trust', comments François Mauriac, 'in the presence of grace and the Holy Spirit in these children themselves.'

There is, then, one significant difference between the Finaly case and the Dreyfus affair, which the enemies of the Church in France have ignored. They sought to show that the Church was still intolerant, hostile to democracy and human rights, unwilling to acknowledge equality before the law; an enemy of the French State. But times have changed since the majority of French Catholics were ranged against the Dreyfusards. The liberty which these Dreyfusards defended means very little to their modern successors, and the majority of French Catholics today are not concerned to defend 'clericalism' or some political or religious 'interest', but those very human rights the survival of which will mean everything to the future of France.

NUCLEAR PHYSICS AND PHILOSOPHY

JOHN BAPTIST REEVES, O.P.

'MANY mathematicians know their details but are ignorant of the philosophical characterisation of their science.' It was A. N. Whitehead who wrote this. He himself made an admirable effort to supply the defect. Assuming that no recognised philosopher knew enough of the details of mathematical science to give a reliable account of it, he read, besides Plato and Aristotle, a selection of seventeenth-century writers—particularly Descartes, Newton, Locke, Hume, Kant—who either knew enough about mathematics to be helpful, or little enough to show in what new way philosophy must be handled to meet the mathematicians' need. He then wrote *Process and Reality*: *An Essay in Cosmology*, which he delivered as the Gifford Lectures for 1927-28 and published in book form in 1929. It is less exclusively addressed to mathematicians than the earlier work he had begun with Bertrand Russell and then abandoned; but its whole drive aims at setting the sciences that use mathematics in their full philosophical and spiritual context. By the time it was finished the revolution

https://doi.org/10.1111/j.1741-2005.1953.tb00591.x Published online by Cambridge University Press

worked in physics by the theories of quanta and relativity was firmly established. The work took into account, with full approval, the new cosmological outlook the change implied. Heisenberg's principle of indeterminacy, still very new, received no express notice, but the system was ready to receive it. Whitehead's work has been deservedly praised by both philosophers and scientists, but neither are satisfied that the character of contemporary mathematical physics has yet been made clear. Though it failed in this respect, *Process and Reality* has all the precision and controlled order that could be expected from so eminent and so widely cultured a mathematician. It still merits the philosopher's close attention. At least it can show him what the problems created by modern science really are. In its philosophical depths, from the thomist point of view, it is but one more example of what Whitehead himself described all philosophy as being: 'a widespread and ill-defined discipline'. With a very few exceptions, to be noticed later, all British scientists emerging into philosophers have been afflicted with the blind insular ignorance and prejudice that still considers philosophy to have died with the Greeks and to have been reborn at the Reformation.[1]

The crying need for a satisfactory philosophical treatment of modern physics has continued. The attempts of philosophers to supply it not having satisfied the scientists, many of them have attempted the task themselves. The most arresting of these attempts was made by Sir Arthur Eddington. He introduced himself as a philosopher with a very assured modesty: 'Those whose work lies in the epistemological departments of modern physics must be counted as specialists in one of the departments into which philosophy is divided—a department not very far from the heart of the subject. In their discussion of philosophy as a whole they are likely to display the faults of a specialist who finds himself outside his own groove; but they are not common intruders.'[2] Beyond cocking a few snooks at philosophers generally (the

[1] In later years, at Harvard, Whitehead was introduced to St Thomas as a philosopher. He thenceforth often spoke of him with respect, but without intimate understanding.

