BOOK REVIEW

RIVAL THEORIES OF COSMOLOGY. By H. Bondi, W. B. Bonnor, R. A. Lyttleton, and G. J. Whitrow (Oxford University Press, 1960).

This small book is the result of the invitation of the British Broadcasting Corporation to Dr. Bonnor, Professor Bondi, and Dr. Lyttleton to present their views on cosmology over the air. The talks aroused such interest that they were rebroadcast, and the speakers were later asked to debate their viewpoints under the chairmanship of Dr. Whitrow. There is much in the book that cannot be fully grasped by the layman, but most of it is of interest, especially to those interested in Swedenborg's cosmology. Dr. Lyttleton says in his introduction:

> If a reader finds obscurity in this subject, he may take some comfort in that he is by no means alone and that his feelings are shared by those who have devoted years of study to this sublime problem. The seeming miracle is that there should be a universe at all, and again one that appears to have an organized structure governed by general laws. It would be too much to expect that the problems it presents are going to prove easy. (p. v)

Lyttleton emphasizes the point that:

> None of the contributors claims for the views expressed here any absolute enduring truth. Cosmologists everywhere are still struggling to find some more certain basis for the theory of the universe than exists at present, and one of the means to such progress lies in the clearer understanding that can emerge from discussion and criticism of rival theories to discover their defects or advantages. It is the business of theory to continue with this while at the same time awaiting and hoping for some great advance in observational technique and discovery, or in some other branch of science, that may precipitate wide revision of our ideas of the universe. We do not know if in the field some great surprise is in store for us, and although it is difficult to believe that there is, we must nevertheless try to keep an open mind and remember that our theories are still at a preliminary stage waiting upon observational evidence for their disproval or precarious survival.

Swedenborg's cosmological theories do not answer all the problems, and New Church men as well as others look forward to a great advance in technique or a discovery that will clarify the whole picture. The New Church man, however, does have guiding principles for his theories. In a sense he may be surprised that there is a universe at all, and he will be impressed and overawed by a study of its organized structure and laws. But he sees the natural universe and its laws as a part of the whole Divine plan. He knows that the end of creation is a heaven from the human race, and so upon reflection he is pleased rather than surprised with the order he observes.

The discovery about thirty years ago that the universe is expanding gave scientific basis for belief in a non-static universe. This together with the general theory of relativity enabled men to deal scientifically with questions of the origin of the universe which previously had been in the domain of speculative philosophy.

> Cosmology, fortunately, must now be considered a science. It is a subject, like any other scientific subject, in which there are means of disproving theoretical forecasts by experiment and observation. It is true that most of these are still rather difficult to make, and require expensive equipment and great skill, but this is the way in which we shoot down cosmological theories.

Some scientists have maintained that relativistic cosmology implies an act of creation in the finite past. Bonnor regards this view as mistaken and thinks it arises from defects in the theories. The steady-state theory of Bondi, Gold, and Hoyle calls for creation, "but in a less unsatisfactory way. The final decision between this theory and those following from general relativity must await more precise observations." In general relativity, space is regarded as

> itself expanding and carrying the galaxies with it—like leaves in the wind—and not of nebulae moving away from each other through passive and indifferent emptiness. This is not merely a difference of words: the active role of space in dynamics is one of the main ideas which Einstein brought to physics when he created general relativity.

This active role of space calls to mind the auras of Swedenborg's *Principia* and the higher natural atmospheres of the Writings.

It is interesting to note that when Einstein was developing his field equations, nothing was known of the expansion of the universe, and he added a cosmological term to obtain a static world model. Later it became evident that the original unaltered field equations were capable of describing the expanding universe, and the cosmological term was not necessary. This no doubt pleased the scientists, since they, even more than laymen, incline toward the simplest explanations.

Theories concerning the expansion of the universe fall into two types.

> The first type predicts that the expansion will continue forever: the nebulae which we see will get fainter and fainter, and the average density of matter in the universe will continually diminish. According to the second type, . . . the expansion is slowing down . . . and will eventually change to a contraction. (p. 4)

Bonnor explains that,

> according to both theories, if we go backward in time, the density of matter in the universe increases, and would have been infinite about 8000 million years ago. There are no theories as to how this could have come about. Some argue that all matter, compressed to an enormous density, was created at this time, an explosion took place, and the expansion started.

