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Sir James Jeans and the New Physics.

THE Presidential Address of Sir James Jeans before the British Association is a fascinating piece of work. Most of it is taken up with a presentation of those aspects of modern physics which have influenced modern scientific outlook—as envisaged by Jeans. In the first place, he makes a clear-cut distinction between the methods of the classical physicist and of his modern successor. The former was keen on trying to construct a mental picture whose elements were derived from objects of every-day experience such as 'billiard balls, jellies and spinning tops'. It is because of this tendency on the part of the 'old-fashioned' physicist to visualise a concrete model in his explanation of phenomena, that classical theories or modifications of such theories on classical lines could not be made to embrace the new facts of observation. According to Jeans the changed outlook of the modern physicist consists in the following:—The content of a set of physical measurements is a set of numbers, each number being a ratio. For instance, to take an example given by Jeans, when we say that the wave-length of a certain radiation is so many centimetres we mean that it is a certain multiple of a centimetre, and since we do not know or rather can never know what a centimetre is in itself, the significant fact in the statement 'so many centimetres' is only its numerical part. Once we concede this, it naturally follows that our theoretical picture of the phenomenal world, which consists in synthesising measured data must be mathematical in form.

The solid rock on which the modern physicist builds is ascertained fact and the bricks used in the construction are the 'observables'. For instance, in the wave theory of light, the solid fact is represented by the word 'wave', and the ether with which the classical physicist filled space, space itself and time, are man-made decorations and do not form part of nature. The same is the lot of the space-time continuum of the theory of relativity, for the General Theory shows that it 'can be crumpled and twisted and warped as much as we please without becoming one whit less true to nature—which of course can only mean that it is not itself part of nature'. The entire knowledge of the outer world comes to our minds through the frame-work of space and time and their product the space-time continuum, as it affects the senses. However important the frame-works may be, they do not form part of nature but are purely mental constructs. *The same is the fate of matter.* It is as much a pure assumption as ether and is an 'unobservable'. Classical Physics was based on the hypothesis that matter existed in space and that its history was mechanistically determined for all time, time being independent and objective. The cardinal weakness in this outlook of the classical physicist was that the rôle given to the mind was that of a passive onlooker without any influence on what it observed. According to Jeans, what the modern physicist has set before himself is the task of studying the impressions that he gets through 'the gateways of knowledge' (*i.e.*, the senses) and not what lies beyond. He is concerned with appearance rather than with reality. In ordering these impressions he adopts two pictorial methods. In one he pictures particles in space and time, in the other, the picture is a system of waves; the former provides for our bias inherited from Classical Physics, while the latter is intended to provide an answer to the question 'what is going to happen next?' Jeans dubs the two modes of looking at the physical world, (which world, as he has already told us, consists only in the impressions which we get through the senses) parables, to prepare us for any inconsistency that may turn out to exist between the two pictures, for parables are *not to be interpreted too literally*. The thesis is developed on these lines with illustrations from the findings of modern physics, the several parts of the thesis often being not in perfect harmony with one another. The burden of the song may be summed up in the words of Jeans himelf: 'The old physics imagined it was studying an objective nature which had its own existence independently of the mind which perceived it, which indeed had existed from all eternity whether it was perceived or not.' *But in the new physics nature consists of* waves and these are of the general quality of waves of knowledge, or of absence of knowledge in our minds.

