MATTER

Lecture 1

The subject with which I propose to deal is too large and, as it stands, too vague to have all its aspects even touched upon by me in the course of two lectures. From my title it is impossible to tell whether I intend to discuss the relation between body and mind, or the naturalistic interpretation of the universe, or the allied problems of human freedom, the relation of the inorganic and the organic, and the concept of human evolution. I may as well state at once, therefore, that I propose to deal with none of these, but with one aspect of the subject only. In its examination I propose to go wherever the enquiry carries me.

The question with which I propose to deal is one which has been asked by philosophers, physicists and so-called plain men alike; or if they didn't ask it they behaved as if they knew its answer. This question is, quite simply: What is the world – the whole or part of which is revealed to us through our senses – what is that world made of? Or, to analyse it into its constituents: What do we mean by the term 'material object', what common quality have the entities which we denote by it, in virtue of which they and none others should be denoted by it, and, when we have obtained the answer, what justification have we for believing that such entities exist, and how, if they exist, are they related to those other entities whose nature they are invoked to explain?

Some people believe these last questions are bogus questions, that is, that it is possible to see that there can in principle be no answer to them, because the propositions which are offered as answers are neither true nor false, in the only sense the words can have, and therefore not propositions at all, but collections of words evocative of images, sensations, emotions and so forth, disguised as propositions. Now the questions which are not known to have an answer, or more than that are known to be unanswerable not because of our ignorance of the answers, but

because they are unanswerable in principle, so that we do not know where to look for the answers, are, rightly I think, held to be bogus questions, that is, not questions at all. The question 'Does matter exist?' and the question 'How do you *explain* the fact that sometimes this table looks bright yellow and sometimes a vague and dirty brown?', being as we shall see cognate questions, are held to be nonsense questions in this sense. With this view we shall deal also. In the meanwhile we must turn to the elucidation of the question itself.

II

The question is: What are things, in their loosest sense of the contents of what we call our experience of the external world, as opposed to the content of our contemplation of ourselves – what are things made of? Water, said Thales of Miletus. This sounds grotesque. Before we call it so, however, let us consider the nature of the question. Let us go back to the table which sometimes looks a dirty brown, sometimes bright yellow. We ask our plain man whether it is the same table which looks different at different times: he answers that it is. If pressed as to his evidence he answers that it feels the same to the touch, that it looks the same shape, possibly that it occupies the same amount of space, that is, is the same size. But now supposing I break it into pieces: is it still the same? No, he will say, the table has ceased to be: all that is left is a scattered heap of variously shaped pieces of wood. But if I piece them together again with glue, and ask whether the reconstructed table is the same as the table which he knew when it was unbroken, he will, with slight uneasiness perhaps, recognise the table as the same. He will at first see nothing paradoxical in the statement that this table which he sees was broken up but is now restored; and yet if he calls the table which existed undestroyed at two o'clock the same table as the cracked but patched-up table which he observes at three, and yet refuses to call the debris which fills the intermediate time by the name of table at all, let alone this particular table, intimately known to him in its individuality, there is an undoubted paradox. If this table has ceased to be, if the words are used seriously, it has ceased to be beyond power of recall: no one would claim for it a capacity for personal resurrection. Out of its parts a new table may no doubt be made;

but the reconstructed table is not a *new* table, we will say, it is not even the successor of the old; it *is* the old table, minus one of its aspects or qualities, that is, unbroken smoothness of its surface. Scarred though it may be by its violent treatment, it remains the same table.

The plain man will at this point realise that in asserting or implying that that which preserves identity from one point in time to another cannot be said to have *lost* it in any interim period without self-contradiction; and admit that the debris, observable only at two-thirty, though for some reason or other one might not call it a table, nevertheless is in *some* sense identical with the table of which we say it is the debris, and also identical with the table it subsequently becomes. Having got our plain man to make this admission we may, I think, consider him to have transcended his original *naïveté*, and to be grasping the meaning involved in his present, *purified*, belief. And this is: One of the senses of the words 'A physical object has changed' is the proposition which states that a rearrangement of its component elements has taken place; this is so at any rate in cases of change in what we call visible or tangible shape, whether these two be the same or not. Now these elements – each, that is, of the *disjecta membra* composing the debris of what was the table and might be so again – can be further divided into smaller constituents; but at a certain point, however remote, we must stop, it is thought, for otherwise there will be nothing left to divide and rearrange. These smallest particles, incapable of further division – particles, that is, smaller than which we can neither discover nor manufacture anything, though in thought we can of course go on dividing *ad infinitum* – are the ultimate components of any given visible entity. Change is now defined as the movements and rearrangement of these particles, which are, however, regarded as of a different character in accordance with the objects which they compose. Tables are composed of tabular particles, horses of equine particles, bulls of bovine, and so on.

But it was soon noticed that things changed into one another, as wood into ashes: these must therefore have particles in common, and things cannot be composed of wholly distinct types of entities, otherwise, as Anaxagoras seemed sometimes to suggest, tables when divided would resolve into so many smaller tables, cows into tinier cows, and so on. But the ashes of a burnt table are not a table, so that I must maintain that what is common to them

inhered in the table even before it was burnt. And – the last step – differences between things could be regarded as frozen change, an arrested process of rearrangement: everything could turn into anything else if the various particles, or various types of particles, were only shuffled about in a certain manner.

The conception of the *smallest* particles, though they are thought to own most properties with things, such as position in space, shape, size, probably colour and the like, is yet relatively abstract: no one was known who had actually seen a particle of this kind. It was not strictly impossible that someone with delicate enough perceptions should do so: its only serious difference from the larger objects in which it was an element was its size. But nevertheless thinkers in primitive, at least scientifically primitive, societies normally think in terms of concrete experience, and Thales, who had made an enormous intellectual advance by supposing that all change involved a changing subject, and that the total sum of cosmic change involved one self-identical type of entity which occurred in different proportions in different places and times, was not an abstract enough thinker to conceive of this subject of change as itself different from any of the particular combinations of itself in which it occurred, and supposed it to be *water*. Why water, it is difficult to say; perhaps because Thales, like Paracelsus, observed that watered plants absorbed the water, and produced more of themselves, which accretion could be due only to the water, which itself disappeared, only to re-emerge in the metamorphosed semblance of an additional part of the plant. Water, being, apparently, capable of changing into something so unlike itself as a tree without leaving any apparent traces of itself behind, is a plausible candidate for being that universal substance the various forms of which were our daily universe. The fact that water is itself one of the constituted members of that universe, different from other members in precisely the same way in which they differed from each other, and cannot be the self-identical subject of change of which all differences *were* differences, did not occur to him, though he was obviously a man of considerable genius. His successor Anaximander took this step, which is one of very great importance: he said that all things were made of the **α**πειρον[1] – the Unlimited. This is really a very great stride forward.

[1] IB's Greek has been reproduced as in the MS, complete with inconsistent accentuation. (All footnotes are editorial.)

It is best studied not in Anaximander, of whose views we know practically nothing, but in Plato, who utilised this concept, though he gave it an unfortunate twist, and in Aristotle, who took it over and obscured its nature for some eighteen centuries.

III

περας-απειρον

To see this let us for a moment go back to our table. Once we have realised that, although we may resolve it into its component parts, yet some identity will persist, the next question which arises is the *method* of resolving it in order to reach that fundamental and irresoluble substratum the various adventures of which result in our world of sense-perception. The atomists – notably Democritus and, I suppose, Leucippus – did it in the simplest way possible, that is, by dividing everything into the smallest spatially contiguous parts. This appeared to Plato, and may have appeared to Anaximander, a crude and shallow proceeding, which could not possibly achieve the end for which it was intended. For if the universe was simply a collection of groups of atoms associated at random, our names for things would simply be the names of aggregates of different odd shapes, sizes, colours and so forth, and we could never say more about them than that. But if asked what a table was, we would not, Plato thought, naturally reply by giving an elaborate description of the *changes* of most tables known to us, or perhaps of the blurred and hazy generalised shape which the word would call to our minds. For if we happened to come across a rock formation shaped rather *like* a table, we would not naturally call it a table and regard it as yet another instance of the tables with which we are acquainted, and think no more of it: we should say that it was shaped *like* a table, curiously resembled a table, was tabular in appearance. If asked what we meant by 'table', we should answer that one of the things we meant by 'table' was a material object which we need for putting things on, reading and eating, and that anything which looked like such an object, but was not designed to be so used, was not a table, though by analogy it might be compared to one. A more natural description is not enough, in other words: we must know the purpose or function of the object, the use to which it best fitted; and we think a given object more or less of a table in accordance as it better or worse serves the

purpose for which it has been made, or to which we turn it. *This* is the distinction, the Platonic and Aristotelian distinction, between *matter* and *form*. In Aristotle it is occasionally called the formal, and occasionally the final, cause: the two are very closely related.