[2] *The Philosophy of Physical Science*, 1939. p. 9.

https://doi.org/10.1111/j.1741-2005.1953.tb00591.x Published online by Cambridge University Press

phrase is his own, though not the application) he manages with great skill and determination to keep off their ground and confine himself to his own. Indeed that is much more than the character of his book; it is his answer to the problem he discusses displayed in consistent action. Though not unrelated to other knowledge, modern physics as knowledge is for him unique and *sui generis*. It can vindicate its claim to be true knowledge of a high, beautiful and not merely useful order, without any need of having those claims confirmed by any other kind of knowledge. Rather it may teach them all what full knowledge really is by showing them in triumphant action a form that they scarcely recognise as knowledge at all. Eddington expounds, criticises and justifies it without ever once stepping outside it. He is always the mathematical physicist philosophising while he laughs at the confusion of other philosophies and their mutual contradictions. He stops very little short of deciding that modern physics not only has an epistemology all its own and different from any other, but that it actually is that epistemology. It is the thought of physicists, systematised. It is what their adventurous thinking has made it, partly by invention and partly under pressure of their subject. It is not knowledge *tout court*, but a systematisation of knowledge. The knowledge systematised is not unrelated to the objective world, but during the process of systematisation—which is, precisely, physical science—it is hermetically sealed off. It uses observational experiment, but it plans the observations in its own predetermined terms; they ask no questions but those it wants asked, and accept no answer in any terms but its own.

This is a condensed summary and therefore something of an interpretation which would not too greatly have pleased Eddington. But it is a sympathetic and appreciative interpretation. If the language slightly colours the meaning, this is unavoidable unless one is to quote Eddington's own language *in extenso*. He uses a very plain and polished English, but even those nearest to him had to put themselves to some trouble to decide what it meant. He has a playful habit of turning round on you and telling you you have taken him foolishly by taking his statements literally and out

of their context. He is always the mathematical epistemologist; his mind is its operational context just as his science is its own systematisation of itself. To most thomists his thought and language are equally incomprehensible and smell of heterodoxy in every sentence. But the book as a whole merits reading and rereading. It does something more for the thomist than the work of other physical scientists who show him where he must purge Aristotle of factual statements which have since his time been proved incorrect if not quite false. It presents him with a factual example of thought which appears and claims incontrovertibly to be knowledge, yet is not, and does not pretend to be, what has passed for knowledge amongst men since they first knew anything. It is a challenge to the thomist to rethink his philosophy from the root. Let it be said in all haste that there is here no suggestion that the doctrine of St Thomas will have to be radically revolutionised. But to meet the needs of this age some of its deepest implications, which he was not called on to unfold to his age, will have to be worked out, and not merely into the methodological forms traditional in our schools, but into the unspeculative, technical formulations which are becoming more and more the habit of mind of modern man, and which we cannot resist even if we think we ought to. Implicit in thomist metaphysical epistemology are the only answers capable of satisfying clear and capable minds confronted with the crisis in which human intelligence finds itself in the twentieth century. But even if its salvation means a return to the simpler habits of thought of the thirteenth century, those habits must be the term, not the starting point of contemporary thomist activity. We may not approve the way the world is thinking today, but we cannot pretend that it is not thinking at all, or that its strange forms of thought and knowledge are not thought or knowledge at all.

Whitehead and Eddington are dead, to the great regret and loss of the generation of physicists younger than their own. But this also has its great names. The best known of them is Werner Heisenberg, whose lectures on the problems with which physics and philosophy still confront one another —delivered between 1932 and 1948—have lately been

made accessible to us in an English translation.[3] To those of us who only knew Heisenberg as the author of the uncertainty principle it comes as a surprise to find him a man of broad and refined culture, thoroughly at ease outside his subject. For, unlike Eddington, he comes outside it to speak about it, holding it up for demonstration with a teacher's masterly control of himself and his exhibit. Very few mathematical physicists can treat a subject philosophically without denaturing philosophy. Both disciplines work in the abstract, but the two kinds of abstraction are subtly different from one another, and they are exercised in quite different subject matter. The physicist is usually so full of his own subject, and so caught up in the ways of thought most suitable to it, that try how he will he can never see the universe under any forms but the forms of matter, and never measures it with any measures except such as are ultimately mathematical. Some mathematical physicists (to borrow Whitehead's phrase) are so 'ignorant of philosophical characterisation' as not to know what philosophy is all about. Apart from one tendency, Heisenberg is quite free from this defect. He is not a philosopher in the scientific sense, but he is a man of very broad human understanding and sympathy, very balanced in his judgments, and very clear, elegant and dignified when he expresses them in literary form. This literary grace and strength comes quite undisturbed through the translation, which is excellent.[4] Heisenberg's one weakness from the philosopher's point of view is perhaps inevitable in one attached to his subject by faith, hope and love as well as understanding. He hopes that physics may proceed in time to such perfection and universality as to become the principle of unity reconciling all sciences in one harmonious consummation. He grants that in its progress it must undergo revolutions that make its new self quite unlike its old self. But through all change he expects it to maintain radical continuity with its first beginning—which was in the atomism of the ancients. According to this hope physics in