To those who are familiar with the writings of Jeans the distinctly subjective trend which *he gives to the findings of modern* Physics will not appear strange. He says, "If we ask the new Physics to specify an electron for us, it does not give us a mathematical specification of an objective electron but rather retorts with the question, 'How much do you know about the electron in question?' We state all we know, and then *comes the surprising reply*, 'that is the electron'. Here the electron itself is not part of nature and our knowledge of it ultimately resolves itself into a set of numbers synthesised into one or more mathematical formulæ. The numbers themselves are ratios of physical *quantities* incomprehensible in themselves. Thus it turns out that our knowledge of the electron in the 'parable' is purely mathematical, nay, more, this mathematical content of our knowledge is the electron. The modern *physicist's* knowledge of nature is, according to Jeans, to be *identified with the mathematical formulæ* which he constructs from physical measurements. The question naturally arises whether the earth, sun, moon and stars which the ordinary man thinks exist in space and time, have any existence apart from the respective mental impressions. The answer to this question would be in the negative if we interpret literally the following thesis in the address: 'The earthquake waves which damage our houses travel along the surface of the ground, but we have no right to assume *that they originate on the surface of* the ground; we know on the contrary that they originate deep down in the earth's interior.' Applying the analogy, the sensory impressions which we have of familiar things do not have their origin, as we think they have, in the sun, moon and stars, which we think we see, but somewhere else, presumably in the mind itself. But if this be so, the main objection to subjective idealism arises, *viz.*, how is it that all of us see the same sun, moon and stars? To this difficulty Jeans suggests an answer. In the *particle picture* we think of individual particles, electrons and so on, existing in space and time; as far as we know, in the truer wave picture, the individuality of the particles is lost. As we think ourselves to be existing in space and time we retain our individuality, but if we transcend space and time we perhaps form parts of a single stream of life, where apparently individuality is lost. "It is only a step from this," says Jeans, "to a solution of the problem which would have commended *itself to many* philososophers, *from Plato to Berkeley, and is,* I think, directly in line with the new world-picture of modern Physics." It is no doubt true this is only a suggestion, but is the suggestion in the right direction and does it naturally lead to Berkeley's Subjective Idealism? To Berkeley the objects of every-day observation on examination turn out to be ideas in the perceiver's mind. For an object to exist is to be perceived. In order to account for the sameness of the objects perceived by a number of observers Berkeley introduced the hypothesis of God in whose mind all objects exist as ideas and our ideas are replicas, so to speak, of the ideas in the mind of God. If we take away God whose existence Berkeley assumed, the difficulty that all of us see the same sun and moon remains unexplained. Moreover to Berkeley individual personalities were not indistinguishable ingredients of a stream of life, as is the case with the electrons in an electron current. In fact, no satisfactory answer to the fundamental difficulty which one encounters in all forms of extreme subjective idealism, has yet been offered by any philosopher; neither does modern Physics indicate a satisfactory way of meeting it. To Sankara, the famous Indian philosopher, both our perceptions and the things perceived are illusory appearances spread over an unchanging underlying reality. Our perceptions have no higher degree of reality than the things perceived. So in his system the idea that all persons see the same objects is in the mind and therefore is itself illusory.

'The old physics,' says Jeans, 'imagined it was studying an objective nature which had its own existence independently of the mind which perceived it which indeed had existed from all eternity whether it was perceived or not.' One would infer from this that there is no objective world existing independently of the perceiving mind. How different from this attitude is the view of Max Planck—one of the most prominent among the makers of modern physics! Says Planck: "A science that starts off by predicting the denial of objectivity has already passed sentence on itself." According to Planck one of the fundamental theorems of physical science is that there is a real world which exists independently of our act of knowing. So the reader of Jeans' fascinating address must not forget that there are prominent physicists who differ fundamentally from him on the philosophical implications of the revolutionary changes that have taken place in the domain of Physical Science.

The Stratosphere Balloon and its Use in Scientific Research.

THE investigation of the free atmosphere by means of sounding balloons carrying self-registering instruments has established that the mixing of the atmosphere due to convective processes extends on the average to a height of about 17 km. near the tropics and to about 9 km. near the poles. Above these levels, the atmosphere is extremely stable for vertical movements, the temperature increasing with height near the tropics and remaining more or less stationary up to 25 km. in temperate and polar regions. The upper stably layered region of the atmosphere is called the stratosphere. The temperature at the base of the stratosphere is about −80°C. near the equator and about −50°C. near the poles.

Among the great scientific achievements of the present decade must be included the stratosphere balloon ascents of the Belgian scientist Professor Piccard and his collaborators. The principal motive for Professor Piccard's adventure was the study of cosmic radiation more thoroughly and precisely than was considered possible by other methods. The repetition of these ascents in other lands with similar balloons and technique and extended programmes shows that voyages into the stratosphere for scientific research have come to stay and that it is only a question of time before power-driven commercial machines will fly through the clear, cloudless air of the stratosphere with speeds not far short of that of sound.

Piccard's own account of the bold and successful flights carried out by himself and his colleagues is contained in his very interesting book *Auf 16,000 Meter-Meine Fahrten in die Stratosphäre* (Schweizer Aero-Revue, Zürich). The essential new feature of Piccard's flying equipment was the substitution in place of an open cabin of an air-tight gondola for the accommodation of the aviators and their measuring instruments. The gondola was spherical in shape, made of aluminium and had a diameter of 2·1 metres. It was provided