Now if this be so, we may ask what, when we subtract the form of a table, is left over to serve as the content of which the form is the form, that is, its so-called matter. We answer, for example, a wooden object of a certain shape. We know why it has the shape: it is to serve our purpose of eating or leaving things about on it. But what is it that has the shape? Wood: that is, a part of some tree. The tree, then, is the matter of which we have made the table. But a tree cannot be defined as simply one of the entities of which tables are made: we come across trees and give them names independently of any of the direct uses we put them to. If so, what was required in the case of the table is required in the case of the tree. We must again ask: What is its form? Now since the form of the table was the function it performs in our economy, the form of the tree must be the function *it* performs, that in virtue of which in it is more or less true to the type of trees: and that presumably is to grow in a certain fashion, rise to a certain height and so on. We can now again ask what *its* matter is, and the answer is, its chemical components. We can obviously continue this analysis, which consists in tracing any object back to its source, until, Aristotle says, we arrive at the original primordial matter, or πρωτὴ ὕλη, which has no εἰδος, no form, at all. Each form is the ὕλη, the material content, of the forms above it: each ὑλη is the εἰδος of the ὑλη below it. This corresponds in Aristotle's logic to differentiation of genera into species, of these into subspecies, and back again. At one end you get *genus generum*, pure form, at the other pure ὕλη, formless matter, than which there is nothing more undifferentiated. The things with which we are acquainted are various stages of this dynamic progressive relation. Ultimately the whole universe is interrelated in this way: of anything we may say that it is the matter of such and such successively imposed, or potentially imposable, forms: and the form of such and such specifically differentiated, or differentiable, cases of matter. We describe a thing exhaustively only by indicating its unique position in the scale or tree of forms, each of which is the matter of the one above it.

If we ask what the root of this tree is, how Aristotle conceived of that ultimate substratum, the formless ὑλη which is both

logically and metaphysically prior to anything else in the universe, it is difficult to answer. The most likely answer is that he conceived of it as a homogeneous, colourless, shapeless, extended substance qualified by the twin couples of dryness and wetness, heat and cold. Anything so qualified, was the proper recipient of form, that is, the purposive structure which converted the substrate into a describable thing. The qualities of heat and cold, dryness and wetness, are very naïvely and crudely thought to be detachable entities the taking away and adding of which left their owner unaltered, but caused changes which were contingent and almost irrelevant, not intrinsic to the natural order, those changes which, not being involved in the inevitable and necessary evolution of each thing into the next highest stage by the acquisition of the next highest form, were the accidental change of, for instance, position and shape, which could not be explained by invoking the hierarchy of forms.

This curious view accounts for the principles of medieval alchemy. The alchemists believed that by varying or removing these concrete detachables, wet, or dry, or hot, or cold, and their combinations you could transmute one metal into another, and shift its matter on to a new column of possible forms, in this case from the set of potentialities actualisable by base metals to the set of possibilities actualisable by gold. You took away brittleness and greyness and substituted fusibility, ductibility, yellowness and so forth, all these being curiously regarded as real entities which you could take away from and attach to matter. What this matter is, either in the case of the alchemists or in the case of Aristotle, was probably never clearly conceived by them: a general recipient of attributes, a colourless extended something-or-other, not so very unlike the description of the physical universe by the late James Hinton – vast, cold, grey, and shaking like a jelly.

Side by side with this view, there continued to exist, you will recollect, the view of the atomists Democritus and Leucippus, who believed that the content of acts of sense-perception were the various configurations of tiny particles continually drawn together and torn apart by the mysterious forces of love and hate, attraction and repulsion, for which no laws could be formulated And as a peculiarly interesting parallel view there was the Pythagorean conception of things as essentially compounded of numbers, numbers being conceived as points ordered in space in a geometrical manner. We shall have occasion to deal with this in

connection with the views held by Renaissance philosophers and also by Mr Whitehead.

What I hope I have made clear so far is this. If you were to ask a philosophical Greek of the late fourth century what the essence of a material object was, he might give one of two answers. If he was influenced by the doctrines of Plato and Aristotle he would answer in terms of the function which the object performed. He would indicate the function or purpose or structure – all these words would mean roughly the same – of one of the next highest forms of which the form of the object in question was the matter, and the next lowest form which was itself the matter of the object in question. This is the celebrated definition *per genus et differentiam*: the genus, the differentia and the denotation of a thing are answers to the questions 'How does this thing act at its most typical?' and 'How does this its action differ from the actions of other things whose action resembles it but isn't absolutely identical with it?' and finally 'How does that act, or what is the end of that, which the similar things have in common, while it is still itself and untransformed, when it is not yet differentiated into two or more cognate but heterogeneous types of itself?' The answer to the first two questions is the form of things with the same matter in them; the answer to the third states what this matter is by asking what is the form of the next highest matter, which is identical with the matter of the next lowest form.

That is one answer, and very fatal to physics it proved too. The second answer, that of the atomist, or even of the Pythagorean stripped of mystical accoutrement, would be the precise description of the shape, size, weight and colour of the object. This is its form: its matter is that something which is capable of having position, shape, weight, size and the rest. Now since we can distinguish between various objects only by stating their relative shape, weight, size and so on, the names we give are symbols for that alone. We cannot talk about matter at all, since we can only talk of what we can discriminate from something else, and what is different is the form, not the matter: there is a multiplicity of interrelated forms which differentiate the primal matter. That matter exists we may say, however, for form without matter is empty, and matter is that which makes the difference between something and nothing: it is presupposed in the assertion that a universe exists, it is the ultimate quiddity, the indeterminate

something-or-other of which suchness and thisness, quality and *haecceitas*, as the schoolmen would have called it, are predicable.

Something not dissimilar is to be found in the doctrine adumbrated by Plato in the *Philebus*, where he speaks of matter as the ἀπειρον, the Unlimited, the pure potentiality, upon which περας, the Limit, operates by means of the Greater and the Less, which is, I suppose, Plato's way of describing the determinate forms of things which form an interconnected whole with each other, where each form is what it is in so far as its edges are the frontiers of the other forms which encircle it, which in their turn are what *they* are only in relation to their proximate neighbours – the Greater and the Less – a way of indicating the relationality of structure.

What is the ἀπειρον, the Limitless? There is no doubt that Plato does not think of it as modern philosophers might, as the limiting concept, the term beyond the series, the purely conceptual goal towards which the hierarchy, the infinite series of discoverable forms, is the unending, asymptotic approach. No such conception is ever to be found in him. No, he definitely thought of it as a genuine self-subsistent substance – something which Aristotle thinks can be composed of the cold and hot, dry and wet – very concrete indeed, a sort of cosmic fluid or gas or either of which everything else was a modification.

I said above that the treatment by Aristotle and Plato of form as purposive, as the degree of perfection in its kind of each thing, was fatal to the development of the concept of matter. It was so for this reason: that the answer to the question 'What is the form of this or that?' was drawn not from actual experience, but asserted on a priori deductive grounds. Herodotus, for example, who represents the advanced thought of his time, thought that, when he wrote of the course pursued by the Nile and the Danube, if he made out that they were symmetrical, he was at any rate making a plausible suggestion, because symmetry was only another name for the perfection which the river system of the world strives to attain, and which really representative rivers like the Nile and the Danube could be trusted to achieve; and this tendency a man who had grasped this – the fundamental essence of all reality – would seek to reveal. This is tantamount to refusing to allow what came to be referred to as the brute facts to hamper the untrammelled flight of pure theory.

You are familiar with Plato's programme for the astronomer in the *Republic* – how he is to have little to do with experimental astronomy, or the mere star-gazer who is content to tabulate his observations. Plato insists instead that real astronomy must be *pure*: must be a deductive science. Once you have grasped – he will not really tell you how – the real essence of the stars and spheres, you deduce what *must* be the path of this or that star, if it is to conform to the ideal which on grounds other than observation of its motion the philosopher knows to be the goal which it necessarily pursues. And whether it is the αὐτο το ἀγαθον, the Supreme Good, the ideal end, upward movement towards which is historical evolution, in relation to which alone everything can be truly understood, or whether it is the God of the medieval scientist – in either case, if the facts do not square with what on metaphysical or theological grounds you know to be true, then with Hegel you say 'So much the worse for the facts!' With Bradley you regard your daily experience as a deception and a cheat, and attempt to correct it in the light of a theory needing no evidence save either the authority of the Bible or its own internal coherence, according as you are a theologian or a dogmatic metaphysician.

