definite order and they are definite events. There is no quantum superposition of states, except those of the minds of experimenters, who are undecided about the outcomes until they have made the necessary inference as to the significance of these actual sense-perceptions.

E. That does not sound so problematical or off the wall to me. What have we done that no-one else does?

A. We recognised that there are some properties of systems which are *essentially* those of the whole system and do not reduce to properties inherent in the separate parts independently. And quantum mechanics shows that these systems can extend across space and time and still maintain their whole character despite being composed of apparently separate parts.

E. Which is in fact something we knew all along, because we ourselves are exactly like this. We are are extended in space and time. In space because our sense-experiences are evidently from places other than where our body is physically lo-

cated. In time because we continue to exist from one moment to the next. Yet we still experience *being* just one whole person.

A. So the price we have paid for understanding quantum mechanics seems fairly modest: we have had to admit this human experience is real *before* we were able to give a meaning to physical measurements, because it is only a human being that can understand the meaning of a physical measurement.

E. That is really quite something. We have here a perfectly *classical* physical system which produces some of the behaviour that has been assumed to be a characteristic only of quantum systems. And every aspect of this was something you actually considered and wrote about around 350BCE. Can we clear up gravity as easily as this?

A. I think so. The connection between the two problems is rotation.

E. Now that I come to think about it, it is a strange thing to think: that indistinguishable fundamental particles have *intrinsic* properties such as spin. Because an intrinsic *property* should allow one to discriminate between two such if they in fact have *different* intrinsic spin.

A. But the spin *had* to be assumed to be intrinsic otherwise the properties of the whole systems would not reduce to those of the fundamental particles.

E. Reducing properties of whole systems to those of their parts considered separately is *necessary* then?

A. In the absence of final cause, yes it seems to be, because otherwise there is no hope of explaining all properties of whole systems. As you said, claiming something happens because it is meant to happen does not seem like much of an explanation.

E. But earlier you seemed to claim this *is* an explanation.

A. Not unconditionally, no. I only claim that final cause is an explanation when it is a *good* of something. That is, when it is known to be the perfection of something and the actions are then *just*. But the intentional actions of someone who is deluded cannot explain anything any more than can random movements of matter that occur in the course of an explosion explain anything.

E. But movements of material can explain a whole system of which their movements are a *necessary* part. So right and just intentional actions are analogously a *necessary* cause of the universe being a whole system?

A. Yes, the good of man's rational consciousness, the perfection of which it is the potential, is the rational soul of the whole Universe.

E. Woooah! That's even more 'out there' than the idea that ether is an emanation from the earth!

A. It should be *exactly* the same degree of out-there.

E. So you think that the ether is this potential and that it is being exuded from the earth, informed in human consciousness and extends out from the Earth throughout the Universe and the ultimate end of this process is the realisation of, what? A cosmic being of some kind?

A. God, yes.

E. So you think human beings are god's neurons?

A. No, because god doesn't exist. The rational thought of individual men is a whole part of a whole only in so far as it participates necessarily in the being of that whole. For example, the bone marrow cell in your body that is functioning perfectly is a part of your whole being. The cancer cells are not, though they they

are themselves functioning as wholes. There needs to be a *middle term* common to both the part and the whole, and that must be the good.

E. So the cancer cells are the cells that are a part of the body but don't share the common good. In a healthy body those cells should die of their own accord or be killed by others, but in cancer they proliferate and the whole body is destroyed.

A. Yes, normal cells only live a few months and then senesce so the whole body is made of young cells. Cancer cells live for much longer.

E. So god doesn't exist because we individually don't have any notion of the common good.

A. The human mind as a whole is pure potential, like an egg.

E. What is going to impregnate it then?

A. The philosopher king.

E. So the potential of the human mind as a whole is completely symmetrical, and the philosopher king will come along and do what?

A. There is no coherence in human thought as a whole: anything is as likely to be a contradiction as not. But it's full of energy in the sense that there are millions of very intelligent people thinking and calculating furiously. All that is required is something to break the symmetry. It has to be something actual.

E. Some actual truth then which will seed the process of crystallization. It has to be something evident to sense-perception then. And it has to have the necessary consequence that the common good is in fact something demonstrably real, i.e. a logical inference from seelf-evident facts. What could that be though?

A. What about just finding an instance of a common good.

E. Well, that the Sun rises each day is pretty universally regarded as A Good Thing.

A. So that the heaven turns is a necessary and essential part of the common good.

E. Don't we just need the *Sun* to rise every day?

A. If the heaven didn't turn then the Sun would only rise once a year, not once a day, and it would go the other way!

E. OK, OK, let's say it does turn, for the sake of argument. So we have a necessary part of the common good which is evident. But how can that influence the way men think?

A. Well, that you steadfastly refuse to see that in fact the heaven turns indicates that it doesn't!

E. Then we will have to demonstrate that it is the heaven that turns, and the earth is still.

A. We can't demonstrate it. It has to be seen as a self-evident fact.

E. That's impossible, because whether the earth is still and the rest of the Universe moves, or vice versa is just a matter of convention. You can say what you like and the laws of physics will just appear a little more complex if you take the earth as the center.

A. No, it's not like that at all. Do you know Newton's 'bucket argument'?

E. Yes, though not being as dilligent as he, I have not in fact 'made the experiment', though I have been meaning to get around to it for many years. As I recall it involves a bucket of water suspended on a rope. If the bucket is still and the water is still then the surface of the water is level. If one starts turning the bucket about its

vertical axis then initially the water remains still and flat, but there is enough viscous drag to eventually set the body of water turning. Eventually the water will turn at the same speed as the bucket does. Then the water will again be still with respect to the sides of the bucket, as before, except that *now* the surface of the water will be concave because of the centripetal force of the turning motion acting against the tendency of the surface to level under the force of gravity and thereby forcing it upwards.

A. Yes, the water is trying to get to the deepest part of the surface, but the motion of the walls of the bucket is constraining it.

E. I don't see that at all.

A. Well, that's the natural motion of water, to get as close to the centre as possible. This and the fact that the water has gravity relative to the levity of the air is why the surface of the sea is a sphere. I proved this in *Meteorology*. It's because the water forces itself into all the places which are closer to the centre.

E. But here the water is forcing itself up against the sides of the bucket and away from the center, of both the earth and the bucket.

A. But we are dealing here with constrained, not natural motion. The walls of the bucket were the initial actual motion and the constraint, and then the potential that motion begins to become actualised as the actual motion spreads inwards toward the axis. The axis of the bucket's rotation is a line of points that do not move with respect to the center of the earth. Then there are all the cylinders which share that axis. These are how the motion started. First with the outermost cylinders which began moving those closer to the axis, which in turn move those closer still to the axis. This is is the propogation by efficient cause.

E. So the efficient cause propogates from the outside in. And thus the motion of the walls of the bucket constrains the natural motion of the water towards the center. The effect is basically to smear the water along the surface in the opposite direction to that of the rotation.

A. The question Newton asked then, was what is the reason for the difference between the two states of the bucket and its content? That the states are different is quite apparent, and he thought this must be because of something inherent in the bucket and the water.

E. And his conclusion was that it is the absolute motion of the bucket walls with respect to the fixed stars. So the motion with respect to the heaven was the cause of the inherent property of the bucket and its contents. But Mach famously objected. He said this is not a necessary consequence of the state of the bucket and its contents being observable, because we do not know that the effect would not go away if the walls of the bucket were *leagues thick*, as he put it. And it is thought that he meant by this that the motion of the walls of the bucket relative to the fixed stars was significant because it was an effect whose cause had its origin in the fixed stars. In other words, just because the fixed stars happened to be where they were, and the bucket and water rotating relative to them, the surface of the water was dished. But a hypothetical blocking of the effect by very thick bucket walls might render it less effective, or completely ineffective, so that then the surface of the water would be flat whenever the bucket was still with respect to the body of water, regardless of the motion with respect to the fixed stars.

A. But imagine a bucket which is sitting in front of us, and both the bucket and

its contents are turning with respect to the fixed stars. Then the surface of the water will be dished. If we stop the bucket turning so that it remains still with respect to the fixed stars, then the natural motion of the water will mean that it finds its way to the centre and eventually everything will be at rest. But if this were Mach's special bucket, then there would be no difference. The water would be flat whilst turning, and on stopping the bucket, the rotary motion of the water would cease without there being any change. We could then start the motion again in the opposite direction and again there would be no observable change. So in Mach's bucket, there is no difference between starting anti-clockwise motion of the water and stopping clockwise motion. In either case, the water moves clockwise with respect to the bucket.

E. So the effect of Mach's bucket is to prevent us from knowing the difference between the direction of rotation with respect to the fixed stars.

A. But surely we could just drop a small particle into the water and see which way it was actually going?

E. It's not clear that that is what Mach meant. It seems to *me* more likely that what he meant was that if the influence of the fixed stars were blocked then we could not by any means affect the rotary motion of the water with respect to the bucket. It would always move as one with the bucket. It is a curious fact that although in many respects Mach's ideas seem very close to yours, in other respects they are diametrically opposed. Mach did not believe in any kind of absolute measure at all.

A. Not even Truth?

E. Especially not Truth! But with the qualified exception of 'economy'. He felt that the task of science was to produce the most economical description possible of the natural phenomena we observe.

A. That is what Truth will enevitably be, I think. Because we will have the causes in the order of being and these are the most efficient way to explain anything. But I claim that this is an absolute order and not something arbitrary or contingent on the order in which we discover things. But we could never know we had the most economical description.

E. The difference then is that Mach believed this ultimate truth was unknowable by man.

A. Then we will just have to part company with the good man. And since I ultimately failed to convince Newton of the error of his ways, he is not going to be any help to me either. The bucket of water in its spinning state is not in natural motion, it is constrained motion. That is the cause of the inherent difference of the two states. Initially when the bucket is still and the water is level within it, all is at rest. Then along comes an animal and starts it moving. This makes the state one of constrained motion, and when the animal stops taking this action then the motion becomes natural once more and the system returns slowly back to the state of rest.

E. And why should it be evident that the earth is at rest and the stars moving then? Because there's no animal turning it with respect to the fixed stars?

A. Exactly. Every time an animal starts its motion from rest it impels the motion from the right and turns right, but it then proceeds in a straight line, each step alternating with the others. The net effect of these later step all cancel out. It is only the initial turn that moves the earth. This impels the earth in the opposite sense.

The sum of all the different impulses in both hemispheres should balance out and the earth won't move at all. But perhaps we should think twice about lanching so many satellites in the same direction because we are very probably causing the earth to turn. And that would make it seem as though the heavens were slowing down.

E. Ah, this is why you were called the peripatetics: 'even walking is a kind of limit'!

A. To understand this sense of knowing one needs to understand both potential and the notion that the whole of mankind could know what no one individual knows. It is criticism that holds together the whole of the thought of mankind. Or it *would be*, if that were what we did, but we cannot do this yet, because we don't actually believe in any common basis for the critical arguments. This should be obvious: logical deductions based on self-evident premisses. Why is that so hard to understand?

E. Who is to choose the premisses? Who is to choose the logic?

A. The premisses are what we observe, and we don't have much choice about this, do we? Nor do we have any choice about logic.

E. Well, both of these points have been contended. The premisses are thought to be culturally dependent by many. They say that what we see is just what we *notice* and that this is what is important to us, and what is considered as important depends on the culture. And some claim the logic depends on culture too: there is a culture of people in academia who believe that the only valid logic is so-called 'intuitionistic logic' where the law of the excluded middle doesn't hold. And others say that people from a culture whose knowledge is based more on relations between things than inherent attributes of things would have essentially different sense-perceptions.

A. Very well. If any of these things were actually the case, then how would we know? Let's start with logic. If Intuitionistic Logic were actually the true logic, say, how could we know? What would be different? Is there anything that can be proved in classical logic which is contradictory in intuitionistic logic, or vice versa?

E. No. They are 'equiconsistent'.

A. So it is merely a question of there being certain arguments that are not valid. You say the law of the excluded middle is not valid. So if I were to argue that 'because some As are Bs, then it is not true that no As are Bs' it would not be considered intuitionistically valid?

E. That is perfectly valid I believe.

A. But it is the law of the excluded middle.

E. It's because if some As are Bs then you presumably have witnesses to this fact, some philosophers that are men, perhaps. So they are counter-examples to the contradictory statement that no philsophers are men. The problem comes when you try to argue by contradiction. For example, if you derived a contradiction from the supposition that not all As are Bs and then used that to argue that some As are Bs. If you can't exactly specify at least one of those As then the proof is not sound, they say.

A. In *Prior Analytics* we explained clearly enough, we thought, that such a proof by contradiction is a *hypothetical* deduction and the hypothesis is that the contradictory of the conclusion is indeed false. The law of the excluded middle therefore

holds because it is in fact no more than the principle of non-contradiction. Do these intuitionists not accept the principle of non-contradiction?

E. They accept *that*, but the problem is that they do not consider that a proof by contradiction is a hypothetical deduction. They think it should be no different to an ordinary deduction. For example, if a proposition A is true then it is an ordinary deduction that $\neg A$ is false.

A. That's not a *deduction*, because it has only one premiss. These two statements 'A is true' and '$\neg A$ is false' are two not very different ways of saying exactly the same thing.

E. Unfortunately *all* deductions in modern propositional logic are like this. They are all tautologies.

A. A tautology doesn't *tell* you anything though, because it's always true. What's the point of it?

E. The idea that a deduction *means* something is rather alien now, I'm afraid. It is said that the most any proposition means is either 'true' or 'false'. The deduction is a reduction of the proposition to one or other of these.

A. This logic is purely formal then. So all the meaning is left to the interpretation. This is not really logic at all, it's just a means of encoding knowledge. You could use anything you like, lambda calculus, SK combinator calculus, Morse code or even Greek. Greek happens to include all the others, but in fact one can encode any one of these in the other. Why is there an argument between the intuitionists and the classical logicians?

E. The argument stems from the assertions that logicians make as to the certainty of the conclusions of deductions. The intuitionists claim there is room for doubt, and that if unrestricted use of the law of the excluded middle is allowed then the results *could* be unsound. It is considered a conservative position.

A. This is wrong. Logic does not produce certain truth. That's not the purpose of it at all. I think the misunderstanding comes from people seeing arguments based on necessary truth of conclusions following from the truth of the premisses. This is the formal logic, and it is the *argument* I use to prove that my characterisation of the forms of deduction is correct. This is *not* an argument that they establish indubitable truth.