[3] *Philosophic Problems of Nuclear Science.* Eight Lectures by Werner Heisenberg; translated by F. C. Hayes. (Faber and Faber; 16s.)

[4] There are two rather discomfiting misprints: 'qualitative' for 'quantitative' (p. 85) and 'proportions' for 'proposition' (p. 93).

https://doi.org/10.1111/j.1741-2005.1953.tb00591.x Published online by Cambridge University Press

the end would still be physics, and so could never render all science the service that can only come from a metaphysic of all reality, absolute as well as relative. Granted (as he reminds us) that in the beginning physics and philosophy were confused in one indistinguishable science, it may not be argued that as philosophy grew out of physics in the beginning so it may again in the end. Until metaphysics sorted itself out from physics and established its right to supremacy amongst the sciences there was no real science of physics. Today we begin with a very highly developed physics. Though it does not acknowledge the fact, it is what it is today thanks to what was done for it by metaphysics in a past age which it now ungratefully prefers to forget and to ridicule. Until it is reconciled with its ancient founder its progress as a disinterested quest for truth will be illusory.

In these lectures Heisenberg presents the philosopher with much information and enlightenment which enable him in his own way to define modern physics for what it really is. One particular point which frequently recurs is of special significance. Quotation out of context involves some loss of meaning, and threatens to become tedious repetition. But it is the iteration of the point that is most significant, so we quote several instances of it without further apology.

> 'The indivisible elementary particle in modern physics possesses the quality of taking up space in no higher measure than other properties, say colour and strength of material. In its essence it is not a material particle in space and time, but, in a way, only a symbol on whose introduction the laws of nature assume an especially simple form. . . . Atoms are no longer material bodies in the proper sense of the word.' (pp. 55-6.)
>
> 'Since atoms explain sense properties of matter it is clear that no such sense properties can be attributed to the ultimate "brick" of matter in a simple way. . . . Science no longer deals with the world of direct experience, but with a dark background of this world brought to light by our experiments.' (pp. 69-70.)
>
> Modern physics have removed all properties from the atom, even space and position occupied, 'by showing that the degree to which such geometrical concepts can

https://doi.org/10.1111/j.1741-2005.1953.tb00591.x Published online by Cambridge University Press

be applied depends on the experiment in which it is involved. . . . It was originally the aim of science to describe nature as it is, so far as this might be possible, i.e. without interference by our observation. We now realise that this is an unattainable goal. We decide by our selection of the type of observation to be employed which aspects of nature are to be determined and which are to be blurred in the course of the observation. This is the property which separates the smallest particles of matter from the range of our commonsense concepts. The supposition that electrons, protons and neutrons are really the final indivisible particles of matter is only justified by this fact. It would no longer make sense to visualise a three-dimensional structure of these particles.' (p. 73.)

'We now know that a piece of a chemical element, say carbon, can be divided into ever smaller parts, until we finally arrive at the smallest unit characteristic of this element. . . . This *conception*[5] helps us to account roughly for the chemical properties of matter.' (pp. 33-4.)

'An atom can no longer, with reservation, be described "objectively" as an object in space changing in time in a definable manner. Only the results of individual observations can be defined objectively, but they never present a complete and comprehensible picture. . . . We can justifiably claim that an event observed by our senses has "objectively" taken place. But atomic processes cannot always be represented as objective events in time and space.' (p. 87.)