There is undoubtedly something impressive about this majestic hierarchy of forms built on forms, the order of each determined by the end or value each embodies and seeks to actualise. There is, however, an undoubted jump between value and existence: the presupposition throughout is, because it is best that something should be the case, therefore it *is* the case. To say that there is no intelligible ideal, no single purpose in the light of which the universe as a whole is to be interpreted, is too bad to be true: therefore it is false, and there *is* such an ideal, and all interpretation must be in terms of it. This statement is too brief not to caricature that Platonic position to some degree. If it is an exaggeration it is one in the right direction: the appeal it makes is to the moral instinct, or the desire for pleasure, or the sentimental of approval, or any or all of these; not to the scientific temper or to the truth, however unattractive. That this metaphysic possesses grandeur no one can deny: but it is instructive to consider the results to which its adoption as a method of discovery led.

Let us consider astronomy, which Plato discusses so explicitly. What happened was this. Planets, it was said, *must* move in circles. 'Why *must*?' you say. Because, is the answer, the circle is the most perfect form of motion, and a planet seeking the perfection of its

species must, if it is not to be a self-contradictory concept, move in circles. Hence an astral chart was elaborated, from Ptolemy to Kepler, in which the paths of all planets were drawn circular, that is to say, you took any three points at which the planet was observed to be and drew the only circle on whose circumference those three points lay. If a planet was seen at any other point of the same circumference it was *ex hypothesi* the planet which traversed the original three points. If a planet much resembling the original one was observed elsewhere, but not at a point in the circumference of the circle the arc of which the original planet was held to have traversed, then, however similar it looked, in however unmistakably similar a manner it behaved – for example, if it were a comet and not easily mistaken – it was nevertheless held to be a wholly different heavenly body, and an independent circle peculiar to it was drawn, and so on *ad infinitum*: The trouble was that the circles, called epicycles, cut each other in places where it could be calculated that collisions ought to have taken place between the stars or planets, and yet none such were witnessed, no effects were observed: the result was that each time a new set of observations was taken, and a new circle drawn, the old circles had to be modified, made greater or smaller, to prevent intersection at points of possible collision, until at the time of Kepler it was impossible to correlate a new datum with the map without altering the whole, enormously ingenious, vastly intricate plan.

The situation grew grossly unmanageable: astronomical prediction failed again and again. It was plain that the gap between what stars should have been doing and what stars were apparently, in spite of their better, truer, natures, doing, if we were to trust our senses at all, grew too great to be bridged by speculation alone; and ignore one's senses wholly one could not. The concept of a star began, at any rate, with perception of luminous points above; the whole conceptual structure was reared on this foundation: to say that all the senses said was false was tantamount to cutting off the branch on which one was sitting. The mystics who did this did in fact give up all forms of rational inquiry and lived in private incommunicable worlds: to misquote a document[2] which discussed a very different situation, science burst its metaphysical integuments and asserted its autonomy. Experimental verification was demanded in place of deduction from self-evident premisses,

[2] *The Communist Manifesto.*

such as that the stars ran in perfect courses or that God was good. This is what Whitehead called the Revolt of Matter.

Revolt of Matter

But revolt against what? Whitehead says: Against Form; against the belief that the true answer to the question 'How does matter behave?' is to be found somewhere outside observation, in the Bible, or in Aristotle, or in the dogmatic and unprovable assertions claiming to derive from the faculty of pure reason, which utters such general statements as that every constituent of the universe is engaged on realising its own proper perfection, and more specific statements such as that the circle is the most perfect figure. Yes, but what was offered as the alternative? The alternative was knowledge by measurement. If you measured a thing you could say something positive about it, as it was, at any rate, at the time of the measuring process; if someone challenged your statement they could go and measure for themselves. Since mathematics *was* a deductive science, and a deductively drawn conclusion is as certain as the weakest premiss, where the premisses were all measurable quantities the conclusion could be tested and re-tested by re-checking the truth of the premisses. And as you could do this by measurement, you could test a general statement about material objects, provided it was in terms of the measurable, for example, weight, size, quantity and so forth, by such quantitative statements, since if any conclusion was false, sooner or later, being as it was deduced from one or more quantitative premisses, and asserting as it did a definite quantitative relation between objects, it would fail to be true of some fresh instance of the original thing measured, and so you would go back and modify the original premisses, in order to correlate more and more measurables by one interrelated set of mathematical relationships, these being expressed by means of symbols carefully defined, the fundamental relation being that of 'greater than', / 'less than', as Plato had obscurely pointed out.

Now you can measure things only by dividing what you measure into equal parts, taking the part as the unit, and expressing size in terms of such a unit: hence the return to the old atomism and conception of the universe as a collection of separate unit-entities moving in a space itself divisible into equal motionless units, with a celerity expressible again in terms of equal time-units. However, because only what can be measured can be thus verified,

it does not follow that only what is measurable is real, or at any rate this is not self-evident. When I say that a given object is of such and such length, breadth, depth, duration, I do not and *cannot* mean that it *is* such length, breadth, depth and so on; to say that would be to fall into Aristotle's or the alchemists' crudities, who thought that dryness or fusibility were real entities which could be removed from or added to matter, stuck and unstuck like labels on a box, and sometimes speak as though they were even more substantial than that, as though πρωτη ὑλη, primal matter, was the name for the combination of these qualities or elements, which compose it as the handle and blade do a knife. Since the measurable *aspects* of things are not *things*, and since it is only these *aspects* that enter into those mathematical formulae which express the relations of physical objects, it follows that the various formulae are not descriptions of things, and that the whole systematic body of mathematical physics is not the description of matter, but only states the correlations of certain properties of matter, namely those properties which happen to be measurable and therefore statable in quantitative form. When therefore we declare that the physicists of the seventeenth century had analysed matter into molecules or atoms, and that the physicists of the nineteenth and twentieth centuries analysed the atom further into electrons and protons and ions, and neutrons, are we not making a mistake both in supposing that we have exhausted the physical universe by abstracting its measurable aspects and concentrating on *that*, as though no other aspects existed, even in the material and sense-perceptible world, than the measurable aspect; and also in supposing that we have answered the question 'What is matter?' or 'What is the structure of the world given us by our co-ordinated and discriminated sense-perceptions?', even under the measurable aspect?

When we say that matter is grained, or that radiant energy travels about in quanta, or that the electrons rotate round a nucleus, what is grained, what travels in quanta, and what rotates? The modern physicist *as* physicist never answers that question: all he is concerned with is the symbolic formulation of the relations, static and dynamic, between entities, without examining the terms which these relations relate. We know they are not our normal percepts, we think it nonsense to say that visible chairs, or visible parts of visible chairs, move about in quanta, or that tables, or visible bits of tables, rotate round a nucleus, and so no doubt it is.

And all that the physicists' formulae state is that given such and such a velocity of a rotating object, its position at various moments is this or that; or if they are indeterminist they think they cannot even say that always. But if the object is nothing that we see or sense, if we are forbidden even to describe it in terms applied to sensibles, on the ground that they are purely conceptual and unimaginable, and yet told to conceive them as owners of symbolisable, nay, verifiable attributes, and to have a definite relation to the sensible world, what are they?

It is the answer to this question that so many modern physical philosophers, notably Professor Eddington, seem to attempt to give: and in my view signally fail to give correctly. With their answers, from Berkeley to Mach and Eddington, I shall attempt to deal in my next lecture. In the meanwhile let me say, firstly: the Revolt of Matter seems to me an utter misnomer. If it was a revolt it was a conservative revolt, a return to a tradition older than Plato, the tradition of the Ionian physicists whose question was 'What are things made of?', which led to atomism, and not 'To what end is each thing made?', which led to fruitful speculation possibly in biology and sociology, certainly in ethics, in politics, in aesthetics, and naturally in theology, but led to a strait-jacketing of physics until, as I said above, it burst its integuments. And secondly, if it was a revolt, it was not a revolt of matter, but a revolt of one conception of form against another. In place of teleological laws you now operated in terms of mathematical equations, instead of saying that a thunderclap was an act of God to frighten men or the self-realisation of the four elements of fire, air, earth and water, you declared that the physical constituents in the world before the thunder, and those after, were equal in number, and that all that had happened was that they had changed position, that is, become reshuffled among themselves: nothing new had entered, nothing old had disappeared.