E. If logic is not formal, then what is it?

A. Logic is dialectic, and it happens in the soul.

E. In the soul, so not on paper or in a formal system.

A. Those can represent it, but the dialectic must be a process and the only place it can happen is the soul.

E. Because this is where the sense is.

A. Yes. There is no dialectic without the sense, because without the sense there's no meaning and no interpretation either.

E. The formal logic guarantees that the necessary truth of the conclusions follows from the necessary truth of the premisses. And the premisses being based on intuition or sense-perception are necessary, so the formal logic surely guarantees the necessary truth of the conclusions?

A. Yes. But that isn't *knowledge*. One can reason from true premisses to a true conclusion and *still* have no clue at all about the real reason why that conclusion is

true. Knowledge is what we know when we know the cause of something and that this is the sole cause of that thing and of nothing else. And the clause 'and nothing else' is important. If I say that a particular philosopher will die because he's a man then I do not know the reason why he will die, because being a man is not the cause solely of him eventually dying, it is the cause of many other things besides that.

E. Aha, so the relation of logical consequence is the relation of cause and effect?

A. Yes. The knowledge is true knowledge when the logical deductions in the demonstrations correspond to the actual causes of the phenomena being demonstrated.

E. So this is why the basic premisses must be appropriate to the science. Because if they are not then there cannot ever be true knowledge: the demonstrations are producing the phenomena accidentally, in the wrong faculty.

A. For example a physicist who takes as a self-evident basic truth the fact that light has an absolute velocity, no matter how apparent it may be, renders the concept of the velocity of light meaningless. If he then deduces that consequentially simultanaeity is relative to the observer's state of inertial motion then sooner or later he is going to run into problems when he has to decide how one cause determines so-called 'space-like separated' events.

E. And so he did. He also ceased to believe in the reality of past and future and claimed they were an illusion, although a persistent one.

A. Locomotion is just change of location or *being in respect of place*. Place is the subject of the science of geometry and being is that of the science of first philosophy or *Metaphysics*. Motion in general and locomotion in particular is the subject of physics. But physics must take as a basic premiss the definition of motion from metaphysics, and that of the notion of place from geometry, it cannot deduce motion and place from other physical principles, because then it deduces motion from non-motion and place from non-place and nothing will really move except in an illusory way. The physicist cannot then explain anything because illusion is not a phenomena proper to physics.

E. So assuming we know then what logic is, why are we assured that we will all be able to agree on the basic premisses?

A. Education. We can all describe what we experience if we are taught to use language properly and if we are taught to observe and if we believe that this is worth doing. We all share essentially the same biology and so we share essentially the same sense-perception. We do not all speak the same language, but we have every reason to believe that all languages are essentially equivalent in terms of what they can express. Some may be more or less efficient than others in certain respects, but all should be able to learn to speak any of them and the reason for this belief is *inductive*: it is because children learn language. If there was something expressible in one language A and inexpressible in B then it could only be because the speakers of A were biologically different from the speakers of B. But as it stands, we have no evidence that any species of animal apart from man uses language.

E. Some chimpanzees and birds have been taught to do something that appears very like using language, albeit at a fairly basic level.

A. Education, as I said. But I will be impressed when I hear that there is a chimpanzee philosopher.

E. Some claim this is just a kind of cultural imperialism. That western civilization with it's particularly Greek foundation was just one of a number of classical cultures and that this was just an accident of history. They claim things could have gone a different way and then we would have had an Indian or a Chinese classical culture and would probably think very differently.

A. The only thing I don't agree with here is the contention that it was an accident. It was deliberate. We changed our written language to make it possible for foreigners to learn it more easily. We itnentionally spread our learning as far and as fast as we could. We gave it to any and every body who would listen. It was cultural imperialism, of that there can be no doubt. City-states grow and learn and die like people. The Helenes grew and learnt and we knew Hellas would not live forever as a state. So we sent forth the spirit *literally*. The polytonic Greek alphabet tells you how to aspirate the words when you speak, it is the *spirit* of the Helenes. We live in this now.

E. Logic, you say is *dialectic in the soul*, and the soul knows the *sense* of the dialectic. This is something that cannot be captured in a formal symbolic representation. But you say the sense can be carried on the breath. That by aspirating the words one could communicate this from one soul to another.

A. Yes. The symbolic representation is symmetrical you see. A formal deduction in Boolean propositional logic for example is equivalent to another deduction which has the opposite sense.

E. This is called the principle of duality. So $\neg(C \wedge D) \leftrightarrow \neg C \vee \neg D$ is one tautology, and if it has some proof then by changing all $\wedge$s to $\vee$s and *vice versa* then we get a proof of the dual which is $\neg(C \vee D) \leftrightarrow \neg C \wedge \neg D$.

A. Do you see that what you have is the mirror image of the proof, reflected as it were, in the division between truth and falsity? Make the division a horizontal line underneath the proposition and reflect it optically in that line then you will get the dual.

E. Except the negation signs have the wrong sense.

A. Do they indeed?

E. You mean the contrary of negating isn't negating?

A. Yes and no. Formally, no, they are the same.

E. You mean the *sense* in which negating is dual to this other operation is not merely formal. It is only in the actual that the distinction exists?

A. Yes. Only in the soul.

E. It *sounds* like something similar to what happens with incommensurable magnitudes. There the formalism of division expressed in the idea of ratio *seems* exhaustive, but it fails to capture the actuality somehow, and so it is possible to construct an incommensurable magnitude.

A. Remember the Greek word for irrational?

E. ἄλογος, literally *a-logical* which means unspeakable or *ineffable*? So its only in the soul that we can know this?

A. Yes. That prefix is called the *privative alpha*.

E. So if black were the contrary of white, then blacking something would be the same as taking the white out of it?

A. Awhiting it, you could say.

E. So blacking and awhiting *could mean* the same, but they have the opposite *sense*?

A. Yes, one is moving away from white, the other is moving towards black. In the case of colours these are not necessarily the same movement. Away from white could be to any colour.

E. But what's the point of going to the lengths of a polytonic alphabet then? If the result cannot be put into words, surely there's no point trying?

A. It cannot be captured in words, but the sense can be carried in the air. It is no good just marking the aspiration on the page, unless the word is actually spoken. The aspiration is what makes the connection between the symbols and the sense *actual*.

E. You mean because it's an essentially human experience to know the sense? And therefore humans can communicate the sense from one to another in actual speech, but not necessarily on the page?

A. No, the written communication gives the aspirants a reference based in human experience, i.e. sense-perception. If someone just learns the shapes of the words and that they correspond to words in their own native language then, unless these words happen to have an isomporphic relation with the physical sense-experience of enunciating them in the other language, then this connection is lost. Then the written communication fails. But when the sense is preserved, the communication proceeds, and it is *from soul to soul*.

E. So it's like the example of the drawings of the cube, isn't it? There it is just a matter of convention that diagrams of this sort indicate three dimensional volumes. People have to learn this and those who are not taught to represent shapes like this on paper cannot see them. So you have to know the convention to get the sense. As you said, it is a trick because those diagrams are not actual volumes. Looking at the top diagram I sometimes see it flip from being an oblong to just the inside of a three-sided shape.

A. Yes, it's ultimately a matter of education. But education is always based on some assumed ability to communicate, and that apparently comes from no prior knowledge on the part of the individual.

E. The *only* thing an actual being knows innately is the sense, isn't it?

A. Yes. And the soul is so constituted to be able to learn from this.

E. But if it so happened that there were *two* possible innate senses, then we would all *think* we were the same, but the sense could be contrary, and then some of us would mean something quite different.

A. You mean that some souls were innately left-handed and some right-handed, so to speak? Then there would be terrible confusion and a lot of senseless arguments and fighting amongst people, and *in principle* nobody would be able to agree with anybody on anything at all.

E. That would be a shame.

A. You would need something to break the symmetry then. A philosopher king could sort out the different senses and explain to people why it is that they have these fundamental-seeming disagreements. Then philosophers from each sense would be able to reason together. But only if they took this existence of the different senses as a basic premiss. This would not be something they could prove from just their own philosophy, it would be a common metaphysical ground for particular philosophies.

It would have to be a self-evident fact that they could verify by immediate sense-perception.

E. Surely they need only look at the difference between their left and right hands then?

A. And then if they looked in the mirror they could see there was another point of view, which, though apparently contradictory, if reasoned soundly, would actually be found to be the dual, the two differing only in the fundamental sense of each others' direct sense-experience.

E. The authority of the philosopher-king would have to be absolute.

A. Yes it would.

E. And he would have to be completely unbiased; *agnostic*, as it were, as to which sense was the right one?

A. Yes.

E. Moreover, it would have to be *known* and immediately evident to all that he was in fact *incapable* of drawing a distinction between the two fundamentally different senses.

A. Yes.

E. So the philosopher king is formal logic.

A. Yes. The perfection of the rational soul.

E. And that's the good of man: to reason excellently. So formal logic is the form of the perfection of human reason. The formal expression of human happiness in other words. And it is at once the first cause of movement in the Universe and its good.

A. Well done Mr Elaitton, you should consider yourself to have graduated.

E. So this was a two-day *viva voce*?

A. Sorry it took so long. There was a lot of material to cover, and we didn't actually go over it all very thoroughly even then, but you have demonstrated that you understand the principles quite thoroughly and from here you will be able to make progress without our help.

E. Without help?

A. We'll always be *around*. But we don't know much more than you now. You have to take it on from here. You have some of our texts to refer to of course. Sorry they're are in such a mess: some weren't finished, and some seem to have been lost altogether. The ravages of time, you know. But the sense is there in buckets. And most of your efforts will inevitably be directed towards teaching, as ours were. So you won't have *time* to do much more research. It was a pleasure to meet you.

E. And it was nice to meet you too Mr Aristotle.

A. It's Mr Dodgson, actually. But you can call me Charles if you like.

E. Oh, I had no idea. So you don't stutter any more?

D. According to Aristotle that was because the breath was too strong for the body, but now I'm not so encumbered it is much easier for me to get my words out.

E. Well, I am delighted to have made the acquantance, Charles. And my friends call me Minor.

D. The pleasure is reciprocally proportional. Good-bye then. And don't forget to go for plenty of *long* walks. One needs a healthy body to do philosophy, and it is so very vexing to have to start again from scratch.

E. Indeed it must be. I won't forget. Good-bye.

[Dodgson vanishes slowly, without music.]

1.1 Scene III

[Elaisson's room, a few seconds later. There is a vigorous knocking at the door.]

E. Come in!

[The door opens and a young woman in her mid to late twenties bursts into the room. She is tall and has large blue eyes, her black hair is wet. She is wearing jeans that are half a size too small for her and a dark blue T-shirt with the slogan 'Old chemists never die…' stretched in various ways across the front of her ample breasts.]

E. Aletheia, hello.

Aletheia. Oh *please* don't call me that!

E. It's your name.

Alice. It sounds like a lisp, I hate it.

E. Alright, Dr Pascoe. But you should know it's probably the most beautiful word in the Greek language.

A. It's Greek?

E. Yes, it means Truth with a capital-T.

A. Well I think I knew that once, but I'd forgotten.

E. You look like you've just risen out of a lake with a sword in your right hand.

A. I've just crawled out of the Cam dragging a punt pole, actually. Are you coming to the fellows' garden party?

E. If I did it would be my third in five days!

A. Just for a bit, pleeease. It's *your* SCR, and I *have* to go if I want to supervise for the college next term, and it will be *very* boring if I don't have someone to talk to instead of the same people that say the same things they said at the same party *last* year.

E. OK, I need a breath of fresh air too.

A. I haven't seen you for days and days. What have you been up to?

E. Working, and I had a very strange 'interview'.

A. Wonderful, you can tell me about it on the way. You'll have to shave first you know, you look like you slept in a flower bed.

E. Thanks. While I do that, can you tell me what you know about helium?

A. It's light: it's the second element in the periodic table. It's a noble gas, so it hardly reacts with *anything*, and it's impossble to make. There's a very finite supply of it, and it comes from the earth and it all eventually escapes into space. It was originally made in stars I think, or the perhaps the early Universe, I forget.

E. What's a Noble gas?

A. It's *perfect*, in a sense. Complete. It needs no business with any other element. A bit like you *think* you are.

E. I'm sorry, I am just busy. Too much stuff to learn. And I have to mark forty Geometric Algebra scripts by Wednesday, but since I haven't even started that I can't really use it as an excuse. Tell me why a Noble gas is perfect. It has all its orbitals populated by electrons?

A. It must be more complicated than that. Not all chemical bonds are covalent bonds. In fact there are dozens of different types of bonds. Everyone thinks chemistry is like λεγο! That it's a matter of sticking little blocks together, and there is a big chemistry set with 105 different types of block, and an infinite supply of each. And they think chemists just add a teaspoon of this, and two teaspoons of that and shake it a bit, boil it for a while and then scrape off the purple scum and Bob's your uncle. It's not like that at all.

E. I imagine it's more like herding cats.

A. Well, if that means sorting out one of five different types of cats, when there are 6.02×10^{23} of them all tearing about the room at the speed of sound, spontaneously turning from one type to another every now and then. Then yes, it's *just* like herding cats!

E. That sounds *difficult*!

A. It's impossible. That's why nobody understands chemists.

E. You are notoriously weird people, it has to be said. What does it say on the back of your T-shirt by the way?

A. 'They just make more of a stink.'

E. Poor misunderstood chemists. Why *do* people think you're weird?

A. We only do things like this to keep ourselves sane.

E. Shutting the stable door after the horse has bolted, I fear. There, is that better?

A. Hmm. . . so you don't have a clean shirt then?

E. No, sorry, is it smelly?

A. We'll be outside. I don't think anyone will notice.

E. And are you really going to wear that T-shirt?

A. I've brought a jacket, come on!

[The College Fellows' Garden. A jovial, musical-looking little fellow plays Goldberg variations on the harpsichord and people stand around chatting, holding glasses of pink champagne. There is a table covered with a white linen cloth, covered with large silver trays which are in turn covered with small pieces of food, of various colours and shapes.]

A. What was I saying about chemistry . . .

E. It's like herding cats at Mach won.

A. Ah yes. The only way you can do it is by using thermodynamics. It's not just a matter of knowing the bond types and the mechanics. In fact, that's something that often comes *later*. If you look at the history of chemistry most of the interesting structure was inferred *after* the reactions were observed.