'Just as the Greeks had hoped, we have found now that there is only one fundamental substance. . . . If we have to give this a name we can only call it "energy".' (p. 103.)

Statements like this are not new. They are to be found everywhere in popular philosophical expositions of nuclear physics. They could be paralleled in equal number from Eddington. But whatever Eddington offers the philosopher with his right hand he takes back with the left. More popu-

[5] Italics mine.

lar exponents—like Jeans and Russell—write so much nonsense about reality in general that no hints they may give about the reality or unreality of electrons can be taken seriously by the thomist. Heisenberg is different. He is clear; he keeps a sense of proportion and perspective; at every remove into further abstractions he tightens his grip on concrete data. His thought as well as his language has a classic virtue: it is strong, temperate, just and above all prudent. He is too prudent to go the whole way of philosophy and precisely define the reality of atoms, electrons, waves of probability, Einsteinian time, space six-dimensional and curved, and other like mathematical expressions. But he very firmly, temperately and justly makes it clear what they are not.

That gives the thomist exactly the start he needs in order to proceed to definitions that will put modern physics in its rightful and honourable place amongst the sciences. He can now start out assured by the highest and soberest authority that the entities of mathematical physics are (as indeed he foresaw, and as the physicists in their uncertain philosophical language have all along been trying to tell him) just *concepts*: abstract mathematical figures; not the rhetorical figures of speech in which they are popularly described, and which the popular mind accepts literally, but nevertheless figurative, just as a Euclidean triangle is, and as the lines of latitude and longitude are—only, by abstraction on abstraction, many times further removed from the concrete data of sense, very much more fluid and kaleidoscopic and intractable to imaginative fixture. In their mobility they are eminently suitable to the science whose subject is nature in motion. When the physicist speaks of motion and energy as of a kind of substance, it is his language, not his thought, that is at fault. For 'substance' read 'subject'—*suppositum*. As St Thomas makes quantity a quasi-substance in his eucharistic doctrine, and as Newton does the same—calling it space—in his mechanics, so the modern physicist makes a quasi-substance of motion. His special business is to measure motion. His primary measures are, rightly, the three dimensions of space and the fourth dimension, time. We can no longer agree with St Thomas that *lux transit in instanti*:

https://doi.org/10.1111/j.1741-2005.1953.tb00591.x Published online by Cambridge University Press

light travelling through space takes time. Two events appearing to the eye to be simultaneous can never be so in fact; they may be separated by an interval of centuries. By a legitimate mathematical abstraction Einstein treated space and time as mere distance, making them homogeneous and univocal as standards of measurement. By the same application of reason that we all use to divide geographical distances into miles, yards and inches, and temporal distances into weeks, hours, minutes and seconds—all subjectively imposed—Planck divided continuous quantity, time and movement into discrete quanta, and maintained that these quanta were essentially indivisible, unlike the units of space and time. The imposition vitiates nothing unless its subjective origin is forgotten and it is given the value of objective reality. Just as twenty yards of cloth and twenty yards of running water are numerically identical, so are n units of a geometrical line and n units of time. The time-space units which thus become the quanta of motion are quite valid as measures of it; but it is of course quite ridiculous to speak of them as the ultimate realities of the physical world, as nearly all physicists do when they are off their guard. It is the mind that atomises nature, not nature that presents itself to the mind already constituted of atoms.

Once the thomist has retraced the development of human knowledge from its first simple apprehension of universal ideas by abstraction from the particular data of sense, and shown just where and how and why mathematical abstractions inevitably impose themselves, he has it in his power to hold the mathematical physicist spellbound. The latter has no problems that thomist epistemology cannot explain to him, and no techniques that it cannot justify provided they are restricted to their proper field. Of themselves they can never bring us to an understanding of what nature is, or what time and space are outside the mind. But they can bring us to a very marvellous understanding of what nature does; by measuring her various complicated doings in terms of one another and relatively to one another they illustrate, not nature herself, but the order of nature. And, most interesting of all for the mathematical physicist, the thomist can explain to him why his abstract operations, pursued in isolation from

https://doi.org/10.1111/j.1741-2005.1953.tb00591.x Published online by Cambridge University Press

observed phenomena, not only can but must keep always in time and tune and step with nature, and issue into a genuine sympathetic understanding—not, again, of what she is, but of what she is doing and by what measured processes she is doing it. This is nothing less than explaining the mathematical physicist to himself. For this, at his best, he cannot but be grateful; for at his best he acknowledges with becoming humility that he is a mystery to himself—a greater mystery than any other in nature.