This was the law of conservation of matter: it said that the quantity of matter at any moment was equal to its quantity at any other moment. It is a relational judgement, as are all laws: *what* it is that is related, that thus remains constant, is not explained, though the name of atoms was given it. Now, a statement not about matter directly, but about the relation between two of its possible states, is not material but formal, that is, it asserts something about the permanent form and law governing the behaviour of matter: Obviously anything stated as a differential equation where on

either side of the equality symbol you have groups of algebraic symbols which denote constants and not variables – that is to say, you say that something is true of the relation between two *classes* of facts or entities, it being indifferent which member of the class you happen to illustrate it with, or test the truth of the formula by – anything stated of that is not a description of things, or matter, or any spatio-temporal particular constituent of the universe. A collection of laws asserted to be evidenced in the universe *is not* the universe, it is an empty framework until determinate content is put into it. It is a conceptual scheme of ideal particulars of which nothing is said, connected by ideal relations of whose *real existence* only a man blind to all philosophers save Plato could be persuaded. As Bradley declares towards the end of one of his great perorations: 'It may come from a failure in my metaphysics, or from a weakness in the flesh which continues to blind me, but the notion that existence could be the same as understanding strikes as cold and ghost-like as the dreariest materialism.' And 'the sensuous curtain is a deception and a cheat, if it hides some colourless movement of atoms, some spectral woof of impalpable abstractions, or unearthly ballet of bloodless categories. Though dragged to such conclusions, we can not embrace them. Our principles may be true but they are not reality.'[3]

The particular point I wish to make is that the abstractions, even if they were not impalpable, the categories, even if they were not bloodless, are formal properties of things, not their material constituents. The difference between particulars, however ideal, and universals, however concrete, is absolute: one is an existent, the other a mode or manner of existence. The question we want answered concerns the nature of the existent: the answer we receive concerns the way in which different types of it are related. The Revolt of Matter was therefore nothing of the kind: it was a reversion to an older doctrine about form. Admittedly observation of actual events – and these are continuous *particulars* – enters into the doctrine by way of evidence: but only indirectly. The atom and the electron, the magnetic charge, the wavelength, which have every appearance of being particulars, constituents of real particular events, are defined in terms of one another, as if they were not entities but relations. Relations, being universals, if

[3] F. H. Bradley, *The Principles of Logic* (London, 1883), p. 533 [Book III, Part II, Chapter IV, § 16].

defined at all must be so defined: if A is larger than B, and you do not know what 'larger than' means, but understand 'smaller than', I can explain it by saying that when B is smaller than A, the relation in which A stands to B is called 'larger than', and either you understand both or neither, and in the latter case I can do nothing at all. But I cannot define A and B like that. In mathematics I can define A as whatever is larger than B: but if I ask what mathematics is and am told that it is whatever has relation X to Spirit, or worse still is itself interrelated by relations X, Y, Z, I go on to ask whether there is anything to satisfy that condition, and if so what. The answer to that *cannot* be more relational judgements since soon there will be nothing left for the relation to relate. Yet when I ask Professor Eddington what matter is, he defines it in terms of stresses; when I go on to ask what a stress is, I am answered it is a system of potentials; when I ask what a potential is, it is alleged to be a system of intervals; and an interval is a class of scales; and finally and triumphantly a scale is a system of measurements of matter. Not only am I told that, but I am told it with pride, as though a circular definition was the only perfect definition.

There is obviously some confusion here. This answer is precisely like that celebrated Indian theory misquoted by Mr Locke according to which the world was said to rest on an elephant, the elephant on a tortoise, the tortoise on a whale, and the whale on the world. I am asking for a description of, or at least a method of inspecting, the terms between which the relation holds, as I understand a term, as this table is what stands in the relation of spatial contiguity to me. I am given more and more relations, that is, more and more formal characteristics; and yet I am not allowed to suppose, at least not by Sir Arthur Eddington or Sir James Jeans, that 'electrons', or 'stresses', or 'matter' are themselves only names for relations between visible patches and tasteable tastes. The electron, they say, rotates. But the patches and tastes do not rotate, and rotation is not a metaphor: *something* rotates. And yet it cannot be a complex of relations either: if it is silly to suppose that this table rotates it is sillier to say that a complex of relations between my sense-data and my instincts and my acquired habits rotates.

It is the absence of a definite statement with regard to the nature of that in terms of which Kepler and Newton formulated their laws that led Berkeley to reject matter and substance as

meaningless concepts. Though I believe Berkeley to have been wrong, I do think that it was the wrong answer to a genuine question.

It is getting late, however, and I will stop here. In my next lecture I propose to deal with the question which Berkeley asks, and which he and Hume, and Mach and the modern school of so called Logical Positivists have, in my opinion, answered wrongly. If there is time, I also propose to deal with the extraordinary confusions of Sir Arthur Eddington on this subject. And finally to state my own view as briefly as I can.

Lecture 2

Last Monday I said that no proposition stating a complex of relations can possibly be the answer to the question 'What is the sensible world composed of?' That of which the question is asked, namely the world I experience through the senses, is, in some sense, a succession of particulars, of 'this-here-now's: however much I may divide, subdivide, analyse, and investigate this succession, I must always be left with a something which must be a subject of attributes or a term with relations, and cannot be solely an attribute of a subject, or, if you prefer it so, a term in relation with another term, not a base relation or a complex of relations. The true proposition that ultimately no terms can be conceived except in certain relations to other terms does not involve the false one that terms do not exist, or that nothing can be said about them. While, therefore, scientists were engaged on division and subdivision, no specifically philosophical difficulties arose: matter was conceived as a homogeneous substance extended in space: even Aristotle, who said that **prwth ulh** was only conceivable in thought, meant not that it was a quasi-mathematical limiting concept or necessary fiction assented to by you and me, but that no instances of primordial matter could be discovered *pure* and by themselves. The limitless varieties of things were resolved into the 92 atoms of chemistry: these were later resolved into the complicated play of two kinds of electrically charged primary particles (protons and electrons). Still all was well: the old notion holds except that the world-picture is much simplified. This became still further simplified by the fact that physicists built the material world out of a minimum of assumed quantities of substance, referred to by the symbols M, m, e, h, c. All the differences of materials and processes known to us were reduced in principle to the general laws obeyed by those very few elements of reality. Everything that we regard as simply existing and perishing through the change of phenomena is already very little more than mathematical form.

Now comes the last and really dramatic step: the last substantial elements are reduced to formal conditions of processes of wave-like nature; in ordinary perceived waves we distinguish between *the fact that* something undulates and something that undulates, the undulating something – between the water and its undulation – but

these processes of undulation have no carrier, in this sense, for physicists *as physicists* don't need one. It is of fundamental importance for an understanding of the so-called world-picture of the modern physicist to realise that to assume the existence of a substance means to assume something which in some way influences the processes which take place in it or by its means. When ordinary waves run over the face of the water as along elastic strings, the *form* is always the same – it is represented by the same mathematical formula – but the 'medium', i.e. the substance, nevertheless always has a certain influence upon the real course of the process: inasmuch as, say, the velocity of the waves depends on the nature of the undulating substance.

But for the waves of the new wave mechanics no such character of the carrier is made use of; it is solely a matter of the formal laws of the process: the result is that physics can now dispense with a carrier or a medium. Physics is not interested in things about which it can say nothing: and it can only say something about things which are measurable, or rather not about *things* which are measurable, but about the measurements, about the numerical values shown by measuring instruments such as rods and thermometers, not about the measured. But even if it does this – this is quite unexceptionable from the point of view of the pure scientist who seeks only to correlate and to predict – it has no right to deny that there are such things: in so doing it is making a extra-physical statement, and encroaching on philosophy. What it is saying is that the collection of abstracted aspects of reality which interest *it*, *is* reality. This is obviously invalid: the universe cannot on any view be a collection of termless relations. It is obvious that science for its own purposes leaves something out, and then behaves as if it doesn't exist. Let us see what it is that it leaves out: the relation between that whereon science is necessarily silent but common speech is not, and that whereof it treats, is the whole problem of the relation of science and philosophy, and science and common sense; it is *focused* in the difference of views about the nature of matter.

The first person seriously to suspect the scientists of this kind of baseless negative dogmatism was *Bishop Berkeley*.

He asked himself what were the irreducible contents of his own experience. He answered: a plurality of particular patches of colour, particular sounds, smells, tastes, muscular sensations, sensations of touch; beyond these and their spatial and temporal

orders he was aware of nothing outside himself. He then asked what it was that Newton had declared to be real; he was told, atoms of matter and their temporal and spatial relations. He asked if atoms shared any properties with the smells and sounds and coloured patches, and he was told that they shared certain properties, extension, motion, solidity, shape and so forth, but not others, namely precisely that which makes a taste a taste, a colour a colour, a sound a sound; and, further, that the atoms had what sense data hadn't, namely force, or power to cause changes in each other, and to generate sensation in us. He professed himself unable to understand what could be meant: he declared that our conception of and our evidence for the shape of a thing was precisely the same in kind as our evidence for and conception of its colour: namely our sight. We affected to be able to check it by our sense of touch; but this was sheer illusion: our *tactual* sensation, though present together with it, in no way resembled our *visual* sensation. When we said a thing was spherical both to sight and touch, we meant that we shared both such and such a sensation if we looked in a certain direction, and such and such a sensation if we put out our hand and felt in the same direction: the invariable (or almost invariable – illusions had to be accounted for) and reversible succession of these two sense data led us to call them by the same names; we took one for granted whenever we perceived the other; and also we noticed that they vary concomitantly. But their *status* was also the same: if my seeing a colour wasn't good enough evidence for my saying that what I saw existed as I saw it, then neither was my seeing it as extended good enough evidence for saying that extension qualified even unseeable objects. Both sorts of sensations were in precisely the same boat ontologically: we could not assert mere mind-dependence of one and deny it to the other.