E. Because you have to start with something real and analyse it.

A. Yes, even the thermodynamics are worked out after the event.

E. Couperin!

A. What?

E. This piece. It's by Francois Couperin. It's my favourite. Baroque and Roll.

[Alice waves her empty glass almost imperceptibly and a young waiter brings over a tray full of glasses of pink champagne.]

A. [Takes a glass and winks] Thanks Paul.

Waiter. Ma'am. [Blushing furiously]

E. Alice, you're a navigation hazard.

A. And you, Professor . . .

E. Master at 11 o'clock.

A. [Groans quietly]

E. Good afternoon master.

The Master. Elaisson, Alice, hallo.

A. Master.

M. How are the stinks and bangs then Alice?

A. Noisy and smelly as ever, master!

M. Ha ha, jolly good. I hope you can surpervise my part IIs next term?

A. I'd love to, yes.

M. Jolly good, I'll let you who they are soon. And you Elaisson, how is the old geometry?

E. Very well, thank you. I discovered something quite exciting only yesterday.

M. It's incredible that there's still anything left to say about a two thousand years old textbook. I saw that some fellows have formalised some of the proofs. They proved that his diagrammatic reasoning is actually sound. Impressive, no?

E. I saw that. Unfortunately Euclid didn't *use* diagrammatic reasoning. I have that on good authority. I should be able to make a *very* convincing argument to this effect.

M. Well, don't take too long over it, it is only the first geometry textbook, you know, and there are a lot more yet to go before you get one that has a prayer of describing the space we actually *live* in.

[Alice is standing a little behind the Master, slightly to one side, crossing her eyes and making faces at Elaisson]

E. Is that so? I thought we lived in Euclidean space.

M. No we most certainly don't. I'm a physicist, as you know, though I hardly have any time to do any these days. In the space we live in, walking across the lawn *here* turns time *over there* into space! And there are objects which, when they turn through 360 degrees are not the same state as they were before. They have to be turned through another 180 degrees! The space we live is not empty space either, it's a seething mass of quantum foam, it's a medium that carries energy, and it's an actual tangible substance, harder and more rigid than steel. If you hit it, it rings like a bell! What would your ancient Greeks make of that eh?

E. I am *quite* sure they would not be able to make *any* sense of that *whatsoever*.

[Alice drains her glass and deftly swaps it for a full one as another waiter passes, he slows his pace only fractionally and turns as he passes to allow her to affect this well-rehearsed manoevre.]

M. No they wouldn't! And you know what? All this was only discovered in the last century and a half. Do you know why?

E. Because that was when we stopped teaching Euclidean geometry and traditional logic to scientists?

M. Exactly! But do you know who was the first to axiomatise Euclidean geometry? David Hilbert! Did you know that?

E. No, I had no idea. I thought it was Euclid.

M. Hilbert knew Euclidean geometry better than Euclid did, and then he took it to the next level. The shoulders of giants, indeed. But I must just catch the President before he leaves. See you at high table tomorrow. You too Alice?

A. I'd love to, thank you master!

M. Delighted. See you then.

[Exit The Master]

E. Oh dear!

A. Odious, you mean.

E. They all think Computer Science is what you do when you can't cut the mustard as a proper scientist. But you know, the standard of intellectual rigour of those Greeks was so much higher than it is in the so-called 'hard sciences' now, that hardly any one even recognises it as rigour.

A. Here, have some more pop, you earned it. [Empties half of her glass into Elaissons', spilling some on his hand]

A. Oops. Sorry! [Smearing the drop slowly along the back of Elaisson's hand with her index finger]

E. You are very definitely a navigation hazard.

A. I was going to say, you're a chemical hazard.

E. God, I'm sorry. Do I smell that bad?

A. It's gorgeous.

E. Steady on Alice! How many glasses have you had?

A. Only three. There must be some organic reaction going on in the bubbles. How about coming with me down there to admire the magnolia? We could lie down in the long grass and you can put your hand down my jeans.

E. For god's sake, Alice!

A. Sorry, is that out of bounds? Am I lewd and disgusting?

E. No, it's lovely, really it is. Just a bit unexpected, and, well, old dons just do not snog beautiful twenty-somethings with the whole SCR looking on! It would scandalize them.

A. You're not old, you're just middle-aged, and they'd *love* it! And for once they'd have something different to talk about at the same party next year.

E. And the next fifteen after that, I should think. Alice, you're lovely.

A. You'd better take me back to your rooms then. Right now, before I do something completely disgusting.

[Exit Alice, Elaisson]

1.2 Scene III

[In Elaisson's room. Elaisson and Alice are in bed.]

A. I'm fed up with Cambridge. All this fawning around, ingratiating myself with people I can't really stand, just so that I can teach their students.

E. You really love teaching, don't you?

A. Yes, even the ones who think the subject is a waste of time. I feel I'm saving thir souls. But the rest of it, the stupid little privileges being handed out here and there and the mutual back-scratching and back-stabbing is just *ridiculous*.

E. Yes. As my friend was explaining to me only this morning, it's all about power and nothing about potential. The power is what you have when the energy is there to make definite things happen. The potential is the subtlety of *possibility* and that is not definite, and no-one values it. But it's the potential that is ultimately where everything that's new comes from.

A. Your friend is a born chemist. That's thermodynamics he's just described. That's why I *have* to teach, because someone has to show these little chemists why it is that the most boring and dreary part of their subject is the driving force behind *everything* that happens. The only chemists that make it are the ones that take thermodynamics head-on. You have to grab the bull by the horns and wrestle him down onto the ground. Otherwise you spend all your time dodging his charges.

E. Crikey! There's obviously more to this thermodynamics than I thought. And when you've got him on the deck, what then?

A. I don't know. I hope he tells you a little secret. But I'm still wrestling. I think he's on his knees, but he's not lying down yet.

E. You seem a bit stir-crazy. What do you want to do?

A. Well, I've been offered a job. I have until Monday to decide.

E. Where?

A. Bolivia.

E. That'll certainly be different! And it's a teaching job?

A. Not really. It's with the government's scientific research organisation. I would be researching and developing processes and designing and commissioning a plant to produce 100 tonnes of pure lithium a month.

E. That sounds quite serious.

A. Seriously difficult. They have hardly any expertise, and almost no money. It's starting from scratch. It's this incredibly poor country with nothing except the natural reserves, and these are traditionally sold off at next to nothing to foreign companies who make huge profits and give hardly anything back except a few well-placed bribes. This is an attempt, for once, to get a fair recompense for selling the family jewels.

E. Do you speak Spanish?

A. A tiny little. I did a gap year travelling around Argentina and Chile, and spent a few weeks in Bolivia on the way to Peru.

E. It's a far cry from a cushy little research fellowship in Cambridge. No garden parties, there, I bet. You know, since getting to England I've only ever been abroad twice. Both times to France, and one was a day trip to Calais to buy wine.

A. What a sheltered life you've led.

E. Yes. But I graduated today. That's something, isn't it?

A. You graduated? Well done! How old are you, forty something? How long have you had your chair?

E. Forty five. I've been a professor for five years.

A. What did you graduate to?

E. I don't know. He didn't say. The next level, I suppose.

A. What *are* you talking about?

E. I'm not sure I know you well enough to be able to tell you this.

A. You can't be shy! Not after what you just did to me. Which was lovely, by the way.

E. I had no choice. You *made* me do it.

A. You didn't *seem* to be acting under duress. And anyway, it would never have ocurred to *me* to make someone do that.

E. It had been occurring to me to do that to you for several weeks, on and off.

A. If you did that to me for several weeks it would probably kill me, even if it was only on and off.

E. Hmm.

A. So what did your 'friend' tell you?

E. That Charles Dodgson was the reincarnation of Aristotle.

A. Lewis Carroll?

E. Yes.

A. He wrote that?! Wow.

E. No, he didn't write it. It's what *I* believe.

A. You believe in reincarnation! That *is* the next level. You'd better not mention it at high table though. Who'd have thought it. You of all people. Why do you believe that?

E. Well, it was partly something he wrote. It was a letter to someone called Edith. It's in that book over there. Pass it over?

A. The Life and Letters of Lewis Carroll. And it's right here, you marked the place with this obituary notice, for one J. Muir, Reader. Natural History, St John's College. Born 1936. Died 2011. There's no better way to make oneself useful from beyond the grave than to give the members of the Regent House a handy bookmark is there?

E. No it seems one can do *much* more. Read it.

A. [Reads aloud]

> Eastbourne, *Sept*. 25, 1885.
>
> My dear Edith,
>
> One subject you touch on "the Resurrection of the Body" is very interesting to me, and I have given it much thought (I mean long ago). *My* conclusion was to give up the *literal* meaning of the *material* body altogether. *Identity*, in some mysterious way, there evidently is; but there is no resisting the scientific fact that the actual *material* usable for *physical* bodies has been used over and over again—so that each atom would have several owners. The mere solitary fact of the existence of *cannibalism* is to my mind a sufficient *reductio ad absurdum* of the theory that the particular set of atoms I shall happen to own at death (changed every seven years, they say) will be mine in the next life—and all the other insuperable difficulties (such as people born with bodily defects) are swept away at once if we accept S. Paul's "spiritual body" and his simile of the grain of corn. I have read very little of "Sartor Resartus," and don't know the

passage you quote: but I accept the idea of the material body being the "dress" of the spiritual—a dress needed for material life.

C. L. Dodgson.

That's not so very wild-sounding, really. He was an ordained Deacon of the Church of England, wasn't he? They are a bit inclined to say things like that.

E. He wasn't a run-of-the-mill Deacon. In those days you had to be ordained as a full priest to be a Fellow of an Oxford College. He refused, and he would have been sent down, but for some reason the dean changed his mind at the last minute. But Dodgson was a very rational man. He taught traditional logic and Euclidean geometry and he was rigorous. He had arguably higher standards than anyone else of his day, including Cook Wilson, the Professor of Logic at Oxford. The only papers I know that Dodgson published were two articles for *Mind*, towards the very end of his life. Both are on formal logic, and one is really just a summary of his argument with Cook Wilson about hypotheticals.

A. So you think he was not just being frivolous, he was serious? You don't think he was trying to impress Edith?

E. No, because the very next letter he writes to her is about a detail of formal logic. It happens to be a very important detail, but he is trying to get her to think logically about things.

A. OK, given all this is true, how do you arrive at the conclusion that he was the reincarnation of Aristotle?

E. Because he wrote '*My* conclusion was to give up the *literal* meaning of the *material* body altogether.' And *I* think that's exactly what *Aristotle* did. This part of the argument is what you might call intuitive, because it is a mosaic, as it were. None of it is made absolutely explicit, but it's a *feeling* I get, that the big picture is something you see when you look at the whole.

A. I'm completely lost now. The whole what?

E. The whole of Aristotle's writing.

A. And the big picture is what?

E. I'm not completely sure, it's terribly hazy and vague, but a part of it seems to be about immortality. The soul dies with the body, he is absolutely clear about that. So there is no question of anything like sense-perception or reason or even 'vegetative being' going on after death. But there is an idea of the spirit, and it is an element, a type of matter and it seems to be carried on the breath. I am not at all clear how, but the spirit and the air are connected somehow.

A. How does this convince you of the fact of reincarnation?

E. Well, there is actually a single Truth, aletheia.

A. Don't call me that!

E. No, really, that's what this single truth is called.

A. Oh. sorry. Go on.

E. And this single Truth is something that seems to be just incredibly difficult for people to grasp. But it's also incredibly obvious. Or it seems so to *me*. But it's written all over Aristotle's writing, and all over Carroll's.

A. He wrote some books about mathematics too, didn't he?

E. Well, he did, but it is the Alice books that have most about it. References to Aristotle are so thick there it's as if there wasn't a single idea that was actually Carroll's and not Aristotle's.

A. For example?

E. Well, a lobster's red hair, the suffering of turtles, starfish, The Duchess' house is an orgy of elements: Fire, Air, Water, Earth and Spirit. The Lobster Quadrille is a formal proof of Aristotle's, as is the Song of the White Knight, where the latter relates meeting Aristotle sitting on a gate. The song is 'Ways and Means' which a term from Aristotle's Economics.

A. That's not what the song *actually is*, that's what the song is *called*!

E. You know it?

A. They were my favourite books when I was a kid. I didn't have a clue they were about logic though. It's more fun than it sounds, then.

E. It's the *most* fun.

A. Only a man could say something like that.

E. I'm sure women would find it equally enjoyable.

A. I'm sure they do enjoy it just as much as men do.

E. But?

A. It would never be as good as sex.

E. You think Tiresias was right then?

A. I know he was right because he *knew* both sides. Women enjoy sex about ten times more than men do.

E. Well, Aristotle said women are venal, but he didn't explain why. That's interesting to know, thank you. Really, ten times more?

A. Yup.

E. It's hard to believe that *anything* could be twenty times better than logic. But if that's true then it's no wonder it's hard to get women interested in logic.

A. Harder than Chinese algebra. So you think logic is twice as good as sex?

E. Somewhere around there. But that's not to say I don't think sex is good.

A. No, *that* is perfectly clear to *me*. But twice as good as good sex? That's better than life itself, I would have thought.

E. Yes, it's better than life itself. Ask Socrates.

A. I can't because he's dead. Do you think people take it *that* seriously, for real?

E. Socrates did. And I think Charles Dodgson did.

A. Maybe Che too?

E. Che Guevara? I've never thought of him as a philosopher.

A. He was, and his last words were addressed to the soldier who'd been charged with his execution. He said to him 'you're only killing a man.' He's considered a hero in Bolivia. It's strange. The Bolivians didn't seem to want a revolution badly enough. Not even the Bolivian Communist party wanted a revolution, they had other plans apparently, which don't *seem* to have come to anything, but you see posters celebrating 'El Che' in Bolivia, some of them with photographs of the Bolivian Communist party leader on them.

E. I understand how there being one Truth means that people who reason well will share the same 'mind', in the sense that they will see the same logical structure out in the world, and they will know that they see that same structure when they

speak to each other. And then it's fairly obvious in a sense that these people are one because they share the same mind. But they will not necessarily be one *identity* or one *person* because of that. If I met someone else alive now and we both found we shared the same intellectual understanding of the world, then we would still be two different people. But Dodgson was getting at something else in that letter. He says 'I mean long ago' and he refers to an identity 'in a mysterious way'. But he doesn't say 'a mysterious *sense*'.