Bonnor regards this view as highly unscientific. It is based on the fact that certain quantities in the mathematical equations for the expansion become infinite at the start of the expansion. Such a situation is called a mathematical singularity, and it usually indicates something amiss in the theory. The physicist's normal response is to try to get a better theory.

> This procedure has not generally been followed in cosmology, and some scientists have identified the singularity at the start of the expansion with God, and thought that at this moment he created the universe. It seems to me highly improper to introduce God to solve our scientific problems. There is no place in science for miraculous interventions of this sort; and there is a danger, for those who believe in God, in identifying him with singularities in differential equations, lest the need for him disappear with improved mathematics. (p. 6)

One can have some sympathy for the viewpoint expressed in this quotation. We, no more than Bonnor, are intellectually satisfied by attributing to God those phenomena that we do not understand. Unlike Bonnor, however, we would attribute the origins of *all* objects and laws in the universe to God, whether we understand them or not, while we look to science to explain the *means* by which God creates and sustains the universe. We know that He operates *according to laws,* not by occasional "miraculous interventions."

Bonnor inclines to the theory that the expansion will be followed by a contraction in an unending series of oscillations. If, as Professor Heckmann of Hamburg has indicated, the universe has a slight rotation, too small to be detected at present, centrifugal force would reverse the contraction when the universe becomes dense. One difficulty with this theory is that it is inconsistent with the Second Law of Thermodynamics.

This law has often been thought to mean that the universe is gradually using up its mechanical energy and converting it irrevocably into heat. This would amount to a sort of running down of the universe, rather as a watch runs down as it uses up the mechanical energy stored in its spring. The idea of an unending series of equal expansions and contractions is evidently inconsistent with this view. However, it would be wrong to take this too seriously, because it has never been properly shown how the Second Law of Thermodynamics affects the universe as a whole.

This last sentence is good news. The running down of the universe does not seem to be consistent with the idea of an All-Wise, All-Loving God who created the universe for the sake of the human race.

The steady-state theory proposes that fresh matter is being continually created out of nothing in empty space, at a rate too small to be detected. But

since matter is a form of energy, the creation of matter out of nothing violates the principle of the conservation of energy. This principle has withstood all the revolutions in physics in the last sixty years, and most physicists would be prepared to give it up only if the most compelling reasons were presented. (p. 11)

In answer to the question probably now in the reader's mind Bondi says:

Of course physics might be different elsewhere and at other times from what it is here and now, but this would not be a fruitful assumption to make. The most fruitful guess, scientifically, is that what we know locally is valid everywhere and at all times; that we can use our ideas about, say, the propagation of light, and apply them to other epochs of the universe and other places in it. If we ask why it should be possible for us to apply our knowledge elsewhere, the obvious answer is that, if our place in the universe, in space and time, is a typical place, then the laws of physics that we have learned here should presumably apply elsewhere.

This reminds me of a story I once heard about a man who was found late at night in a very dark alleyway crawling at the bottom of a solitary lamp-post. When asked what he was doing, he said he was looking for his key. 'But do you know you've lost it under this lamp-post?' 'Oh no,' he said, 'I know I've lost it someplace in this alleyway, but if I haven't lost it under this lamp-post, I haven't got a chance of finding it.' Well, this is very much my attitude to cosmology. Either the laws of physics, as we have them here and now, apply everywhere and at all times, because the universe has been the same at all times and is the same everywhere, broadly speaking, or cosmology is a very much more difficult subject than I would like to tackle. (p. 38)

Bondi believes "There is no way of reconciling the notion of a universe unchanging in time and uniform in space with the idea of local evolution and aging without appealing to continual creation." Bonnor argues that on grounds of simplicity, it is much better to maintain that energy is accurately and exactly conserved. He thinks we must demand a big dividend in return to justify our giving up this fundamental principle. Lyttleton replies that

Eddington put his finger on it when he pointed out that the reason why the principle of the conservation of energy has survived so long is simply because in physics energy has come to be defined as that which is conserved. And what has happened is that from time to time new things have been introduced as energy to save this principle. I do not think myself that the idea of creation violates the principle of conservation of energy. What has been done conceptually in the past is to push an approximately verified law right to the limit, or even beyond, and enunciate it as if it were an absolutely exact law of science. But, in fact, the principle of conservation of energy right down to the last place of decimals is not knowable at all as an exact law, because it has never been established in this precise way. In postulating a rate of creation that is far smaller than the most refined measures of the law of conservation, no conflict with empirical evidence has been introduced at all. On the contrary, I would maintain that this is in accord with one of the typical ways in which science advances. You may remember that at one time in chemistry all the atomic weights were thought to be exact integers, but a great advance occurred when it was pointed out that this was not precisely true. (pp. 42 and 43)