So far as the equation of sensible shape and sensible colour is concerned, he is plainly right: such a *bifurcation* of nature as Locke had introduced was arbitrary and indefensible. Professor Whitehead supports Berkeley in this; and indeed he is right. The distinction between primary and secondary qualities (if both are sensible) as sometimes drawn by Locke cannot be sustained; so far so good. Having established this, Berkeley asked: What then were scientists talking about? He answered: Either sensations and their relations, or nothing. Indeed, when pressed, they seemed to be unable to say themselves what their substantial matter was. Locke

talked about an 'I know not what', and this was not untypical; and yet they obstinately refused to discuss sensations. 'Sensations', they said, 'cannot be *measured*;[4] consequently no physical laws can be established for them unless we invoke something which can be measured or counted, e.g. wavelengths which concomitantly vary with colour. But waves of what? 'Certainly not of anything we can see and form an image of,' argued Berkeley; 'for if we could, then we should see it [meaning, say, wavelengths] directly, and would not place it *behind* phenomena as their causes. If we *cannot* see them, then they cannot resemble our ideas, as Locke certainly said they did; for if one thing is said to resemble another, this means that, while different in some respects, it shares some identical elements with it, otherwise they would not be comparable at all. But if the atom is so far different from the visible and tangible *table* that it lacks the one thing which makes a table a table for us, namely that we can see and touch the something we call a table, it is surely perverse to call them similar. Indeed, they are so different that they cannot be compared at all: *so* different that we can neither imagine them nor perceive them, nor, being screened from them by what we do see and feel, have any reason to suppose that they exist at all.'

All this is very admirable criticism, and scientists, notably Ernst Mach and his followers of the schools of empirico-criticism and logical positivism, have followed Berkeley in this. 'Show us the atom and we will believe in it,' they said; 'otherwise, all it is is the name for a *relational formula* between certain mathematical symbols, by means of which we predict our own sensations. The world is composed of our thoughts and our sensations. Our sensations are the content, our thoughts the categorical, universal relations obtaining between them or believed to obtain between them, or obtaining between algebraic symbols which themselves are elements abstracted from sensations. Verifiability is the only test of, and indeed meaning of, truth: the only things we can verify are our own immediate experiences. A formula is true in the sense that it is verifiable, and has been verified, and is believed by us – because it has been reliable in the past – to be likely to be verified in the future. The universe is composed of verifiers and their guesses, and what verifies these guesses for the *guessers*. "Matter" is the name of a group of formulae whereby, with some other

[4] Blue and bluer – not 2 blue.

formulae, we verify sensible events. It certainly does not *exist*: to say of a thing that it exists means that we have sensed it or are sensing it or have a memory image of it or believe that we shall one day sense it or have a memory image of it. But atoms, which it said that we are in principle incapable of sensing, are in principle nonsense-concepts – real only as mathematical formulae are real, i.e. as symbols in the minds of their inventors and employers.'

This position is bold, clear and not wholly unattractive: it enormously simplifies the world. If it be objected that this leaves out the main objection, indeed that which originally prompted Locke's dualism, namely illusions, whose unreality can mean only that, whatever normal presentations do, abnormal ones, such as mirages and hallucinations, do not correspond to something real, taking 'correspond' in its wider sense, the phenomenalist overcomes this objection easily by saying that 'real' and 'unreal', 'illusion' and 'reality' are question-begging terms. If you have truly emancipated yourself from the notion of the occult thing cowering behind appearances, you will simply say that some presentations, which have previously occurred together in company with certain others, occasionally occur alone or in unusual company. You cannot ask why or how they do so: that is a meaningless question. You can only note that sometimes they do and leave it at that.

The two chief reasons for assuming entities connected with appearances but themselves not appearances both disappear. One is the seventeenth-century reason that sense data cannot be measured, while reality can. This is invalid, as there is no reason to think this latter can. Nothing, strictly speaking, is measured: only certain appearances of certain instruments are correlated by fixed convention with certain numbers, and certain manipulation of these numbers enables us to predict events quite well on the whole. To construct the number series we do not need anything save the conception of certain abstract terms and their relations. These are systems of relations and not existents. The second objection disappears if we regard illusions as instances of the failure of our calculation and expectations. If we fail, so much the worse for us; we always hope to invent symbols or relations between symbols which will enable us to predict these also; once predicted and expected they cease to be illusions. If we know that under certain conditions a stick will look bent, i.e. in water, that is not a *necessary illusion,* as Kant called it, but not an illusion at all. We know that certain tactile and visual sense data which [were]

previously associated are dissociated under certain describable conditions, and in place of one visual datum another will appear. The terms 'illusory' and 'real' are simply terms of comparative frequency of association of sense data. If we lived in a world of sticks reflected in water, a stick which looked straight and felt as a stick half in water usually feels would be regarded as illusory. This is only true if seen straightness and felt straightness are so called through constant association and not because of a real common quality: but philosophers accept that. This is no more than saying that sometimes the tactile sense data which are elements in apples are accompanied by red, sometimes green appearances. This happens often and we are not surprised. The combinations called illusion are so rare that we often do not take the trouble of remembering to expect the exceptional possibilities, and so are trapped when they occur. There is here no difficulty of principle.

What Berkeley did was to say: Science omits to discuss two subjects: firstly the data immediately given us in our sensible experience, and secondly the abstruse subject of the formal characteristics which they do talk in terms of. But the two are really one: there is no external world which we can discuss save the sensible appearances. If the sciences purport to examine the world we live in, *that* and no other is the only world we know. The world is not given twice – once by sense perception and once by physics – but only once. If the real subject of physical propositions is not this single universe given by the senses it is nothing at all.

Let us consider an instance. When I say that I am seeing Orion, what the non- Berkeleyan, what we may call the realist, scientist would want me to say is that I am aware of a small shimmering gleaming speck above me, from which I infer by complicated mathematical machinery that there was, at a certain calculable time before the event of my looking up, an extended body of measurable size – itself invisible to me – at a measurable distance from me, whose emission of waves of radiant energy affects my brain and optic nerve and the retina of my eye so as to generate my act of seeing. Probably this extended object exists still, but to verify this I must wait until light now being emitted reaches me in what now is still a future event for me. This is nonsense, Berkeley and Mach would say. What I should be saying is: I am affected in a certain describable way, from which I can fairly reliably infer, by assuming that my experience is fairly uniform, so that what has often occurred in the past will recur, and I've no reason so far to

think the contrary, that were I look again and again in either the same or in a regularly varying direction under certain describable circumstances I should see a very similar brilliant patch. That is all I know and all I need to know, in order to know all there is to know. Since I cannot in principle verify the unseeable cause of my present perception – if I can never see it, and that not because of the weakness of my eyes but because to see something is to be affected by something else, which *ex hypothesi* is itself not seeable – then there is no such thing. The matter of which I say Orion is composed is only a way of saying, a pompous way as some would say, a useful compendious abbreviated one as others would say, of saying that I believe that I should experience such and such sensations under such and such conditions. All I can ever be aware of, all my symbols can symbolise, is sensibles, their relations and their constituent sensible elements. To say there are objects behind them, to say that matter is other than its sensible attributes even to the extent of owning them and not being them – to try, in fact, to explain what I sensibly experience in terms denoting something I cannot directly experience, is to talk mystifying nonsense. We cannot *explain,* we can only *describe* what we sense and what we've reason to think we shall sense, and what we remember to have sensed in the past: i.e. the components of experience are present sensations or perceptions so vivid that we call them our external world at this moment, certain memory images, and certain images which we expect will one day will be succeeded by vividder images very like them, and as vivid as our present vivid images.

To say with followers of Kant[?][5] that when I see the table I only *see* the front of it in perspective, and that the back of it, which I take for granted, is not a sense datum and yet is a constituent of the perceived table, is no objection to this view; for what I take for granted, i.e. the element which in Mr Price's terminology distinguishes perception from sensation, is a set of guessed-at sense data, or an inarticulate belief that when I move my body I should see certain sense data: so no external entities are needed.