A. You're reading this letter *very* carefully, but are you sure he *wrote* it that carefully?

E. Not certain, but I know he *could have*, you only need to look at the Alice books to see that.

A. How can you *know* something so haphazard as *Alice in Wonderland* was carefully arranged? It's like saying that a pile of bricks only *looks* like a pile of bricks, but was actually arranged by an artist who claims to have placed every brick according to some deliberate plan. You can only *know* that when you know the plan and can *verify* that the bricks were indeed arranged according to that plan *and no other*.

E. A few years ago I went to the Tate Modern with my daughter, and in one of the exhibition rooms there was just a pile of scaffolding in the middle of the floor, some empty cigarette packets, a plastic bottle and what not. It was obviously a random pile of junk left behind by workmen setting up an exhibition, but who had taken the day off. And it it was only when I went and read the write-up by the door that I realised that it was in fact all faked. The whole thing, right down to the spent matches and cigarette butts, the crumpled Camel Filter packet, the scaffolding planks and even the paint-roller had been made from modelling clay and fibreglass, hand-painted with acrylic paints. There was nothing random, everything was deliberate, and it had been so meticulously placed to *appear* as though it were random and meaningless.

A. So the Alice books are cooked up to look random, but when you look, there's reason behind it all?

E. Yes. But on closer inspection it seemed incredible that I had been taken in by it, because the cigarette packet had so obviously been hand-painted. But because I knew that it was a cigarette packet, I hadn't needed to more than glance at it. Their *genius* was in knowing that they only had to produce something that fitted the expectations people had of junk. And this mere resemblence, though slight, was enough to trigger the expectation which then became reality.

A. That I can understand, because no-one expects children's books to be actually about ancient Greek philosophy. Children's books should be fun and should moralise a little.

E. But Alice doesn't have much *fun*. Apart from random acquantances she's completely alone. She's reduced to tears, and no-one, not even the nicest of the creatures, is *really* kind to her. And where's the moralising? There are the Duchess' morals, and there are morals like 'Don't drink from a bottle marked POISON, but do drink from a bottle marked DRINK ME'. The books are really nightmares. She is plunged into madness for a day and it is only when she wakes up that she finds out that life is really good and she has her family and her kittens.

A. I think that's why I liked them so much. They tell you that all the insanity *might* all be just a bad dream and you could wake up and see that everything's really

lovely.

E. No no no! I don't think that's what he meant at all! Dodgson believed, *passionately*, that the world was *not* like that. It is said that this is the reason he refused to become a priest, because he couldn't accept that any god would make people suffer for eternity for not believing in something, the knowledge of which could in principle not be demonstrated.

A. But he could demonstrate knowledge of the world being good and beautiful and all dozing with kittens by warm fires on winter afternoons or dreaming on summer days by the river?

E. Well, we *know* that this is what it *is* like. And that's what the logic is all about. It's made to *look* like insanity, but every little bit of insanity is a little *logical reason* why things actually appear as they do, and why things are really *not* as they seem.

A. How do we know it is really like that?

E. Well, even in Bolivia, little girls can cuddle kittens and doze on the banks of a river.

A. I suppose so, even if they can't afford to feed the cat a week later and the little girl dies of typhiod.

E. That isn't *always* like that though.

A. And you say he *proves* it is like he says?

E. Yes, I think he does.

A. For example?

E. Well, the Cheshire Cat's mad. He says so himself, and he gives a *sophistical* argument.

A. What's that?

E. He gets her to agree to a premiss. It's not a *necessary* premiss though, and it's not even true. The premiss is 'a dog's not mad'.

A. Why doesn't he say 'dogs aren't mad'? Because she might say 'some dogs *are* mad'?

E. I think so.

A. The argument is he's mad because a dog wags his tail when he's pleased and growls when he's angry, but *he* growls when he's pleased and wags his tail when he's angry.

E. But because a dog's not mad, *he* must be mad. But this doesn't follow necessarily, because these are two *signs*; they're not the actual states of being angry or pleased.

A. Because the signs of the same states *can* differ in different types of animals.

E. Did you notice that the cat in the Duchess' kitchen is '*a* Cheshire Cat'. But the cat Alice sees sitting on *a* bough of a tree, is *The Cheshire Cat*.

A. It's just *the* Cheshire Cat she saw earlier, isn't it? But what's the difference between *a* bough of a tree and *the* bough of a tree?

E. I was hoping you would tell me that. I think it's a difference of *sense*. But I would like to know exactly what you think this is before I say what I think, because I might influence you. Take your time, and think carefully what is the difference.

[Several seconds pass in silence.]

A. Well, first I should warn you that when I was an undergraduate we had a series of lectures on Russell's theory of singular descriptions, so I have probably been

indelibly tainted. But having said that, it didn't make a great deal of sense to me. It seemed more like Humpty Dumpty's theory of the meaning of words. Let's see, what do I think is the *sense*? The word 'the' is *called* the definite article, and the word 'a' is called the indefinite article. So I suppose *the* bough of a tree is a definite bough of some tree. But *a* bough of a tree *could* be any of them. So if he had written 'had she looked then she might have seen the cheshire cat sitting on a bough of a tree' then it would be ambiguous. *However* since she *actually saw* the cat sitting on some particular bough of a tree, it does not make sense to think of that definite thing as an indefinite branch of a tree unless it were actually *removed* from the tree.

E. In summary then, 'a bough of a tree' is possibly not attached to the tree, and 'the bough of a tree' is definitely attached to the tree. But this refers to possibility, whereas if we are speaking about the actual, then 'a bough of a tree' is quite clearly not an integral part of a particular tree, and 'the bough of a tree' is definitely a particular part of a particular whole tree.

A. Yes. Is that what you thought?

E. Yes, but I didn't argue it nearly so clearly. I failed to distinguish between the actual and the possible. Your analysis is better.

A. That's just chemistry.

E. The actual and the possible?

A. Yes, it's the only way you can get a grip on what's going on down there in the soup. You have to use the actual to change what's possible. And all the real work is done by Brownian motion.

E. Like the Cook in the Duchess' kitchen.

A. She's horrible, she just throws things at people. Is that supposed to be Brownian motion?

E. When the Duchess shouts 'Pig!' at the baby, the Cook stops stirring what is apparently soup and sets to *work*, which turns out to be wreaking havoc, basically.

A. Oh, I missed that. One assumes that her work should be stirring soup, since she's a cook, but it's actually wreaking havoc. *Apparently* soup?

E. Yes, when Alice first enters the kitchen '. . . the cook was leaning over the fire, stirring a large cauldron which seemed to be full of soup.'

A. I didn't notice that. But are you sure it's that it *is* soup that is apparent, not just that it is *full*, which is apparent?

E. Well, if it is apparently full of soup then they're both apparent.

A. Well, I'm a chemist, not a logician. I don't see why it can't be just one of these facts that's *merely* apparent.

E. If its contents are actually soup and nothing else, then you're a *magician* if you can make it apparently, but not actually, *full* of soup.

A. If it were just half-full of actual soup then I could do that with mirrors or something couldn't I?

E. And then it would actually be mirrors and soup, and probably air which it was apparently full of.

A. But if what it was actually full of was in fact only apparently soup then it would be only that it was actually soup that was merely apparent, but that it was full would not be *merely* apparent, but apparent because it was *actually* true.

E. Exactly. So the *only* way it could be merely apparent that it was full of soup is if it were actually full of what is merely apparently soup.

A. And *you* think this is more fun than sex?

E. No, I don't. This sort of argument is not what logic is *about*, but it's the way you have to learn to argue to be able to understand logic. You have to be careful about how you use words. And if you are not, then you spoil all the real fun, which is what happens when you can reason well about what the words mean.

A. It seems like splitting hairs to me.

E. There is a reason for this distinction though. Aristotle is making the point that substance is always a form realised in some actual material. This is crucial because substantives are the *only* basis we have for knowing *anything* about the world. Ultimately all our knowledge is based on sense-perception, and this *has* to be true.

A. You mean *Dodgson* is making the point. But we keep making him speak of things not being as they appear. This doesn't seem to add up.

E. The things that are not as they appear are never the substantive objects of sense-perception though. They are *abstract* ideas like good and evil and full and empty.

A. And soup!

E. Soup is an abstract idea in so far as its meaning is a definition of a certain species of concoction. But an actual cauldron of it is substantive. It has the *material form* of soup, however we have defined it: watery suspension of more than one type of solids.

A. Surely you can't mean that he claims no one is *ever* mistaken about what they see?

E. Not he's not saying that at all. He says that when these things happen they are *always* accidental. If we ever know the *reason* why they were mistaken about what they actually saw then we cannot say that their perception was at fault. What they saw was really what they saw, and the reason it appeared to them in that way is understood. For example if a car looks brown one night under a sodium lamp then someone is not mistaken when they see a brown car that is actually red. But of they saw that their aunt was driving a green car yesterday but it turns out that it was in fact red, but no one ever finds out why that happened, then it was an accidental error and has no explanation.

A. It's kind of *extreme science*. What we see *is* what we see *absolutely*, and if it turns out to have been something other than how it appeared, then it was that other thing that we actually saw.

E. I would just call that common sense, and if it is considered extreme then perhaps that is rather telling. It amounts to taking seriously the fact our deductive knowledge of the world is *always* based on other knowledge about the world. This has to have some beginning though, which is knowledge we have which is not based on deductive inference, but on sense-perception.

A. So when we experience an optical illusion, we know it is an optical illusion, but this knowledge is ultimately based on sense-perception.

E. However we don't then completely lose confidence in our sense-perception, do we?

A. No we don't. In fact it's the reverse: because we actually know *more* than we did before about how it works, our confidence *increases*. That's how knowing the

exact shape of the distortion of the mirror enabled them to fix the the Hubble Space Telescope by just changing the electronics. That's rather deep.

E. And then when Alice is arguing with the Duchess that if the earth turned round faster it would not change anything because a day and a night is defined as being the time it takes the earth to turn round, she says 'think what *work* it would make with the day and night…'

A. It would make work, not wreak havoc.

E. Because a day *actually is* just the time it takes the earth to turn on its axis. If the earth did turn faster it would not necessarily change a thing.

A. Surely it would change a lot. There would more days in a month, for a start!

E. Not *necessarily*. If the earth can turn faster, then why can't it also orbit the sun a bit faster, and the moon orbit the earth a bit faster as well?

A. I suppose it's *possible* but it seems pretty unlikely. And the relative distances would have to change, wouldn't they?

E. Well, in considering the earth turning faster, I don't think we're constraining ourselves to the realm of the probable, are we?

A. I suppose not. But if all the gravitational relations changed to compensate, surely there would still be chemical clocks that wouldn't change. It would still take the same time for a certain reaction to complete in a certain concentration of a certain solution.

E. Yes indeed, and what this means is that we wouldn't have any *science* of gravity at all if we did not have some sensible processes that were independent of gravitation in some fundamental way. Gravity is just the logical relation between mass length and time consistent with what we actually observe. If our only means of measuring time were by reference to gravitational effects then we would be unable to detect any change in the fundamental constants relating these three dimensions. We would lose the empirical basis of the science and it would all be just a question of consistent formal logic.

A. Just like saying that if god got a new computer and ran the simulation of the Universe faster then we wouldn't know. This is chemical thermodynamics. I'm so silly to have missed it.

A. Have you ever actually seen Brownian motion?

E. No, I'd love to, though.

A. You would, it's quite mesmerising. This little thing makes it's mysterious way around the microscope slide and there's no apparent ryme nor reason to it, but it never moves in a smooth curve. It only ever *jumps*. Most of the jumps are roughly the same length, depending on the size of the thing itself and the temperature of the water, but a few are tiny and a few are huge. Einstein did a lovely bit of thermodynamics and showed that this was completely consistent with the atomic hypothesis, and he was able to give a quantitative relation betwen the distribution of jump lengths and Avogadro's number. So he was really the founder of modern chemistry, because this was the first real experimental evidence of the reality of molecules. Until then chemists had treated them as a sort of abstract relation that held between quantities of formulae in reactions. Of course everyone probably had in the backs of their minds the idea that these relations were due to the combination of atoms according to some

inherent physical properties, but no-one had the slightest idea what those could be, mechanically.

E. Gosh. So Einstein conjured up *all three* of the most perplexing substances in modern physics. Objective space-time, photons and atoms.

A. Space-time is a *substance*?

E. Yes, you heard the master. It is a seething mass of quantum foam, and electromagnetic and gravitational energy propogate through it spontaneously, just like heat propogates through a solid.

A. That's why he was a genius. All these incredibly implausible-seeming things turned out to be actually real tangible substances.

E. The thing is they're *not* tangible. You can't feel quantum foam, you can't hit empty space-time and make it ring like a bell, you can't see an individual photon and you can't see or feel an atom.

A. But we *deduce* they're real, because we can do these experiments that verify their existence. And these experiments are based on real tangible things. Actual measurements made using actual sunstantial things like thermometers and litmus paper.

E. But the experiments don't directly reveal the phenomena like photons and atoms and what-have-you, these are based on deductions from the actual experimental data. But just because the deductions are consistent with these intangible substances being real, we don't know that some completely different real substances could produce the same experimental results.

A. It's just a question of faith in the existence of objective world. That's what a scientist has to have to make science worth doing.

E. Wouldn't it be better though if we could *prove* that the intangibles were the *only* things that could actually cause what we actually experience?

A. It *would*, but that's crazy! We don't know that the world isn't just a simulation running on god's great big white computer.

E. Laplace's demon? I'm not sure Laplace imagined anyone knowing the result of any of its computations.

A. And *the* Cheshire Cat?

E. He actually writes '. . . she was a little startled by seeing the Cheshire Cat sitting on a bough of a tree a few yards off.' Even in Victorian English, wouldn't it be more natural to say 'she was a little startled to see. . . '?

A. It seems like that *now*. The way he puts it suggests it wasn't just a momentary surprise but some more permanent state.

E. The cheshire cat grins, and the Duchess has asserted that all cats can grin all the time, and most of 'em do. And Alice still says she doesn't know of any that do.

A. Oh, I thought she meant all cats can grin, and most them do. Not necessarily all of the time.

E. She *asks* 'Please would you tell me why your cat grins like that?'

A. Are you sure she doesn't just mean 'why does your cat grin the way it is grinnning now'?

E. Yes I am, because when the Duchess explains that it's because it's a Cheshire Cat, Alice says 'I didn't know that Cheshire cats always grinned; in fact, I didn't know that cats *could* grin.'