As for the dividend, Bondi replies,

I believe that we get the dividend in the resulting picture of the structure of the universe. An unchanging universe is simpler than the evolving type of universe that you favor, Bonnor. I think we ought to make it quite clear where the difference between us lies. You, Bonnor, suppose the universe to be uniform in space. We call this the ordinary Cosmological Principle. What Gold and I postulated was the so-called Perfect Cosmological Principle. According to this, the universe was uniform not only in space but also in time. This unchanging nature in time applies only to the universe as a whole, not of course to the individual constituents, the galaxies, each of which ages in the course of time. (p. 43)

The question of the universality of scientific laws is often raised by New Church men in connection with the question of the habitability of the planets. They ask what makes scientists think that the requirements for life are the same on other planets as they are here. On the other hand the New Church man believes in the unity of the universe under one supreme Ruler, and thus he is inclined to believe that the *general* laws are probably the same everywhere. The question as to which physical laws are general and universal remains unanswered. For example,

The principle of conservation of mass and energy, like all physical principles, is based on observation. These observations, like all experiments and observations, have a certain measure of inaccuracy in them. We do not know from the laboratory experiments that matter is absolutely conserved; we only know that it is conserved to within a very small margin. The simplest formulation of this experimental result seems to be to claim that matter must be absolutely conserved. But this is purely a mathematical abstraction from certain observational results that may contain, indeed are bound to contain, errors.

The creation of "one atom of hydrogen in a space the size of an ordinary living room once every few million years" would never be detected, and this is all that is required to fill up the space left by the expansion of the universe.

Lyttleton tells us that

All sorts of attempts have been made to avoid accepting the expansion of the universe, but the suggestions have been metaphysical at best, and at worst in conflict with the rest of established science. . . . There seems no escape from accepting the expansion of the universe as an established fact. (p. 22)

He explains why the present theories are unsatisfactory and proposes an electrical theory to explain the expansion.

The idea begins with the proton and electron. These are two of the elementary particles that go to make up matter. They bear opposite charges, which make them strongly attract each other, and when they are locked together in electrical embrace, they form an atom of hydrogen. The charges of the electron and proton have hitherto been supposed to be *exactly* equal and opposite, and this must certainly hold to a very high degree of accuracy if all sorts of effects are not to occur that it is known do not occur. The charges can be measured indirectly with fair accuracy, and all evidence is that the two are equal as near as makes no difference for all ordinary electrical purposes; but even so, there is no experimental evidence for absolutely precise equality. Once this is realized, it becomes of great scientific interest to postulate a small difference that does not upset established results, and see if anything can be explained or predicted thereby.

If the proton has slightly greater charge than the electron . . . then instead of cancelling out to zero total charge, the proton and electron will give a hydrogen atom a slight positive charge excess. (pp. 24 and 25).

In a large quantity of hydrogen atoms this charge-excess would exert an electrical repulsion that would counteract gravitational attraction. Lyttleton goes on to explain how galaxies and stars can form in this material, which according to the theory above would tend to fly apart.

> The charge-excess in a region of space containing hydrogen will immediately be driven off if the hydrogen atoms within it become ionized, that is if the protons and electrons are free to move independently. Consequently the material within the ionized cloud will become electrically neutral. Gravitation then takes over entirely and condensations in the cloud could continue to grow. . . . In this theory the galaxies are separating from each other because they are embedded in the expanding gas. They themselves are not electrically charged and are not directly repelling each other. They rather resemble raisins in an expanding cake. (pp. 40 and 41).

The belief in the expanding universe is based upon the red-shift in the spectra of galaxies. The red-shift is generally attributed to the Doppler effect, but, Lyttleton says,

> There have been claims from time to time that the Doppler shift is not the proper interpretation. For example, there is the suggestion that hundreds of millions of years ago, when the light by which we see distant galaxies was emitted, the laws of physics were not the same as now, and that is why the spectral lines were in a different position. Now, I cannot see that laws of physics that change with time are really laws of physics at all. This is perhaps an act of faith on my part.