Science is engaged on inventing dodges, in the shape of formulae, for predicting which of our present vivid sense data, or, more generally, states of perceiving, could have been foretold from which present memories, and which of the present sense data or

[5] MS hard to follow here. 'Prof. Moore' also occurs in margin without a clear point of insertion.

perceptions can be used as a basis for predicting which future sense data or perceptions; i.e., given that we are contemplating simultaneously two images, one vivid and one hazier, can we draw up a rule about such couples whereby we can declare that the first of these will be succeeded by a very similar memory image, and the second by a similar vivid sense datum? This is simply description of the present plus a rule for describing the future more or less correctly. As Hume observed, we cannot *explain* anything. If I say that this table is heavy, and if I say that this means more than that I should be surprised if what I see before me were suddenly to rise in the air and fly away, and a set of similar judgements, I am talking nonsense. That is the position known as Positivism or Phenomenalism. According to it, a hypothesis is a set of predictory formulae, which refer only to my own future and correspond to nothing independently real; or they may be looked at as a mechanical instrument like an abacus or a counting machine. Only the sensible exists.

We have now rebutted those objections which are urged against this doctrine, but in fact hold no water. Yet I believe this doctrine to be fallacious; to argue this is my next talk.

What are we left with? We are told that nothing exists save sounds and smells and coloured patches and a great deal else of this kind which is more private and incommunicable. Atoms, magnetic fields and so forth are the names of constituents of mathematical formulae which are not true or false any more than counting machines or motor-cars can be said to be true or false. They either do their work of describing events, either in the past or in the future, in terms of present events efficiently, or not: if not, they are useless and must be rejected.

Let us consider the implications of this: (1) *esse* is *percipi*, we are told; to say that it is not is *not merely false,* as Locke thought in the case of secondary qualities, but self-contradictory, nonsensical, as Berkeley thought. There is no need, with him, to deny real universals as relations between particulars; we need only deny non-sensible particulars. The experienced world is a collection of complexes of sensations. Very well; this table is a complex of my actual sensations coloured by memory and expectations. The phenomenalists among you will agree: *but what are you*? More complexes of my sensations. Supposing I were to ask one of you whether he was sitting on a bench and he said that he was, all I could report would be that I had a muscular sensation called

talking, this was accompanied by a noise, and I had then heard a noise which was a further complex of sensations, the relation of which to the previous complex of my sensations, i.e. appearances that I call one of you, was only the relation of contiguity or simultaneity in time. I could not say that someone had answered me *because* he had heard and understood what I had said, because understanding involves the mind, which I cannot directly inspect, and which is therefore not a complex of my sensations, and not an existent. This seems strange enough. The difference between heard answers and the noise made by the wind outside is, beyond the pure inspectable difference of tone, pitch, timbre and so on, mostly a difference of usefulness and pleasantness to me in conducting my life. I think I can say that I know that this identification is false, if I know anything. I think that no scientist would really assert that what other scientists had said were simply useful complexes of his own sensations, which enable him to predict his own future sensations as the sound of an approaching motor car can serve to predict certain visual data, i.e. the colour, shape etc. of the car.

I think I must call any theory which involves one in this a silly theory. But the case is worse than that. If I ask what my own status is, how I myself receive perceptions, I cannot assert the real existence of, say, my brain or my optic nerve, for I can never see these, and they are therefore not even complexes of my sensations. If *esse* is *percipi*, I cannot exist save when I am being perceived. As I am not in the habit of continually perceiving my own body, let alone my brain, which I never see at all, I must assume not merely, with Malebranche, that in some sense I disappear when I am said to be asleep, but that I do so every time I brood on a mathematical problem, or am completely absorbed in listening to music. Without enquiring what the 'I' is which does these things, and how I came to be aware of it, which cannot itself be a complex of sensations, I plainly require someone to observe my body, and possibly my brain and optic nerve when I do not do so myself, otherwise having been once allowed to disappear through not being attended to, the brain, optic nerve, nervous centres etc. which do the sensating cannot reappear, for being that to which sensations occur, and by whose state they are influenced, they cannot recur even to themselves after we say that they had totally ceased to be.

We have here a gaping contradiction of experience which demands explaining away. Berkeley does so by invoking a non-sensible God who observes me when I don't do so myself. But that is a violation of the phenomenalist principle of evidence which says *aut sensibile aut nihil*. The argument is very precarious. I say: Here is a group of facts for which my theory won't account; it will account for them only if I either introduce a fresh fact or modify the theory. I refuse to modify the theory. Therefore I postulate an unverifiable fact in the shape of God or a noumenal self; but such a postulate destroys the principle of the theory which it is meant to bolster up. So I am left with my theory destroyed, and the facts still unaccounted for, undescribed.

Mach and Mill tried to avoid the scandal of Berkeley's theology by talking of permanent possibilities of sensation. Though the proposition 'There is a tree on the left' is to be analysed into the proposition 'There is a long grey patch in the left-hand corner of my sense field and I believe that were I to make certain movements I should have certain visual sensations in a graduated series, each continuous with the last, and similar to it, and also a series of certain tactual sensations of a predictable kind', there is also the proposition 'Were I to look to the left, which I am not, as a matter of fact, doing, I *should* see a tree.' All hypothetical propositions of this kind are reduced by Mill to references to the Laws of Nature, i.e. the belief that there is a uniform succession of sensation, i.e. that sensations tend in fact to occur in experience in similar groups, so that if you have one you may, relying on certain rules formulated by you by using the evidence of observations (which is one sort of sensation) and memory of observations (which is simply another sort of sensation), whenever these cohere, predict the next sensation. Thus again the universe consists of our present sensations and rules of prediction, highly reliable in the case of scientists, fairly reliable in the case of ordinary man, and hopelessly unreliable in the case of small children, lunatics and common fools.

The fact is that there is a great deal of bad psychology employed in this doctrine, since, e.g., sensations do not occur as isolated units of experience, but always in patterned complexes, so that success in discrimination between them and discovery of their order would, I suppose, represent the degree of intellectual development of a man. But we can afford to neglect this. Relations and structure, being only ways of being and not existents, aren't a

new kind of entity in the sense that matter, if it exists, is; not a new kind of concept in the sense that matter, if it is a real concept, would be. A phenomenalist system could be built up, free from the errors of Mill or Mach, which nevertheless made it necessary to hold that all propositions containing names of material objects or matter could be resolved without residue into propositions containing only names of sensations, so that to talk of matter as something other than complexes of sensation, with their laws, would be self-contradictory nonsense.

The position of this school of thought is 'The meaning of the proposition is the means of its verification.' If, therefore, I ask what is the meaning of the proposition 'Napoleon is dead' or 'I lectured last Monday', the answers would roughly be, to the first: I have memories of words in books which said 'Napoleon is dead', or something like it, and quite possibly I have an image of a man with arms crossed on chest resembling certain memory images I call memories of pictures of Napoleon's face; and also if I were to utter at the complex of sensations I call a historian the noises 'Is Napoleon dead?' I should hear the noise 'Yes' or something like it. The question 'Did Napoleon really exist or is he a figment?' is translated into the question 'Is the group of present sensations by which you would verify the proposition "Napoleon was Emperor of the French" of one kind or of another kind?' and no more. The distinction between the groups is entirely psychological.

Mill, I think, thought, and some philosophers do now, that you can build up the world, not indeed out of our present sensations only, but also out of the assumption of a heap of sensations, real still, but in the past – past particular facts, as it were. But past sensations are monsters which a phenomenalist cannot admit. If it is genuinely past it is not verifiable unless you suppose past events in some way to have effects in the present, which begs the question at the outset, since it assumes their real existence in the past, not as verified but as the basis of verification. A sensation of pastness is not a past sensation. If verification is your *only* method there is no real past, and there are no other persons, there is only I and my present sensations, some of which are clouded with a sort of feeling of pastness, others with a feeling of premonition which I call 'belief that x will occur'. Beyond that nothing. So 'I lectured last Monday' analyses simply into 'I have a memory image of myself as lecturing plus a sensation of pastness and an image of an entry in a lecture list, and if I were to ask someone "Did I lecture

on Monday?" I believe I should hear the noise "Yes".' You observe what this involves. It involves that all propositions are necessarily propositions either about my present state of mind or about my future state of mind, since verification can proceed in them only. 'The past' is the name of a certain class of propositions about my present and my future.

This is strange enough, you will own. The fact of my birth and the atom of the scientist are of the same order of entities now. Both are names for groups of verifiable propositions, or the names for the method of building up such groups, called logical constructions. This seems rather curious, since ordinarily it would be said that people existed who had witnessed my birth; but no one could lay claim to having encountered an atom.