A. I am beginning to see what you mean now. It's full of these little apparently random discontinuities. But are you *sure* they're not accidents?

E. Yes I am absolutely 100% certain because Dodgson was meticulous about detail. He must have driven Tenniel to the brink of insanity over the illustrations. He objected to the White Knight's whiskers and the amount of crinoline in Alice's dress. He had the most elaborate system of index cards for record keeping. And his reasoning was precise to the point of seeming obsessive. And secondarily, I don't seem to have much trouble at all finding the *reasons* for these apparent flaws. Often they seem ambiguous, but even that ambiguity seems deliberate.

A. So all Cheshire Cats can grin all the time, and most of them do. They must be grinning and bearing something.

E. Baring something other than their teeth?

A. Being mad? Being in pain?

E. Remember this:

> The Cat only grinned when it saw Alice. It looked good-natured, she thought: still it had *very* long claws and a great many teeth, so she felt that it ought to be treated with respect.

A. Actually, no I don't.

A. Aristotle's *The Parts of Animals* is comparative anatomy, you might say. He draws correspondences between this part of one species with that part of another. Birds wings with men's arms, a man's nails with a cat's claws, and even between plants and animals: bark with skin, thorns with teeth, etc.

Is this not just completely blindingly obvious yet?

A. No, it isn't, sorry. So he's a dangerous looking cat up a tree.

E. Why is he dangerous? Why is he up a tree?

A. He's dangerous because he has long claws, and a great many teeth, and he's on a bough of a tree…Ah, so he's most likely not up a tree, just on a branch. And I suppose he's not necessarily dangerous either, I just assume that if has long claws and lots of teeth …He commands respect, and he's on a branch of a tree.

E. If you put this *all* together, the madness and pain, the nails, the wood, don't you see that he's wearing a crown of thorns and he's nailed to a cross?

A. Aha, yes, he's *The Christ*, and his grin is a crown of thorns so when she calls him *Cheshire Puss*, he just hangs his head and that's why he appears to grin even more. And he tells her 'this way, there is a hatter, and this way a hare, they're both mad …' So they are the thieves.

E. It's actually:

> 'In *that* direction,' the Cat said, waving its right paw round, 'lives a Hatter: and in *that* direction,' waving the other paw, 'lives a March Hare. Visit either you like: they're both mad.'

Then alice says 'But I don't want to go among mad people'.

A. Who talked about 'to go among thieves'?

E. I don't know, but it sounds familiar. And it's not 'visit either *if* you like' it's as if she has no choice about whether or not to to visit one of them, just *which* one, and

they're *both* mad, and so is he! Then later when Alice says she wishes he wouldn't keep popping in and out of existence, what happens?

A. He fades slowly, leaving just his grin. And Alice thinks 'Well! I've often seen a cat without a grin, but a grin without a cat! It's the most curious thing I ever saw in my life!'

E. Which means what, on this analysis?

A. 'Well! I've often seen a christ without suffering, but suffering without a christ! It's the most curious thing I ever saw in my life!' Oops, that's probably a bit heretical!

E. Aristotle said there is nothing that isn't evident in the actual substantives of sense-perception. There is no other world, and no other life as far as Aristotle is concerned. The soul dies with the body, and that's the end of the life of sense-perception and thought. The idea that pain and suffering in this life is inevitable but that Christ paid for our sins so we won't have eternal pain and suffering if only we believe in this, is untenable.

A. But it is pretty obvious that there *is* suffering in this world. And surely suffering is caused by evil, not christs *per se*. So there is *evidently* evil in this world. I agree this much with the Christians, but I disagree about the solution. I don't think we should just believe that the next world will be better because of Jesus, and that this will *make* it better for those who do belive exactly this. And I certainly don't believe that those who don't believe exactly that will suffer for eternity. That's just totally uncalled for. But I do believe that if we don't want to keep on suffering in this world then we should fight evil, like Che did. So I think he was a christ in this sense, and he certainly suffered. But I don't think he was the cause of suffering, either his own or anyone else's.

E. You mean that christs are *signs* of suffering.

A. Not just signs, no, they *really* suffer. I think that we should fight evil even if we suffer as a consequence. Suffering is real and is caused by evil and so I *don't* think we can ignore it or believe or reason it away.

E. I agree that suffering and evil are *apparent*, certainly, and sometimes very obviously apparent. But Aristotle *demonstrated* that there is a divine proportion. This is the good of man, which is perfect reasoning. The only evil is a movement of something that is not a movement towards the good of that thing. In nature, all things move towards their good, naturally. The natural movement of man is towards his good, just like all the other natural things. The good of a species is its essential attributes, and in man that is being rational, so the good of man is perfect reason. However man is capable of deliberately starting *unnatural* movements. And one of these is moving towards what is not his good, so he is being evil only when he acts deliberately but doesn't reason excellently.

A. Why is that not just thinking or rationalising the evil away?

E. Because it is only with respect to *deliberate action* that he can be evil. The only evil things are therefore deliberate acts which are the result merely of bad reasoning. In other words, the bad are just the actions or the *movements* of the mad. If your thinking is right, then you will know only the good of the different things in the world.

A. But if you just make a mistake, that's not evil? Even if it causes suffering?

E. If you make a mistake and you don't know about it then it can't be evil. But as soon as you know that you did indeed make a mistake then you know that you did indeed do evil. But in that moment you are making a movement towards good, not evil.

A. So the only actual evil we can know is our own?

E. Yes. And only when it is no longer because in the act of coming to know this we do good. But if we continue to act, knowing that we are in error, then we are what Aristotle called shameless, because *shame* is the good of error. All error is a movement towards shame.

A. This so-called shamelessness is what I really mean by evil: intentionally doing what one knows is wrong. If every thing moves towards its end, then what is the end of shameless action? That will be the true evil.

E. Deliberate action in error is not an error, as such, it is an intentional mistake, which is really just another name for a contradiction. So it has no end: it's to no good at all. It is just a totally random act which is completely meaningless.

A. Senseless acts of random violence. Like tidal waves or earthquakes.

E. Yes, things insurance companies like to refer to as *acts of God*.

A. That makes actual evil awfully hard to pin down, doesn't it?

E. Awfully hard to be certain about, yes, in our own actions because it's always potential, never actual. In the actions of others, it's impossible to know because they will appear to us to be just like things which are happening for reasons we don't understand. But that it is not say they are *necessarily* bad. And that's why the Cheshire cat 'waves his right paw round' to point one way, but just 'waves the other' to refer to the opposite direction.

A. Carroll only refers to the *good* by name and the bad as simply the other.

E. The right is strictly speaking the *direction* of the good, not the good itself. The point being that the good is a *movement* towards the perfection of something, not a state or a place or a property of the thing itself. There is only one *sense* in which we can truly know, and that is the good sense.

A. This all makes perfectly good sense. The Cheshire Cat makes Alice choose between one of two mad places, and he is himself mad. So we are to understand this as saying that it's mad to force people to choose between one of two mad alternatives, namely the idea that good and evil are inherent in particular things, or in the world even, when in fact they should reject both? But what is the meaning of 'I've seen a christ without suffering'? This christ has a crown of thorns, and he's nailed to a cross, but he's not suffering?

E. All his suffering is allegorical. He's actually just a grinning pussy cat.

A. That's cheating! He's only a christ because we put this interpretation on it, you can't then take it away to avoid a contradiciton.

E. But the real Jesus was a christ because we interpreted his actual life as an allegory. He is really God, and we are then to think that his suffering was exactly that of an ordinary man? But an ordinary man is condemned to suffer ordinary man's suffering for eternity if he doesn't succeed in willing himself to believe this theory. So this allegory doesn't work either way either.

A. There are doubtless some very subtle theological arguments to deal with this problem.

E. The principal device being the Holy Trinity. As well as God and Jesus we have a middle term, which connects the two, and this is called the Holy Ghost. But I think that's probably a very bad translation because it is much more like a substance than a whole body of any kind. But Aristotle's argument is that what we percieve is actual substance, not allegory. And unless men are actually gods we don't perceive an actual man which is at the same time a god, whether one in this world, or one in another world.

A. What about Che? Do you think he didn't suffer either? He fought for nearly a year and had hardly any support and lost and died. His wounds were *horrible* because the soldier had instructions not to shoot him in the head, so he had half a dozen bullets in him.

E. Of course *I* don't know what he experienced. I have no doubt though it *was* horrible. But what you told me about his last words indicates that he had an inordinate courage. And if that was real, and we have absolutely no reason to think it wasn't, then I would say that he did not suffer as an ordinary man might have suffered on being captured and shot in the same way. I think this would be the case with anyone who *knew* that their actions were right and just. I think they would feel the same pain, but I don't think they would be affected by it in the same way. But it's very hard for me to know about someone else's experiences.

A. So when someone is actually suffering, first hand, then you say it is a physiological sensation that they experience, and that would be the same for everyone, but some people will somehow transcend this?

E. No. The little I know of real pain is that it has the effect of focussing the mind. And a focussed mind is not transcending anything. But it does not know fear. I think most suffering is actually *fear* of pain. And that's how empathy manifests itself. But if someone is sure that they are right, and that what is is happening now is right and proper, they will not be afraid, and they won't suffer first from fear, then die in horrible pain, they will just die in horrible pain. So that's the way I think they can transcend suffering, through knowledge, but pain is pain.

A. It would not be *entirely* obvious to me that knowing *I* was right would make what other people were going to do to *me* right and proper.

E. But we can only know our own deliberate actions are right and proper. We never know about the others. So his right and proper action was reassuring the soldier who had been tasked with his execution that what he was doing was not as bad as it might seem.

A. You don't think he was taunting him, saying 'you're only killing a man, the revolution will go on forever'?

E. I don't know, But I'm giving him the benefit of the doubt. Che *knew* what it was like to execute someone, he'd done it dozens of times, personally. And when he did that, he would have thought 'I must be prepared to die like this too'. The kid would have been petrified by this thought, and visibly so. I think Che would have told him that it's the fortunes of war, and that he's got to do it. And if he meant that the revolution will live on, then that too would have been just to reassure the guy he wasn't personally going to be responsible for the end of the revolution: that his responsibility did not extend beyond his trigger finger.

A. You have a very odd way of looking at things, but I can't really fault the logic.

E. I think that all these christs are in a way the only reason that people feel they know what suffering is. We empathise naturally, because that's how we *know* what others feel in the circumstances in which we see them. But this empathy is not itself anything more than a sign in our sense-perception, like seeing a cut and bleeding and knowing that this is something that is not altogether good. It isn't their actual pain we feel, and its not a deduction, it's called an *induction*. We don't need the actual experience to learn from others' experiences, we just need *analogous* feelings. But it's a mistake to suppose that those induced feelings are what the other persion is *actually* experiencing. We see someone break their arm in the playground and we empathise with their pain because they scream, but we haven't a clue what it really feels like to break our arm in exactly that way.

A. It certainly fits, and it's evidence that these are not random mistakes. *But* it seems an awful lot to expect of anyone to spot all this without your suggestions. If this particular meaning *was* intended, it was with the expectation that it would be read by someone with *exactly* this very *quirky way* of looking at things. How do you know that this isn't just because *you* are the source of all of this ingenious detail, and you're merely building it to fit into something he deliberately wrote to have an open interpretation? These things have double or triple meanings. And it does seem remarkable that you can find consistent interpretations from the same source. But how do we know no others are possible? Is this sense what you inevitably get if you study Aristotle and Euclid?

E. Yes. Well *I* think it *is*. And I can even say exactly why its so easy to do in this case. It's because Aristotle wrote about *everything*. Philosophy, Politics, Economics, Physics, Animal Physiology, Plants, Meteorology, Cosmology, Poetry, Rhetoric, Dialectic, Ethics, Logic, Mechanics, Geometry, Arithmetic, Colours, Sense, Memory, The Soul and Sophistry. So it is easy to find connections from many texts, but the connections I find are rather quirky and seem only to fit Aristotle. Ways and means, red hair of sea creatures, suffering of turtles. But the real clinchers are the proofs in Lobster Quadrille.

It's actually the Euclid/Aristotle connection that strengthens the Dodgson/Aristotle one. The middle term as it were is Geometry. But I find it really hard to understand why nobody has spotted this, because Euclid and Aristotle were almost contemporaries, each in one of the two great centres of classical knowledge, Athens and Alexandria, and Aristotle explains Euclidean geometry beautifully. He gives the big picture, he explains all the *reasons why* the axioms of geometry have the structure they do have. People who study Euclid and don't study Aristotle are running a three-legged egg-and-spoon race with both hands tied behind their backs.

A. That sounds positively dangerous.

E. And Aristotle's thought was the basis for the early Christian theology amongst others.

A. I just cannot imagine any theologian making such a careful logical analysis of sense and meaning as we had to do to get this reading. Was Aristotle really this precise?

E. More so. And he did these sorts of analyses of sense *constantly*. Could you please pass me that book there, the one with three dead Regents sticking out?

A. Posterior Analytics. Do you think this title may have adversely affected the

reputation of Aristotelian logic?

E. Logic is the driving force behind life. Life is the boundary between the food and the faeces, the prior and the posterior, the potential and the actual. According to Aristotle life is all about penetration and impregnation, putting in and squeezing out.

A. Warm and smelly and noisy and fun, like sex or chemistry is. But who really thinks *logic* is like that?

E. Probably only me. But I don't understand why. I'm not so much cleverer than the next man. If anything I'm rather slow on the uptake. I simply cannot understand why nobody has noticed this before.

A. I think you may be overestimating the number of people who have read the complete works of Aristotle. I don't know of any one else who has done that, and I can't imagine anyone other than a classicist who had Aristotle as his special interest would do it. I mean, it's vast, isn't it? And notoriously difficult. If you throw in Euclid and some quite technical geometry, then you throw out the classicists. So you are probably the only person who has made that connection between Aristotle and Euclid.

E. I'm not. I'm absolutely certain that Euclid made it, because he *was* it, and I'm equally certain that Dodgson made it. Very probably Diophantus too, and Fermat. In fact I would be very interested if someone could give me some concrete evidence that Diophantus and Euclid were *not* actually Aristotle. Hardly anything is known about the actual lives of either of them.