Here we are back at the same argument. The cosmological problems would not be solved, but the argument would be clarified and to a large extent eliminated if these authors would recognize a difference between "laws of physics" as man, on the basis of his discoveries, has formulated them, and the real laws of physics as they are in themselves. There would be still more light on the subject if they were to acknowledge "the Origin of all things—that Being who is all in all."

> For without the utmost devotion to the Supreme Being, no one can be a complete and truly learned philosopher. Veneration for the Infinite can never be separated from philosophy; for he who thinks himself wise, whilst his wisdom does not teach him to acknowledge the Divine and Infinite, that is, he who thinks he can be wise without a knowledge of and veneration for the Deity, has no wisdom at all. The philosopher sees, indeed, that God governs His creation by rules and mechanical laws; . . . he may even know what these are; but the nature of that Infinite Being, from whom, as from

their fountain, all things in the world derive their existence and subsistence—and what is the nature of that Supreme Intelligence with its infinite mysteries—he in vain strives to know. (*Principia* Part I, chapter I, p. 38, Tansley).

This was Swedenborg's act of faith. I believe he would agree that the real laws of physics do not change with time nor place, but he might point out that what we now know of those laws as seen from here and now may not be the whole story.

Aside from Swedenborg, few philosophers or scientists have discussed the origin of matter. Most theories of cosmology begin after matter has somehow come into existence. Bonnor says,

I would like to raise the question of the age of the universe. This is not a term which I like; I prefer to call it the period of expansion. It seems to me that one of the defects of relativistic cosmologies has been that they supposed that at a period 8,000 million years ago, the universe had a definite creation or definite start. In my opinion, this is an unscientific view. Instead, we shall have to try to decide what was happening to the universe before the start of the present phase of expansion.

It does seem, however, that there are certain indications that something surprising and unusual happened to the universe between 5,000 million years ago and 10,000 millions years ago. It is not merely that the age of our own galaxy seems to lie between these limits. . . . There is certain other evidence . . . which suggests that [other galaxies] may have been in existence for only about the same period. It is clear that the steady-state theory would be in very serious difficulties if it were found that all the galaxies were about the same age. (pp. 53 and 54).

It would be interesting to hear from students of Swedenborg's theological and philosophical works some contributions to this discussion of "steady-state" versus "big bang" theories. Bondi points out that evidence for or against the steady-state theory is not impossible to attain since

If we look out in space, we look back in time. For, owing to its finite velocity, the light that we now receive from the very distant galaxies must have left them a long time ago to reach us now. Therefore, we have some idea of what the universe was like a good long time ago by looking at the most distant galaxies. The times in question are quite substantial, extending up to several thousand million years. If a difference is discovered between the galaxies in the remote past and now, the steady-state theory will have to be abandoned. . . . In the last twelve years there have been two claims by observers that in fact there was such a time-effect. But in neither case has the original claim been substantiated. (p. 54).

As Bondi says, the astronomers disagree strongly, and none of them as yet have clear views on the evolution of galaxies. There is hope that radio-astronomy will contribute evidence on this subject.

Another topic dealt with briefly is the problem of the origin of the elements. Eddington expected to find that iron, carbon, oxygen, and the other elements were built up from the simpler elements, hydrogen and helium, in the centers of stars, but physicists objected that the stars were not hot enough for the production of heavy elements. The search for a hotter place went on, but some people concluded that the hotter place would only be found in the origin of the universe.

> For if there are no natural factories for making heavy elements in the universe at present, then there must have been factories for making them a long time ago. In the steady-state theory, this explanation is quite unacceptable, for if there ever were any factories for making heavy elements, then there must be some now. On this assumption, Burbridges, Fowler, Cameron, Hoyle, and others attacked the problem a few years ago. They showed that certain fairly common stars could generate the heavy elements and then explode and distribute them throughout space to produce the observed abundance ratios of heavy elements. This theory has been so successful that we must regard it as one of the classics of modern physics. It was directly inspired by the steady-state theory. (p. 59).

Such explosions are associated with novae or supernovae. Swedenborg refers to these same explosions as confirmation of his theory of the breaking up of the solar crust to form a belt and then planets. (*Principia* Vol. II, p. 191, Tansley.)

Readers of the NEW PHILOSOPHY will find many more points of interest in this little book.

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