No thomist will be qualified to serve in this important task of reconciling, unifying, co-ordinating and delimiting the sciences unless he himself is as well practised in habits of mathematical abstraction as in habits of metaphysical abstraction. Under the guidance of St Thomas he must analyse both activities as vividly conscious mental experiences. There is no force and usually little meaning in a parade of book-learning about the *intellectus agens*, the *intellectus possibilis*, the *recessus a particularibus et phantasmatibus* and the *recursus ad phantasmata et particularia*, unless the exponent is vividly aware of all these in the life of his own mind, and is able to distinguish them in direct experiments upon that mind and the minds of others. The weakness of thomists in face of modern scientific developments is largely due to their neglect of mathematical disciplines, and to their accepting on faith from St Thomas an epistemology that can be tested and confirmed by delicate reflection on one's own mental life when this is in the healthy condition guaranteed by sane relations with objective reality and other minds acknowledged to be healthy. If the rising generation of thomists are to serve the world of science according to its need they must be properly educated for the task. They must be grounded first in a genuine classical humanist discipline, so as to acquire the great natural virtues of temperance, fortitude, justice and prudence in the life of the mind. These virtues are as necessary in the life of the mind as in the moral life; necessary for the practical direction, in judgments, of the mind's own speculative virtues of knowledge, understanding and wisdom. Indeed unless they are controlling the mental life of a man in this way, they can be controlling his morals only blindly. A classical education

of itself elicits habits of metaphysical abstraction and brings them into full consciousness. Mathematical habits of an elementary kind can in rare cases be acquired spontaneously. But the habits of the modern mathematical physicist which he needs to have explained to himself by one who understands them at first hand are far from elementary. The thomist who is to help him adequately must himself cultivate them as a special discipline. The difficulty here will be to balance the two habits of metaphysical and mathematical abstraction, and keep both vigorously alive. Each tends so to monopolise the mind as to exclude the other. Until there are minds equally versatile in both the rupture between physics and philosophy will persist.

REVIEWS

THE WORD. By Adrienne von Speyer. (Collins; 10s. 6d.)

Adrienne von Speyer is a new writer to English readers, and this, one of the first of her books to be translated, is more remarkable than the layout or the chapter headings suggests. The twelve chapters might be inadequately described as progressive commentary on the first eighteen verses of St John's Gospel; but this is only the framework for a piece of remarkably penetrating illumination (there is no other word for it) of divine truth. Of course there is the apparatus of learning and sensibility. If this book had been written to impress a body of learned men it would have been crammed with footnotes and references. As it is, the learning, experience and sensibility are merged in and subject to the work itself which is 'to bear witness to the light', and the writing appears deceptively facile. It is neither facile nor superficial. As we read through the book we are borne deeper and deeper into the heart of the mystery of God; and the deeper we penetrate the nature of God the more fully do we grasp the meaning of human life. It is commonplace to demand that the Christian view of life should be God-centred; this book not only offers a logical argument to prove that, but by its 'illuminative' power makes the reader see and feel that truth. In other words, here is a piece of truly creative writing, an epithet we bestow with alarming prodigality on all kinds of work. Creative art is that which comes from genuine human experience engaging the mind and the passions and by its own self-sacrificing purity is capable of recreating that experience in the reader. This is creative writing about God: a very rare thing; the love of man that it generates is even rarer. It can hardly be rash to predict great popularity for Adrienne von Speyer's writings because she not only explains