A. How often do any of these mention Aristotle?

E. That's what is so odd. Euclid never mentions him, nor does Diophantus. I don't know about Fermat, and Dodgson mentions him only once, as far as I know, when he refers to a sorities as being *Aristotelian*.

A. A *sorities* sounds like the sort of pickle you can get into if you tell a fib about where you were at some particular time.

E. It's exactly that. It is a chain of deductions where the conclusion of one is the premiss of the next. It's the sort of thing *time travellers* revel in.

A. If the source of so much of this is Aristotle and he only mentions Aristotle once in all his published work, and then only in passing, then he *must* have been deliberately hiding it for some reason. Is there any clue in Aristotle why someone would do that?

E. Yes, and no. Nothing explicit, but as I was saying earlier, one gets the definite feeling that there is a bigger picture here, and that one must see the whole to understand what it is. He spreads things out far and wide. For example, you have to read 'On Prophesying from Dreams' to understand formal logic properly. Otherwise you miss out the fact that the truth values the logic deals with are completely indeterminate. Why not just say that explicitly in the Prior Analytics?

A. So he wants you to see the whole picture, not just a fragment.

E. And Dodgson? What was he trying to do?

A. Exactly the same thing, for the same reasons, and more likely if in fact they were the same person. But you know, I think you face a formidable thermodynamical problem in convincing anyone that they were.

E. Well that's what I have to do then. Learn thermodynamics. I need to spend at least a year on this. More perhaps.

A. Can you take sabbatical?

E. Not for another two years.

A. You need access to libraries to do this, don't you?

E. Not really. Just a few good textbooks.

A. I couldn't interest you in a trip to Bolivia, could I? Spiritual companion, help-meet with sundry carnal duties, all unpaid. I couldn't go otherwise.

E. You wouldn't to go? What happened to your independence and confidence?

A. Nothing, but I wouldn't *want* to leave behind someone who did things to me like those things you did to me an hour or so ago. Wouldn't, couldn't.

E. You are so delightfully impetuous. It's wonderful.

A. It's not really fair of me to ask. I'm only giving up the last 18 months of a fellowship, you'd be giving up a permanent post, and there are people that would kill for that. You'd better think about it carefully.

E. I have, and I think it's a good idea. When will you have to start?

A. I suppose in about six months time. I'll have to ask on Monday. Ooh, I've got butterflies now! You're right, this is impetuous. Maybe we should sleep on it?

E. I don't want to sleep on anything at the moment.

A. No? . . . Well then,. . . how about doing that thing to me again?

E. What thing was that?

A. That lovely, startling, unspeakable thing which you did to me before.

E. It might not be so startling this time, you know.

A. That's alright, because I'm already a little startled.

E. Oh, of course! A man's star is his soul!

A. Twinkle, twinkle, little star, how I wonder who you are!

E. Now I know why men have more teeth than women.

A. They don't.

E. They do, because men's souls have teeth. A man's soul is pure potential—a beautiful rounded whole, an 'O', a gorgeous, curvy, completely naked . . . woman.

A. This spiritual intercourse is lovely, but if you don't *actually do something* to me, right now, this potential is going to explode, please . . . O!

2 Scene IV

[Seats 42A and B The cabin of the Aerolineas Argentina flight from Madrid to Beuenos Aires. Ellison is in the window seat and Che Geuvara is sitting next to him. Che takes a huge Havana cigar out of the left-hand breast pocket of his Olive Green shirt.]

E. They're going to have a fit if you light that thing in here!

Che [lighting the cigar and speaking from within a thick cloud of white smoke] It's a very good Cuban cigar. No body will mind.

E. Your courage is inhuman.

C. Che, it doesn't take courage to light a cigar, all you need is a Zippo and a cigar! Here.

[handing Ellisson a cigar and his Zippo]

E. Thank you.

C. De nada.

[Ellisson lights his cigar and hands the lighter back. Both are now invisible, obscured by cloud of thick white smoke]

E. These *are* very good cigars.

C. Che, there's no such thing as inhuman courage, you know.

E. When you left your wife and your young family in Havana for Bolivia, you knew you would never see them again, didn't you?

C. Yes.

E. And yet you went, of your own free will. That's inhuman.

C. Well, if you'd done it yourself you would know that it is completely human. I never in my life felt so human as I did then. The pain is impossible to describe.

E. Oh Jesus! Then why did you do it?

C. It was right.

E. But you *knew* you would fail.

C. Che, the revolution *cannot* fail. That's impossible. But in fact, I would probably have died sooner if I hadn't left Havana. There were so many asassination attempts on Fidel alone that he stopped counting them. If you ever find yourself in the centre of a revolution, you can be sure of one thing only, which is that you're going to die.

E. So you weren't *totally* welcome?

C. Not by the Americans, no. You know that photograph of me taken at the memorial service for all the people that died when that ship exploded? Well, the reason I look so intense is that I was waiting for a bullet. Whenever we stood up in public, we *expected* a sniper's bullet, at any second.

E. When you say the revolution cannot fail, you mean it's *logically* impossible?

C. Dialectically impossible, yes. But whether an individual man fails or not is another matter.

E. Why did you go if you thought you would fail?

C. To draw the enemy's attention to where we wanted it, and away from where we didn't want it.

E. And you were the focus of the enemy's attention.

C. Yes, the Cubans were. Everywhere we went to help the Americans poured military aid on the other side. It became very clear that the *worst* thing that could happen to a nascent revolution was to get help from Cuba. As soon as we showed up, the money and weapons and military advisors were flown in. Then the problem the revolutionaries faced was double or triple what they would have faced if we hadn't gone.

E. Is that why you withdrew from Africa?

C. Yes. We wanted to help, but it had to be done invisibly. So we stopped giving direct military aid. And the Americans eventually stopped supporting the regimes and they all folded. The whole continent is almost free again.

E. What did you do instead?

C. Education. We trained doctors and teachers. The revolution is something that happens *only* in the minds of the people, and their minds are in their bodies. So to

keep the revolution going you need doctors and teachers. And we made rum and cigars too.

E. What was the rum for.

C. To keep people's spirits up. It's an old pirate trick. A ration of rum.

E. Dutch courage?

C. Yes. It doesn't make you courageous because it deprives you of your senses though. It makes you immortal.

E. You're pulling my leg!

C. Che, trust me, I'm a doctor.

E. So you would only pull my leg if it was good for me.

C. Ha ha! Don't you want to know how it works?

E. Yes, tell me.

C. Have you ever watched closely what happens when you mix alcohol and water?

E. Yes, it's beautiful. Lots of very intricate convoluted flows all mixing together.

C. It mixes perfectly with both water and air. And when you heat a mixture of water and alcohol?

E. It separates, the alcohol evaporates first.

C. It refrigerates. It's the quickest way the mixture can lose heat, when the alcohol evaporates first it takes more heat with it than just evaporating water would.

E. And how does this make a man immortal.

C. It never does that. A man is a man and a man is never immortal.

E. You said 'it makes *you* immortal' didn't you? I thought you meant me, or men in general.

C. I meant *you*. Do you know what happens to most of the alcohol you drink?

E. It evaporates.

C. Yes, you breathe it off. Only a part is metabolised.

E. So the heat of the blood is carried away as a complicated pattern of mixing in the air.

C. That feeling of invincibility, of being more than just a physical body, is not an illusion caused by the alcohol. It is an accurate perception caused by a part of the brain failing to bound your thoughts as it usually does. This faculty is the one that makes you ignore what is doubtful. But when you ignore everything that is doubtful then you can't see potential, so you don't act. But when you believe in what is merely possible, then you see potential, and then you can act. And then you act willfully, because your actions are not determined by your circumstances. So you act creatively, and it is your *spirit* that acts.

E. But it acts in random ways because it is not certain what will be the outcome. Especially if you're drunk!

C. But we are never certain what will be the outcome of our actions. Someone who only acts when they are certain of an outcome is going to be paralysed in a fight. A fight is total and utter mayhem and chaos. People's heads turn inside-out. Nobody knows what is happening now, nor what will happen next, and nobody knows the outcome. If they did it would not be a fight, it would be a rout. In a rout, men are certain about what will be the outcome and then no body can do anything.

E. In battle, a rout is an error. The good of battle is chaos. Senseless random acts of violence.

C. Che, you know the theory! Yes. The more random, the more senseless, the more violent, the better.

E. Guerilla logic. But terrorism is senseless random acts of violence.

C. No, acts of terrorism are calculated to cause fear and suffering. They're not random, they're deliberately planned to be unexpected in unexpected places. They're not targeted at enemy fighters but at unarmed civilians. The guerilla fights the barbarians, only a terrorist fights civilians.

E. But why does rum make the fighter immortal?

C. Because we are what we know. That is what identity is. Our identity is what we know we are.

E. So our identity is not connected with our material bodies, it's connected with our acts?

C. You've got it, che.

E. Why do you keep calling me Che? *You're* Che.

C. No, *I* call *everybody* che, so *they* call *me* El Che.

E. It's like the way we use the word 'one' to mean any particular person taken at random.

C. In Cambridge they say that. In Argentina it's used just like the word 'dude' is used in America.

E. Then you're 'The Dude'?

C. I suppose so. Here, have you noticed this before

[Che takes a United States One Dollar bill from his breast pocket and hands it to Elaisson.]

E. It's a Little Bill. Gearge Washington. Federal Reserve Note. One Dollar.

C. This is a *de facto* currency in all the poorest countries in the world. This is still enough to feed a family of four for a week in Bolivia. Look at the back.

E. It's bizarre, isn't it? A pyramid with a human eye looking through a triangle in a blaze of light. 'Novus ordo seclorum'.

C. 'A new order of the genera.' The eye is supposed to be the eye of providence. Do you believe that?

E. It's very clearly a human eye though. What does 'Annuit Coeptis' mean?

C. It means 'One approves'. This is the reverse of the Great Seal of the United States. On the other side there is the eagle and the motto 'E Pluribus Unum' which means something like 'Of many, one.'

E. And here in the middle it says 'IN GOD WE TRUST' and underneath that the word ONE in huge capital letters. So the one is on the one hand who does the approving, and on the other hand it is the people, as a whole. This so-called eye of providence here is unmistakably the eye of a man. I suppose it's man that knows providence when he sees it?

C. Yes. And if you look closely you'll see it's the right eye of a man. After a decisive battle, when you analyse what actually happened, the order of events, then you see that *everything* was in your favour, and *nothing* was planned. And it is impossible not to believe that providence was on your side. But yes, we must then realise that it is in our eyes that we see providence, because it is in our eyes only that victory or

defeat is significant, so we are the only ones that can know the significance of these myriad little effects.

E. So the mind of the people as a whole is god, and it is to the whole that the people trust the individuals. And this is the revolution. So the revolution *is* the mind of god. What's the purpose of a revolution?

C. Chaos.

E. Isn't that just destructive?

C. No, its creative. It's what makes new things possible. Without chaos there is no potential, so there's no change and no life, just stagnation and death.

E. So the revolution is working when the people are acting as one whole to *see* the events within the chaos as significant?

C. Yes. That's how potential becomes becomes actual. The potential is there and then some random event happens which fits the next step and it is siezed upon by the soul and this changes the potential again. But if the parts of the soul aren't alive and sensitive to the potential then they don't respond to these fortuitous events, because they can't see them, and then everything appears senseless and random.

E. But they have to see the good of the whole, otherwise there can be no agreement about what is good and what is not and no agreement about the significance of anything that happens?

C. Yes. It's a matter of judgement. This seal was designed during the American Revolution. It was commissioned on 4th July 1776. The design seems to have mostly the work of one Francis Hopkinson, the son of a good friend of Benjamin Franklin's, and Charles Thomson, the secretary of the Continental Congress. Hopkinson seems to have been a bit of a geometer, and he earlier designed a $50 Bill of the Continental Currency with some interesting symbolism on the back. Then in 1935 Franklin D. Roosevelt had it put onto the One Dollar bill. Before he approved the design he had it changed so that the eagle is on the right and the pyramid on the left. And he had the words 'The Great Seal of The United States' added.

E. What does the D stand for?

C. I don't know. *Dick*, maybe?

E. Benjamin Franklin is the $100 Bill, so perhaps Hopkinson was the middle term. You say FDR had the pyramid put on the *left*?

C. In heraldry, that side is called the *dexter* side. And usually the symbols of war, like soldiers or eagles, appear on the other side. And you'll see the eagle has the olive branch in its right talon, which is the dexter side, and the arrows in the other.

E. And it isn't the Great Seal of the United States of America. Just the United States. Unqualified, as Aristotle would say.

C. Yes. The United States. So the revolution still had supporters in the USA, until some time shortly after the Second World War when they became strongly anti-communist, because they were *afraid* of the USSR. And when they became anti-communist they had to become anti-revolutionary.

E. The USSR was the centre of the revolution then?

C. Yes, and it was powerful and frightening, because the powerful are always frightening.

E. They aided the Cubans though.

C. Enormously, and in many ways. But I thought we had to try to distance ourselves from them: we wanted to inspire people, not make them afraid, because when you are afraid you cannot actually fight, you only think of defending yourself.

E. You wanted the *enemy* to fight?

C. Yes. We wanted them to fight, in the minds of the people. We wanted the people to see who was really who on each side, not just to see overwhelming power because then you cannot fight: there's no point if you know the outcome will be that you lose, it's a rout. When the USSR moved missiles to Cuba that created a total unanimity in the minds of the Americans. There was clearly just one enemy and it was not any American. That was the end of the Revolution in America and the end of the Russian Revolution too.

E. And the beginning of the cold war. That was like a container under enormous pressure, divided in two by just a thin film of soap. The pressure on each side is exectly equal so the soap film just sits there and divides the two sides perfectly. Every time there was a tiny excess of pressure on one side it is balanced by an equally tiny one from the other side. They called the film of soap the iron curtain. But in the end it just melted overnight, and almost silently disappeared.

C. The revolution is not a wheel, it's a sphere. It's the first cause of motion. The perfection of the rational soul. And the revolutionaries are gods, and these gods move the bodies of men in mysterious ways.

E. And these 'mysterious ways' are actual events?

C. Yes. They are chains of actual events.

E. But the bodies of men are not gods. They are mortals like all the other animals. So the mysterious ways are the chaotic events of a battle?

C. Or a puff of air; a spoken word, or a sneeze.

E. Our bodies though, are the only way we can know actual events. So all these 'mysterious little ways' are actually known, in so far as they exist.

