LETTERS TO THE EDITORS

COSMOLOGY

Interpretation of Cosmology

PROF. W. H. McCREA's views on the interpretation of cosmology[1] call for some comment. If the universe turns out to have an inhomogeneous character, then his remarks may be justified. But, in view of the paucity of observational tests that have been adequately investigated so far, it would seem that he takes up a prematurely pessimistic position.

McCrea asserts that there is an uncertainty of knowledge of the factors affecting the physical conditions in those remote parts of the universe which we now see at an early stage in their history, due to the finite velocity of light. This uncertainty, he claims, increases with the observed red shift, and he is led to suggest that differences between various cosmological models cannot be detected as a matter of principle. In particular, calculated distinctions between a steady-state universe and an evolving universe may be meaningless.

There is, of course, uncertainty about the factors affecting any set of phenomena, until we put forward a definite theory accounting for them. For this purpose it may even be necessary to introduce factors or agents that we cannot ourselves observe, if we have reason for believing that they must be observable to other observers whose past experience has been similar to our own. This is in accordance with accepted scientific method. We must try to fit the facts to what seems the most likely interpretation.

In the case of the cosmological problem the simplest and most direct approach, suggested by the Hubble law and the nebular counts, is to assume the 'cosmological principle'. This leads to a definite set of cosmological models : one is the steady-state model and the rest are evolutionary.

As I have shown in recent papers[2,3] there are several tests which, given a plausible continuation of present advances in astronomical technique, should definitely decide whether the universe is in a steady state or not. It is true, as McCrea points out, that the steady-state predictions differ from those of the evolutionary cases only in terms of order z, where z is the red shift. But on the other hand, the predictions for a steady-state model are quite definite and must be realized in a steady-state universe on a statistical basis, if we always choose fair samples for our observational data. There is no uncertainty in principle about the conditions prevailing in remote regions of a steady-state universe, since they must be the same conditions that we experience in our own 'neighbourhood' at the present moment. Consistent agreement of the universe with the various features predicted by all possible tests for the steady-state model must therefore establish it, scientifically, as the correct fit. Consistent disagreement, in ways that cannot be explained by observational errors, must eliminate it.

If the universe is found to be not in a steady state then, retaining the cosmological principle, we must next regard it as evolving in a systematic way. In this case there are indeed great difficulties in predicting exactly what we should see in remote regions in the various models, because of the uncertain degree of evolution that has taken place during the 'light time'. However, it should be appreciated that, by the cosmological principle, the conditions viewed right up to our observational horizon were realized in our own neighbourhood at the same cosmic epochs in the past. It is not inconceivable, therefore, that we may ultimately find an adequate description of these phenomena in agreement with our own discovered past. Such a possibility should not be excluded as a matter of principle.

The difficulties of interpretation which arise in an evolutionary universe were of course pointed out by the original advocates of the steady-state model[4]. Even greater difficulties arise if we drop the cosmological principle and assume, say, a hierarchical model of the universe. In this case the uncertainty of the universe *in toto* would indeed be of the fundamental character that McCrea has envisaged.

An observational decision in favour of a steady-state, evolutionary, or hierarchical universe would have an importance not confined to physics. In due time it would find its place in the basic philosophical outlook of all mankind. Every possible effort should therefore be made to reach it.

W. DAVIDSON

Mathematics Department,
Battersea College of Technology,
London, S.W.11. June 30.

[1] McCrea, W. H., *Nature*, **186**, 1035 (1960).
[2] Davidson, W., *Mon. Not. Roy. Astro. Soc.*, **119**, 665 (1959).
[3] Davidson, W., *Mon. Not. Roy. Astro. Soc.*, **120**, 271 (1960).
[4] Bondi, H., and Gold, T., *Mon. Not. Roy. Astro. Soc.*, **108**, 252 (1948).

DR. DAVIDSON re-states the orthodox view, and it is this view that I venture to call in question.

Suppose we know all about the laws of interaction of different parts of the universe, and suppose we make all the observations of the universe that are possible to us in principle. Then, for the reasons that I stated, I conclude that there is an uncertainty about what we can predict about the universe. The orthodox view is that theory can enable us to overcome this uncertainty. The view I suggested is that we cannot do better than in the circumstances just supposed, and that therefore theory ought to be modified so that it does not claim to do better.

The uncertainty contemplated here is of a more novel and fundamental kind than appears to be altogether recognized in Dr. Davidson's discussion. Also, there is nothing necessarily pessimistic about it. If we could properly take account of it, it would be expected to lead to the discovery of new phenomena just as the sacrifices made in going from classical theory to relativity and quantum theory led to the discovery of new phenomena. Finally, there is nothing contrary to the 'accepted scientific method'. For, in regard to what Dr. Davidson has to say on the subject, we have to recall that no amount of agreement with observation can 'establish' a theory ; all that such agreement means is the absence of what we deem to be a contradiction.

W. H. McCREA

Royal Holloway College,
Englefield Green, Surrey.