The reason for their being treated as similar is the crux of the whole situation. It is because I and I alone can verify my beliefs. Other people's beliefs or verifications cannot *ex hypothesi* take place in *my* consciousness. 'I have a headache' is verified by my contemporaneous and incommunicably private sensation called headache: 'You have a headache' is verified by the group of presentations I call your appearance, the noises *I* hear if I utter the noise 'Have you a headache?' and so on. This is a kind of solipsism from which there is no escape.

Those who declare that the questions 'What are things made of?,' 'Is there a something called matter?,' 'Are atoms real?' are bogus questions, meaning that as the answers are in principle unverifiable by us they are nonsense, because meaning is the method of verification, are involved in a curious position in which I cannot say that at 2 o'clock I said that it would soon begin to rain and at 3 o'clock this was verified by my seeing certain silvery sense data and feeling successive cold stabs in my hands, for at 3 o'clock I cannot verify the fact that at 2.30 I asked a question,[6] all I can verify is the fact that I now have a datum in my mind framed as a question plus a sensation of pastness called 'a question asked by me half an hour ago'. If it is the entity called by me 'you' who hazarded this guess about the weather, all I am allowed to say is that I have heard a sense of noises which was followed by a state of mind in me called the state of mind of understanding a

[6] The MS originally had him asking at 2.30 whether it would rain rather than saying at 2 that it would soon rain, and the alteration was not carried through.

proposition. But whether it is possible that you (whom I connect, through constant conjunction, with that sort of noise rather than with the noises I call the singing of birds, or the rustling of leaves or the babbling of brooks) – whether it's possible that you might be said, even by analogy with me, to have been in the same state of mind as I know I should have been in if I had used those noises – though it is obscure whom I intend to communicate them to – if I ask that, I am talking nonsense. The expression 'your state of mind', save in so far as it means my perceptions of certain presentations called your face, your movements etc. plus a belief as to what presentation will succeed them, is nonsense. The expression 'my state of mind' is verifiably different in meaning from the expression 'the data I see in a mirror plus my muscular sensations'; the expression 'your state of mind' cannot be different, since if it were it would not be directly verifiable by me, i.e. [mean] nothing for me.

This is a behaviouristic solipsism which goes one step *beyond* old, Humean solipsism. It does not deny that other beings exist outside myself; that would imply that there was nothing impossible in the proposition that they might, but in fact I have no evidence for it and so reject it. It asserts that proposition to be absolutely meaningless.

At this point I think I may say that any philosophy which drives me to say that it is meaningless to assert that I know that I am speaking to you and that you are listening to me and that we are distinct, similarly organised entities with limited scope of communication is false. There is no possibility of refuting any kind of solipsism logically since on its own premisses – here certain assertions about meaning – it is valid. I cannot *verify* the statement that you are sentient beings and not merely a percept of mine plus a certain emotional attitude, or that this table is more than another such percept plus a different attitude – that a bore's conversation and the hoot of a car are not different only in the sense that my means of stopping them would be different – I cannot verify or prove these things any more than Descartes could, who agreed with me. But I see no reason whatever to believe that they are true, or even probable or possible. No complete theoretical refutation of logical positivism is possible, indeed no real theory can be deductively refuted on its own premisses. But if I have, as I hope I have, demonstrated that positivism or phenomenalism is only a cloaked form of solipsism, that is almost enough. I pronounce a

theory false when it fails to account for certain indubitable facts of my experience. This theory fails to account for my knowledge or well-grounded belief that you exist and are not all skilfully built inanimate automata which are themselves complexes of my sensations.

But to return to the narrower question of matter: I have more reasons than this to urge against the phenomenalist and positivist view which is now so widely held.

My second reason is that it fails to account for the success of mathematics when applied to physics. The phenomenalist or positivist says that the physicist, having assigned certain mathematical values to certain verifiable sensations and perceptions – which means simply that the percept called by Mr Joseph tabulinspection, or seeing the dial of a measuring instrument with some point in its dial indicated, occurs together with some other percept like my impression of the moon or a feeling of heat – having done this, he performs certain mathematical operations with the figure obtained by looking at the dial, and so getting some other symbol translates this back to the corresponding point of the dial, and then declares that certain sensations which occur simultaneously with one dial reading will be followed in fact by other sensations which will necessarily coincide with the dial reading obtained by calculation. He then constructs a serial arrangement – like that of the wavelengths, which means that he can predict what colour will appear by the point on the dial at which the needle of the instrument stops. This is very convenient; but why does it all come out so pat? 'All questions of "Why?" form are nonsense questions' says the positivist: it just does. That is all we can say.

This is surely very insufficient. Why should mathematics prove a more reliable guide to events than crystal-gazing? The whole of our disbelief in crystal-gazing is really due to the fact that in the end the crystal-gazer cannot explain her method, and says that the crystal just *does* foretell. Yet our distrust of crystals is not simply founded on the fact that successful prediction with crystals is *rarer* than with microscopes and test-tubes, and therefore less reliable: in fact we are usually sceptical enough to call successful prediction a coincidence. But for positivists there are no coincidences because there are no necessary laws. Everything is equally a coincidence, only there are better and worse methods of prediction. But the enormous success of mathematical physics, which the early

physicists explained by saying they are measuring what was *real*, is not explained at all: it is simply successful magic.

This is very unsatisfactory: Now the alternative explanation of why one formula more successfully predicts a given event than another is that it more faithfully symbolises the real structure of something: if there really is something possessing mathematical structure, then there is no ground for surprise if mathematics are helpful. This is what Pythagoras thought, who said all things were made of geometrical points, and what Kant thought, who believed that the mathematical form of reality was imposed by our own mental activity. Now, we have seen that our sensations are not mathematical in form: then what is? Unless we are solipsistic positivists we have no reason to believe that everything is a complex of our sensations; and the fact that mathematical laws are the laws which our sense-experience on the whole obeys inclines us to the belief that this same experience must be correlated, by a fixed law of correspondence, to a world of entities which, whatever else they do, must obey mathematical laws. Now if there is no probability at all that anything save our sensations and percepts exists, there is no probability that such a world exists. But why should we say that there is no probability at all? That mathematics helps us only by luck seems far more improbable. If we allow any probability at all, as, if we are not solipsists or Berkeleyan theists, I think we can and must, then this probability can be shown to be very high. For if we postulate a possible entity as a premiss, and the deductively drawn conclusions from this postulate plus verified sensations are themselves verified, the postulate becomes more probable. If having accepted the scientific postulate of, say, the undulatory theory of light, we predict that we shall in fact see in the centre of the candle flame a dark patch, or, having accepted the reality of planets with properties of gravitation or occupation of space, we predict the appearance of the new planet Vulcan, as was done three years ago or so, and in both cases observation verifies our prediction, the probability of the real existence of planets with such properties as we ascribe to them, or of the really undulatory nature of light, is increased by far more than one successful prediction would enable a positivist to strengthen the reliability of his rule. According to the positivist we cannot say that the dark patch, or Vulcan, was always there, only we had not seen it, because what we have not sensed is nothing, by definition. But if we abandon his assumptions, and try to

systematise our perceptions by assuming that Vulcan was there all the time, and this assumption connects certain loose ends, and leads to a more coherent system, this again strengthens its probability. The probability of what? Not of a fiction or of a formula, for fictions and formulae have no probabilities: but the probability of a hypothesis. The more improbable my seeing Vulcan through a telescope seemed before I framed the hypothesis – and to the positivist it was practically nil since I had not seen anything like it before – the more probable the hypothesis becomes when my seeing Vulcan becomes not probable but certain by direct verification. This is the basis of induction used by the sciences and unaccounted for by positivists.

The hypothesis in this case is that there really exists an entity possessed of such properties, such as causal properties or an electromagnetic charge, or the certainty of appearing in one of a determinate number of places within a determinate time, the possession of which enables us to calculate the future and explain the past. These properties, though they need not be imaginable, must be conceivable in terms of our ordinary experience – size must mean size as the percepts of our experience are greater or smaller than one another – otherwise they mean nothing to us. So when we hear that microscopic entities have size only in the sense that it may be said that there is a finite probability that they will be in one of a set of places during a certain interval of time, we know that this must be nonsense if macroscopic entities are composed of microscopic entities, and the former are measurable in the normal sense. Though it may be for scientific purposes more convenient to use one method in the case of microscopic entities, and another in the case of macroscopic entities, yet the use of the same word is unnecessarily confusing for laymen and leads certain writers on popular science to say that ultimately matter consists of probability waves. Perhaps you will forgive me if I expose this fallacy, too, as briefly as I can.