C. And so…

E. And so we know these gods, first hand. They're what constitute the devious paths of our own thought.

C. When we are thinking right, yes. But mostly our thinking is constrained and so we can't follow the natural movements and they have no significance or meaning.

E. The idea then is that the revolution is the natural movement of the human mind, unconstrained?

C. Yes. The constraints are power. Wherever you have a concentration of energy flowing from a source you have a constraint. It could be heat, electrical potential, money supply, an oil well, a uranium mine, a coal mine, a gold mine, a diamond mine, a hydro-electric power station. These things are bad. The natural movement is the anihilation of these sources as quickly as possible.

E. You mean the natural movement is to use up all resources as quickly as possible?

C. Yes. To destroy all structure as quickly as possible and use it for new structure.

E. Ceaseless turnover, to what end?

C. The production of chaos. Potential.

E. No, this is all backwards. The natural movement must surely be towards order, not destruction.

C. It *is* towards more order che, you get *more* order if you use the existing structure to fuel the construction of new structure than you do if you just let the existing order decay slowly. It's not doing any good if its decaying slowly, it's just taking up space.

E. So we should cut down all the trees?

C. Only if you know that's the fastest way to create entropy. If you know something you can do with the wood or the space that is left behind that will create entropy at a faster rate than the trees can, then yes, you should cut down all the trees. But I very much doubt there is anything like that. You have to consider the whole system.

E. So what structure should we destroy?

C. Fossil fuel is a good one. We should use that as fast as we can, and use it to demolish all the concrete buildings, break up roads and car tyres and incinerate non bio-degradable waste and all the λεγο! In lots of extremely hot, but small and short-lived fires.

E. So we destroy the concrete buildings, then what do we live in?

C. Mud or stone ones with grass roofs, or wood if there are a lot of trees growing nearby. Until the end of the nineteenth century *all* houses were like this.

E. Why destroy perfectly usable concrete buildings and replace them with ones which will rot and fall down in a matter of years?

C. Because they're permanent. A concrete building is a hard surface and a constraint. And it causes violence. Natural motion acting against the constraint of a hard surface causes huge forces. See what happens to a city in an earthquake. But in a forest you can have the same magnitude of earthquake and nothing happens. The only difference is that concrete is a hard surface and reflects and concentrates forces, the forest is full of different surfaces and the forces dissipate. The same happens with flooding. In a city the concrete makes a hard surface on the ground and a flood can destroy buildings because the water is constrained and moves in certain asymmetrical axes which contain a concentration of power. If the ground were not concreted over the same rainfall would probably drain away in a matter of hours.

E. That makes some sense. But mud buildings would just dissolve in a flood.

C. Which is good.

E. OK. Let me try and reason this one through. It's good when people's houses fall down because . . . they have to build new ones. And I suppose they might learn eventually to build better houses for those conditions. Or I suppose better still they might move to another place which was not so prone to flooding.

C. Which is better than living in the same place when they get flooded year after year. Because if you are in a flood plain, then one day there will be a big 50 or 100 year flood and you will really have a problem. But when people have made an investment in concrete buildings they are much less inclined to move. Their property ties them down, and eventually they drown because of it. It's just another constraint on natural motion.

E. And if you have made a huge investment in concrete infrastructure on a major geological fault, say, then you are inclined to just sit there and wait until it all falls down around your ears. But when we have extracted all the fossil fuels we can, we go and look for more?

C. If you can do it without building more machinery, or drilling more wells or opening more mines, or extending existing mines deeper to find new seams, yes. Keep extracting what is already at the surface using the existing machinery, but no more spare parts can be made. If something breaks, it has to be fixed by cannibalising some other machine. The rule is that no more material must be incorporated into structures. It must all be taken from existing structures. All extractive industries should be banned.

E. But what about necesary infrastructure. For example hospitals, factories, offices etc.

C. Most of that is necessary solely because of the kinds of lives people live. We are proposing to change this, so most of this won't be necessary. The advertising executive won't need to sit in an office because his only purpose in life was to sell more of one concrete producer's concrete than another could sell. Likewise hundreds of thousands of others won't have any work to do and it therefore won't be necessary for them to have offices to sit in or cars to drive to work in, or refrigerators to keep their beer in, or televisions to watch when they get home from the office or microwave ovens to heat up their pre-cooked dinners.

E. But how can we built the necessary hospitals and factories if there are no cement works and no-one making new construction equipment?

C. We have to cannibalise the existing machinery and buildings. Either re-use them as they are, or take them apart and use the parts to build the machines we do need. Everything has to be based on cannibalism so that the existing order is used to create new order and entropy. The parts have to get smaller and smaller and the machines more and more intricate. More intelligent, and less powerful. More chaos and less order.

E. What about drugs and medicine?

C. Five percent of the drugs on the market treat 95 percent of the cases. The rest are not even available to most of the people in the world.

E. What about the five percent of other cases?

C. They'll either recover without that treatment or they'll die.

E. So the doctor says 'I'm sorry Mrs Brown, a year ago we had a drug that could treat your daughter, but the revolutionary government has banned its production so she will have to die.' What is she suposed to say, 'long live the revolution'?

C. There would have to have been an education programme teaching people the necessity of this. If that programme had been carried out well, then she would understand, and yes, that's exactly what she would say. And her daughter would say the same, and they would *both mean it.*

E. I can just see this scene on a little propaganda movie shown on National TV. This is too much to ask of ordinary people.

C. Che, there *are* no ordinary people. We are *all* gods.

E. Why should either of these people feel grateful to the revolution?

C. They are grateful for the education they recieved which allowed them to *know* that the state *actually is* the good of the people and the good of the state is *prior* to the good of the family, which is prior to the good of the individuals within it.

E. They *know* this? You mean it is proved to them?

C. Yes. In much the same way that you prove to biology students that the animal body is the good of the cells that it is made up from. The cells must necessarily die if the body is to live: even an old body is made of young cells. So you can remove a malignant tumor and those cells and some other good ones will die, but the body as a whole survives. The difference between cells and bodies on the one hand, and human beings and the state on the other, is that the human being is capable of knowing the reasons why the state is their good. The state cannot survive if it has to use resources to keep unhealthy people alive until they are ninety years old. But this is what happens if you have wealthy people who can afford private health insurance. What right do they have to a greater share of the resources, just because they used their health, a gift from the state, to grab a greater share of the wealth? The wealth is for all the people, as a whole, past and future. If some people want to work harder they will become heroes and if they have the good fortune and ability to do great work, then they can do that, but they do not then have more right to health, or food, or shelter, or comfort, or happiness than anyone else.

E. But this doesn't happen now, why should it happen with a different government?

C. Because the idea of a state now is completely corrupt one. These states we see around the world now just loose affiliations of people with power of one kind or another. There is no potential and no understanding and no coherence. In these so-called democracies the state is governed by people who are elected solely on the basis of what they promise the populace. The only criterion to govern is knowing what the masses want, and this can be determined just by market research. So these states are cults of the individual. They claim the individual is the only real thing, and the state doesn't exist. But they're right, because the state is empty, it *is* just what the people want, or rather, what they thought they wanted, last time they were asked. In between elections the people in power do pretty much what they like, within the limits of what they think they can get away with.

E. Who is going to ask for your revolutionary government?

C. No one will ask for it. There's no point. They will have to *fight* for it.

E. But if only a few want this, what *right* do they have to fight the majority who don't want it? That's not democratic.

C. If the majority are prepared to fight against the revolutionaries then the revolution will not very likely happen. That is not usually how it goes though. Usually a small group of revolutionaries fight professional soldiers of one sort or another. Most civilians will not join in a fight. The retaliation always comes from those in power who have most to lose. So the capitalists and the politicians use the state's resources to fight the revolutionaries, maybe they raise taxes to do this. This is not going against the will of the majority. The majority usually have no will at all.

E. It's not *meant* to be democracy, is it?

C. No. It's aristocracy. Government by the best. Democracy is a foolish idea, it's like letting anyone be a doctor or a teacher, whether they are trained or not. A leader needs to have been trained and selected. Leading a successful revolution is a good enough training and selection procedure to start with, but subsequent leaders should be specially selected and trained, as Plato suggested. Fifteen years on top of an ordinary professional training such as a doctor or a teacher would get. But a

revolution is not won by a minority without popular support. By the end of the Cuban revolution we had the vast majority of the population with us. And I don't mean just cheering and shouting, they *loved* the revolution as much as we did, and like us, they were happy to die for it if necessary. And that's why it was a success. The whole country was in love with the government, and the government loved the people like a mother loves her children. And that's the real reason why Americans were not allowed to visit Cuba. It was because their government didn't want them to see how happy the Cubans were, despite the embargo and the poverty. These caused problems, but it didn't matter because we were free, and we were all in love with our country. And the people were *strong* because of that. They weren't afraid of *anything* because they knew they were part of something real and their lives were meaningful because of that.

E. They really loved their country more than life itself? They were *all* prepared to die for it?

C. Yes. Did you ever wonder why it's called Cuba?

E. No I didn't. I wonder *why* I didn't though?

C. We don't pay enough attention to entymology.

E. Is it the feminine of *cubo*, which is *cube*? Surely not.

C. Yes it is. It's Earth,

E. The *second* Platonic solid.

C. And the *first* is a *pyramid*, if I'm not mistaken. Euclid ΙΓ.ιγ′.

E. Two entirely rational co-ordinate systems.

C. We don't die, it's just our bodies which die, and because we can actually *know this*, intellectually, the individual life is not so important; whether it's just our own or someone else's. That's why it's possible for someone to be detached and at the same time to be human. This is how the revolutionary knows that it is worth laying down his life for the revolution, and also how the revolutionary government can justify the execution of individuals for treason, because the state is a real thing, it is *necessary* for the lives of citizens. The lives of citizens are made meaningful because they are individually a part of this bigger, real thing, but this is *only* because they are prepared to lay down their lives for it. And having a meaningful life is all you need to secure your immortality.

E. And you think our clinging to security is the only thing that stops us from realising that we are immortal?

C. Yes, and at the same time it stops us from realising we're human. But it is only the security if *individual* life that's misguided. Individuals always die eventually, individuals can never be secure, this is plain to even the most stupid person. It's only as a whole that man has security and immortality, but only if the individual man knows that individually he has *no* right to expect that.

E. It's only because of this immortality that we know we're human?

C. Yes. A dog doesn't know he's a dog. He just *is* a dog and he doesn't know he is alive and that he will die one day. It's only because we are an abstract chain of particular contingent events that we know that we are somebody. Our identity is not in the material substance of our body: that changes constantly. It's like the material substance of a flame. It's one flame, but it's a flux of air and fuel that exists as a plasma. So the identity, what we think of as the one that lives in this body, is a

chain of abstract events. And it is only this that allows us to know these peculiarly human feelings like love and sorrow and fear. But these events are not the subjects of our knowledge: they are our actual sense-perception, which is the *substance* of our knowledge.

E. You are not alive now, Che. And this revolution you're suggesting is the most hare-brained scheme I've heard in my life.

C. No I am not alive now. I was summarily executed, without trial, in Bolivia in 1967. But what you think about the revolution is irrelevant, because it is inevitable.

E. And what I think about you is irrelevant because you are just a figment of my imagination.

C. I am an *object of thought*, che. And that is the only way that most people in the world knew me when I was alive. Some others like my family and Fidel and Raul and other fighters knew me as a person as well as an object of thought. Others only ever knew me as an object of thought. But the substantial body that walked around was accidental. The *I* which actually *was* was a movement in the material called spirit. And it's what lives now in that same spirit of anyone who knows who I was, no matter how little they know about me.

E. What's to say they know any of the truth though? How do we know even the truth about *where* or *when* you really died?

C. It's not an exact science. This is a faculty: you have to use the *sense*. You have to judge the truth of what you hear by your knowledge of the feelings of those who are saying it. We do this naturally. But this is crucial to making a good judgement. For example we automatically doubt the veracity of someone who is angry about an event he reports. Without the sense there is no meaning and no truth. If you found out that I actually died somewhere else, what difference would that make? In itself this is accidental. You know almost nothing about where it is said I did die, so what difference will it make?

E. But you can say that about anything I know about you.

C. But not everything together, because the object of thought is something real, that exists. It's exactly as real as you appear to yourself right now. You would not be any less real if tomorrow you discovered you were actually born somewhere else a year earlier. And the same holds for *any* other facts you know about yourself.

E. These ideas are quite difficult. So it's only intellectuals who can start revolutions, isn't it?

C. You need a very broad education, yes. And you have to love the whole of humanity. And you have to love dialectic more than you love life itself.

E. That's an uncommon combination.

C. Socrates had it.

E. He started the revolution?

C. Yes. And Plato and Aristotle continued it.

E. This is what Aristotle means when he speaks about those who argue as competitors and rivals to the death, isn't it?

C. If that's the passage I'm thinking of then no, he's referring to women, who *are all* revolutionaries, as it happens. And I'm not so sure it was Aristotle who wrote that little paragraph.

E. Who else would it have been?

C. I don't know for sure, but I can imagine his wife as his *amanuensis*. The work would have been a joint effort. She probably wrote very well. And I can just imagine a spirited, intelligent woman, adding that passage in the final copy, just to amuse him. And I think he would have been delighted with that.

E. So you think we may know more about Pythias than we think we do?

C. I *do*. I think someone who knows ancient Greek should have a look at the orginal text, and perhaps compare them with, say, what's left of Sappho's writing.

E. Socrates was never *sure* that he knew the Truth.

C. But he was more than prepared to die to defend the fact of there being one Truth.

E. You are sure that the revolution is right?

C. Yes. What we can never be sure whether we as individuals *are* actually revolutionaries.

E. But you are still prepared to die for it?

C. I *was*, yes.

E. But what if it turned out you were wrong about that very fact: that there *is* one just, right revolution?

C. If there *isn't* then it doesn't matter if we die, because life is meaningless. So it's no big deal, really. But very few have any doubt the revolution is just, just as very few actually doubt there is one Truth. Even raising the possibility there might *not be* one Truth is a contradiction, because that in itself would be one truth. But it is an implausible one, because why would there be one truth, and so many definite things in the world, and these two be completely separate? It seems much more plausible that there *is* one Truth, and it is this one Truth that is the reason why there are definite things in the world that we can understand. And then it is not hard to see that there is one right movement in the affairs of men. And that is the one that we should be trying to understand as a whole. And there you have the revolution: a single scientific fact.