What is a *wave* of probability? It is, I think, the name of certain mathematical curves used to map the fact that it is possible, whether in principle or because we are too ignorant to know more, to say only that a given phenomenon will occur in one of a determinate number of parts of space or time, or that an event will occur to one of a determinate number of objects. I can tell for certain that within a given area the event will occur: but where in particular I cannot tell. Then the probability that any given part of

the area is the scene of the event is smaller and smaller, as the size of the minimum area of which I can say for certain that somewhere in it the event will occur is greater and greater. If I say that it is certain that every thousandth man in China will die in the course of the year, then the probability of any one man's dying is 1:1000, a thousand to one that he will not: thus I can plot a straight line on a graph to show this. But if disease or war begins spreading, then the number of men who will lose at least one in the number every year grows smaller. I can say one in five hundred is bound to die: my graph begins rising. As conditions for survival change from favourable to unfavourable and back again my line curves and undulates: I get a 'wave of probability' over a certain time. Obviously this is a name for a formula and not a wave of anything real: the graph undulates only because the formula describing real waves and the formula for mortality possess certain abstract mathematical properties in common. This is a useful metaphorical name, but it is obvious nonsense on my view to say that reality is composed of probabilities: this is the old fallacy of substituting relations for what is related, which I had to expose earlier. What is probable is a spatio-temporal existent: and whether this existent is grained or continuous, undulates or shoots in quanta, is for the philosopher as such immaterial. It is a real particular, not a proposition in my mind.

The same nonsense emerges if we say that things are collections of point-instants, as Pythagoras and certain modern mathematical physicists and philosophers, perhaps Professor Alexander, have tried to do. Whitehead, who with great insight, realising that a point is a relational entity, whose whole essence consists in the fact that it is related in a certain unique manner to other points as members of a mathematical series which is not an existent, that physics deals in terms of points and instants, and that what is called matter, or what are called events, cannot simply be a collection of relations with no existents to relate, tries to invent a definition for physical points in terms of concrete sensible things. He asks you to conceive of an infinite set of solids like Chinese boxes, each one containing one smaller than itself. The smallest box, which since the series is infinite is not to be found within the series, is the limiting concept towards which the series is decreasing. This limiting concept, or sole element which *every* term in this series has in common with the rest, is the definition of a point. As a definition in mathematical physics this is probably

unexceptionable, but as an attempt to translate physics into the language of sensation it plainly will not work. A term in a series is what it is because it is where it is in the series. Whitehead's point is what it is because it is where it is, as the goal of the series. A term or a point in this sense cannot *move*: it is fixed in its relational structure, just as the number 5 cannot move from between 4 and 6, and change places with 7. But things or bits of matter do, or at any rate are conceived as able to, move: indeed it is their relations in *movement* that are geometrically represented by curves and projections. However small a bit of matter is, it cannot become a *point*, not because a point is conceived as *smaller* than any perceptible bit of matter, but because points and bits of matter are philosophically in different universes. Bits of matter are elements in events and move about and obey the laws of dynamics; or, if matter be resolved into energy, they are the electric charges which interpenetrate and affect one another. To do this they must exist, or be conceived as existing. Points are the mathematical concepts of certain geometrical relations, and in no sense existents at all.

The second footnote is to the effect that physicists *as* physicists rightly scorn to ask the questions 'Do atoms exist?', 'Does ether exist?' As Poincaré said, 'Whether ether exists or not is no affair of mine as a physicist. Provided it is a useful concept by means of which I am able to predict real events, I am satisfied. Let metaphysicians ask the other question.' In this he is plainly right. It is only when physicists begin to expound the ontological status of their concepts or rules that they became liable to philosophical attack. Provided they keep themselves and their conceptual apparatus to themselves, and do their job, which is to correlate and predict sensible experience, no philosopher can have anything to complain of. But it is his business to examine the meaning of these concepts apart from their specific use; and we must be careful not to suppose that because a man is a great scientist he necessarily understands the nature of the entities which he may employ with much genius.

What we as philosophers can say, I think, is that matter – the particulars of which the mathematico-physical properties are predicated – must be conceived of as capable of having them in the only sense in which we understand the possession of such predicates, in the sense of being existents in the same universe with our sensible percepts. Sensibles they cannot be, for they are invoked to explain them: but since imagination is not our only

faculty, and I can conceive the earth as a particular existent so-and-so many times larger than myself with myself on its surface, without needing to imagine any such picture, or at least knowing that my image cannot be used as evidence for the fact,[7] I can conceive particular existents endowed with certain inferable properties, the whole concept being only probable, and not certain, and strengthened by the width of its applicability. Formulae and sensations are not enough, nor has any scientist operated solely in terms of them.

'We construct models of reality in order to test the reality of the model,' said the great Hertz,[8] and what he meant was that we build a model to be a copy of discovered elements in reality, and then see that this model necessarily involves properties other than those we strictly need for depicting what we know already. We then wonder whether, corresponding to these additional elements, there may not be an equally additional element in reality: We perform an experiment to discover this. If this was not the question which we were attempting to solve in making our experiment there would be no system in our research. We should not know what questions to ask; no experiment would prove anything save that its results in fact occurred once in our experience. Obviously the conception of the crucial experiment, the conception that one negative instance can destroy a law, cannot be founded on any ideal of description, for description can only present you with a heap of similar data which you classify as you like, similar data from no one of which can you infer even to the probable existence or nature of another. This is not a method which any scientist has in fact pursued. *Hypotheses non fingo* is not an ideal which any scientist has ever been able to pursue, however much some of them have protested that they did. For if science is, as I believe it to be, an attempt at the systematic correlation of more and more data under fewer and fewer general laws with finite probability, and the ideal is a general model of the universe the relation between whose parts it will faithfully record, so that as Bosanquet said, you will be able to read them off wherever you may begin, then the model is not a formula but a plausible reconstruction whose correspondence to nature has such and such a degree of probability. This is not a system

[7] This was of course written before the earth was photographed from space.

[8] As yet untraced.

descriptive of my sensations, but an explanation by means of correlated and verifiable hypotheses. For this reason hypotheses, as someone said, do not die, nor do they commit suicide, but they must be killed. A scientist will hold on to the worst and most unverified and improbable hypothesis until a better is substituted, instead of doing without any, as Mach recommended.

The positivist position is well described by Poincaré, who says that the positivist is like a man who stands at a crossroads and. fearing that he might lose the way whichever way he turns, doesn't move at all, but stands still. This quietism and refusal to theorise is not the attitude of any genuine scientist. Tycho Brahe did it in the sixteenth century, when he collected an immense amount of observations about the heavens: but this entered science only when Kepler produced hypotheses about it. Science is not explanatory, as Berkeley accused it of being, of the *clarum per obscurius*: the entities in terms of which it explains are particular existents owning properties definable in terms of elements of sensible experience, but not therefore sensible. Because what we see is both extended and coloured and because nothing we see is other than coloured, it does not follow that these characteristics are necessarily connected: because what is coloured is necessarily extended, it does not follow that what is extended is necessarily coloured; nor therefore that it is necessarily visible, for if it is colourless it cannot be so. Whether matter is in fact extended continuously or moves in quanta is not a question to worry philosophers: whichever it does it is an existent. The waves of probability are probability of the behaviour of *its* parts: *it* is not logically constructed out of waves of probability, whatever that may mean. I think we must accept some such view unless we are to hold that it is sheer luck that we stumbled on mathematics, which has proved very helpful while not being a characteristic of any existent. Since probability statements are mathematical and complicated mathematical properties are not a characteristic of sensations, laws of probability must be, and by phenomenalists have been defined as (as by Hume also), degrees of strength of my belief in the occurrence of an event. Thus the probability of something may be said to vary as the strength of my belief in its occurrence, and be small before dinner when I am morose, and leap upwards after it when I am more optimistic. This is very peculiar if applied to the sciences. It has been calculated that the probability of a state of affairs in which a brick would rise unaided

from the ground and leap into the bricklayer's hand is 1 in 10 with three trillion noughts to follow. It would indeed be fascinating to know the man who had succeeded in calculating the strength of his belief in that possibility so nicely. Yet if you accept positivism you must accept that also.

I have by now said enough to make clear what I believe matter to be. Very briefly, I believe it to be a particular existent with mathematical properties and causal properties. By the former I mean qualities like extendedness and position, which may be finite and may be infinite, by the latter, responsibility for movement and for change. The probability that such an entity exists is increased by every successful explanation carried out in terms of it. If you call it energy you only endow it with other properties: then its particularity and existence are irreducible. If this is denied, science explains nothing and is a complicated and fortunate illusion.[9]

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[9] At the end of the MS the words 'Apology for Eddington' indicate that IB did not, as he had hoped earlier, deal with Eddington's theories in more detail.