E. The science is Political science, and the faculty is Rhetoric. This idea of one Truth is anathema, even amongst rational scientific types.

C. Why is that?

E. They believe that science is rational only because it abstracts from contingent detail. So they think science is calculating trajectories of atoms, and that because you cannot calculate the trajectories of the atoms in the minds of all men, that you cannot have political science, or economic science. The only real science is physics.

C. They must believe medicine is not a science either, then?

E. No, they think it is an art, I suppose.

C. Then before someone goes under a surgeon's knife, they ask to see examples of his work?

E. No, but nevertheless they *do* expect that all surgeons will do the same quality of work. And in fact they expect the same of all doctors and they will sue their doctor if they believe he made a mistake.

C. They believe that the threat of being sued is a guarantee that their doctor will do the best possible work? And they are prepared to stake their lives on this reasoning?

E. Apparently.

C. They don't see that this reduces the standard of medical care to the lowest common denominator and that because of this behaviour, thousands are dying pointlessly?

E. Apparently not.

C. They have been let down by their teachers.

E. It seems so. But it's not the teachers' fault, really.

C. The teachers don't choose what they teach, do they?

E. No, the curriculum is set by the government.

C. With what aims?

E. The needs of employers, mainly.

C. So the purpose of education is to make workers?

E. Yes, it seems that way. In fact it is not hard to see that the whole of society is geared to making workers and housing them and getting to their place of work, and getting them back home again. Or getting them off on holiday so they can relax before coming back to work. Or entertaining them in the evenings so that they can forget about their work before going to sleep.

C. And all this industry is to what end?

E. The production of order.

C. And who benefits from this order?

E. It can't be the people, because most of their energy is spent on things that are not to any purpose other than the creation of this order. As you say, an advertising executive whose role in life is to sell more of one company's products than its competitors. He's only working for the shareholders. But anyone can be a shareholder.

C. If this advertising executive were a shareholder in that cement company, would his work then be meaningful?

E. No, but perhaps he could use the extra income to pursue some meaningful occupation when he wasn't working.

C. He is short of money, and that is all that prevents him from having a meaningful occupation in his free time?

E. No, it's not money. It's time he's short of. He needs to spend his free time relaxing and getting ready for work the next day.

C. The shareholders of these companies don't benefit in any meaningful way from being shareholders, do they?

E. Not really, no. Unless they hold a huge number of shares it's just pocket money. Everything is just palliative, in one way or another.

C. So who benefits from the order?

E. A few people who sit at the top of the so-called food-chain. That really is what they call it, the food chain. These people deal in companies, passing ownership from one to another. They are venture capital firms who handle investments on behalf of their clients.

C. The clients are who?

E. Pension funds, mainly. But also banks, charitable trusts, private and public trusts. Insurance companies, health trusts and also government investment funds, I imagine. And one or two extremely wealthy individuals.

C. What do these venture capitalists actually do?

E. They broker deals, they administer funds, handle regulatory paperwork etc., they often sit on the boards of directors of the companies they own. Then at the allotted time they close funds and disburse the profits.

C. When they close a fund, what happens to the company whose shares they bought with the money that was in that fund?

E. They sell the shares, perhaps to another fund.

C. And these venture capital firms themselves, who owns their shares?

E. I think many are ordinary companies like any other. Some were even charitable trusts themselves.

C. So it's all based on cannibalism, isn't it? It's just the incessant creation of chaos, for the sake of turnover of money. It's not the actual value of the money that's important in this process, it's the rate at which it is dissipated through the system. The capital flows from the concentrations outwards to where it can be invested and used to generate more capital. It does this at the maximum possible rate. What is valued are these sources of capital flow.

E. It's like the material revolution you propose, but the movement is just that of money, not energy. Perpetual economic motion.

C. But it's not real motion. It's only apparent. Everything is actually staying still. No one learns anything from this because it is just senseless activity. The only thing that changes is the information in computer systems. But this is where the revolution has to go now.

E. The computers?

C. Well, I was thinking of the UK and the USA and all these other places where all the capitalists hang out, Bonn and Paris and Milan and Moscow and Beijing, wherever.

E. But they're all civilians. There's no one for a guerilla to fight.

C. That's good, there's even a chance, but it's a *tiny* chance, that you won't actually need to fight. But I wouldn't count on it. What you have to do is identify the enemy. That's always the hard part.

E. They're all mixed up. Tens of millions of people do what they do just because they have no idea it could be different.

C. Yes, so you have to let them separate out. You have get like to go to like. Sort out the revolutionaries from the enemy. All you need to do is say to people 'If you're not completely satisfied with your work and your life is not meaningful and fulfilled, then take your kids out of school, leave your job and join the revolution. You will be fine and your families will not starve because your comrades at arms will help you. And you will have meaningful employment immediately because there will be millions of people leaving their jobs and they will all need help to get by on no income at all. If you're a teacher or a doctor you will be especially needed.' That should do it. Then all these people will start leaving their jobs. At first you won't notice anything, but they'll start getting together, and setting up websites and writing guides on how to live on air. They'll figure out the traditional signs revolutionaries use to identify each other. Different groups will have to meet and decide how they see what's happening. They will have to learn how to negotiate between themselves and make agreements efficiently and in the interests of the whole. There will be a lot to learn.

The most important thing is that it should have no centre. If you have a centre you *will* fail. It's got to be a perfect sphere. If you want to understand how this sort of long-range synchronisation without a centre works, study thermodynamics.

People's houses will be reposessed and what have you so you'll have to organise camps. These won't be popular. Pretty soon you will start to see the other side identify themselves. They'll start by throwing money around, and you'll lose a lot of people who will go off and get high-paid jobs. But when this doesn't work, they'll start to gather together for protection and they wont want any of *you* nearby. So they'll start moving you away. And if you resist then they'll start getting violent. But you mustn't retaliate, not yet. You must identify who is behind what, who's with who, because they won't even be unanimous. You'll have to see whose side the police and the armies end up on. Sometimes different divisions of the same force go different ways. Lots of new boundaries and new surfaces come to light, and they shift and change. Never start any violent action, and never plan to start any. Don't accumulate weapons, and on't even read my book on guerilla warfare, it's hopelessly out of date, it never applied to developed countries or urban warfare, and those rifle grenades were, well, funky at the best of times. No one should ever say a word to anyone about any kind of violence. Not in public or in private, not even to friends or family. Don't even write about it in your private diaries. Learn about non-violent direct action and practice the techniques amongst yourselves. But *prepare* yourselves *mentally*, for a fight, individually. When the time comes you will all know instinctively what to do, and you'll do it perfectly.

E. That's it? The revolution in a hundred words?

C. There's not much point planning total and utter chaos in any detail. Just get on with it. But I warn you it might be a little *slow* getting off the ground, in which case the revolutionaries will just be an alternative education movement for the first few millenia or so; the only way you'll get more revolutionaries is by educating the people, because most of them don't know what the revolution is.

E. So that's how it could happen without a fight. Just a slow but inexorable increase of people who really undertand what it's about?

C. But if you ever do get into a fight, you need a chica on your side.

E. A woman?

C. Yes, these macho guys are all show, they're actually pussies and they can't stand pain. Chicas fight like the gods and they *never* give up, haven't you noticed?

E. I had.

C. And men can surrender more easily to a woman who's got them at gunpoint, because they can tell everyone 'What else could I do? I'm a real man, I couldn't *ever* shoot a woman!'.

E. When you were about to be shot you said 'You're only shooting a man'. Why did you say that?

C. I'm *not* afraid to die, nut I just can't *bear* pain. I said to him '*Please* shoot me in the heart so it's quick, you're only shooting a man.' What I mean't was 'I'm not a woman, so take it easy.'

E. But he didn't did he?

C. No, he fucked it up completely, like a man *will*!

E. Did it hurt like hell?

C. I don't remember. That's *why* we die, che. Men can't bear pain, so we have the memory wiped every 70 years or so. Women don't need that.

E. Why do they die then?

C. You don't know much biology, do you, che?

E. No.

C. Let me quickly tell you about the birds and the bees. Do you know what the first few steps in the development of a female embryo are?

E. Well, cell divisions. It's the oocytes that are the first cells that develop, isn't it?

C. And so when a woman is conceived, it is the *eggs* that are the efficient cause of the resulting development of the embryo. Then the eggs just wait around until they get blasted by some hot white air, and then they repeat the action. The first cause of a chica is an egg.

E. In men though, the eggs aren't produced at all, of course, the body develops from the efficient cause of the white hot air. The sperm cells are first produced at puberty.

C. You'd think an evolutionary biologist would have explained that by now, Wouldn't you? Why don't they mention it, do you think?

E. Well, it means women are all the same body. That's quite something, isn't it?

C. And men?

E. Well, we're like the fruit.

C. So we ripen, let some seed fly around at random, then grow hoary and grey, and fall off the tree. If we're lucky. Otherwise we get *plucked*, sometimes violently.

E. So a human being: the body of an individual man, is a composite of a shellfish, a plant, and an animal?

C. You're just guessing. But you will be able to prove this, and then you'll know you understand. And the girls could help you figure it out, if you can persuade them to try.

E. But the men have been running the show for so long that it looks now like there's nothing else worth knowing. And the women have been fighting so long that some of them have *forgotten* they're fighting, and they think like this too.

C. Change it. Good to meet you che, and good luck.

E. Goodbye. See you again, I hope.

C. What goes round comes around. It's inevitable. Chau.

[Che fades slowly to the sound of ABBA singing 'Fernando' in Spanish]

3 Scene V

[Elaisson is working at his desk in his room in the African Institute for Mathematical Sciences in Musenberg, Cape Town, South Africa. El Che is sitting at the window, looking out at the sea. Both of them are stark naked.]

E. There's something I've been *dying* to ask you, Che, but I'm worried it'll upset you.

C. You can't upset me, I'm already up-side-down, remember?

E. Shame on me, I'd forgotten. Well, what I wanted to ask was, who *are* you?

C. I'm Ernesto Rafael Guevara de la Serna, and I'm from Rosario, Argentina.

E. That's a lot of names. And who is Fidel Castro? And why does he only have one?

C. He was the president of Cuba.

E. But I happen to know that the FBI assassinated Fidel Castro more than once.

C. They tried so many times he lost count, *I* told you that.

E. I imagine he would have lost count on *each* successfull assissination, wouldn't he?

C. Who told you that?

E. My accountant.

C. Why do you believe him?

E. Well he told me face to face, and there was a certain shameful look in his eye when he said it, and I think he liked me. He was a good man. I believed what *he* believed. I believed that Fidel had doubles and they stood in for him in public meetings.

C. What do you believe now?

E. Well, I've been thinking a lot about the birds and the bees, after what you told me on the flight to Argentina.

C. Ah, that's a *good*!

E. Che, could I meet your mother one day? *la Serna*?

C. Maybe you've met some of her daughters.

E. I would very much like that.

E. [Whispering] *How's her hearing, Che?*

C. And you can guess why Fidel has only one name, can't you?

E. Because he has *two* names?

C. Yes. Fidel and Raul.

E. Is Fidel more or less *Derecha* than Raul?

C. You mean are they RDF or are they FDR? You know, that's *a good* question! I don't actually know the answer.

E. Che, I am wondering if maybe *you* were a just a nice piece of ass that the girls got to take to war with them. Something to keep their their spirits up. A blast of hot air, so to speak.

[There's a knock at the door.]

E. Come in!

[Charles Dodgson enters, his right hand extended. He too is stark naked.]

Dodgson. D. . . Do . . . D . . . Do . . .

[He pauses a few seconds, looking at the carpet, then puts his right hand in his pocket, looks up again.]

D. I'm Charles.

E. I'm Minor, as I think you know.

D. Minor major, or Major minor? Either way, I'm de*lighted* to meet you! So what do you think of the little girl then?

E. She's lovely. She's really lovely.

D. She's quite a logician, isn't she?

E. Who, Sappho? Yes indeed. That was quite a proof she cooked up.

D. Two and a half millenia in the pot. *Actually* it was the old man's proof, of course.

E. That's true! All his white hot air. He did love to pull legs didn't he?

D. He was outrageous. The Silkworm pipe!

E. Musical Miccalus will die tomorrow!

D. Man is *potentially* musical!

E. All the logicians since poor old Frege owe their entire *careers* to that!

D. Yes, *poor* Frege, shame.

E. It was a finely finished surface.

D. The old man's? Very *smoothly* polished bronze, wouldn't you say?

E. Those who take themselves too seriously see just nonsense.

D. But wise girls can see straight through polished surfaces.

E. Do you think any of her work might turn up now?

D. Sappho's? I hope so, I do *so* hope so.

E. Their *burning* the Library at Alexandria was *probably* a mistake though, wasn't it?

D. Sending all the words up in smoke, you mean?

E. Yes. The girls may actually be able to sort them out again.

D. From *her literal materials*? They could do this by *teaching men intuition*, couldn't they?

E. Yes. Because the men are potential blasts of hot air and they *could* yield the actual knowledge from the smoke. But we have so few of those words for certain.

D. It might be enough. O! what a foolish, *shameful* thing of them to do.

E. If it *isn't* enough, you *do* know what that means, don't you?

D. We're going to have to learn to write like that.

E. Oh God, I could never, ever, ever do it that well.

D. Nor I.

[Both men break down in tears. Racked with sobs, they go down on their knees and their forearms, and lean forward, pressing their left cheeks to the ground, with their arses as high in the air as they can get them. El Che steps forward from where had been lurking in the shadows.]

C. I can't write either. They *must* return the words. We have to plead, come on.

[He takes their hands and on their knees, the three, bollock naked, move to the front of the stage, then they raise their eyes *up*wards and say in unison]

C., D.&E.

You, whoever you are, we forgive you your trespasses,
*for you **have** trespassed against us.*
***We** beseech you, in the name of the one True God,*
to return to us the words of her father, which he wrote for her mother.

His little godess needs to hear them now;
*If she doesn't, she **will** die,*
*and we will **all** die with her. This we beg of you on bended knees,*
*in **both** the names of our **precious** little godess*

ΨΥΧΗ our ΓΑΙΑ

[They go down on their knees and their forearms, and lean forward, pressing their left cheeks to the ground, with their arses as high in the air as they can get them. The light fades to black and the curtain opens.]

THE BEGINNING

[Any resemblence to persons living or dead is purely a result of wishful thinking.]