LETTERS TO THE EDITORS

COSMOLOGY

The Interpretation of Cosmology

We have to postulate that every part of the universe interacts, directly or indirectly, with every other part. We are probably justified in assuming that all fundamental interactions are propagated with the speed of light. It follows that we see all other parts of the universe in the state in which they influence our own part of the universe now. Therefore we can in principle predict the immediate future behaviour of our own part of the universe.

The situation is quite different as regards any remote part P of the universe. We see no other part of the universe in the state in which it influences P. For example, if P is 10^9 light-years away and Q is a part of the universe 10^9 light years away in the opposite direction, then, if the universe is static, whatever influence Q has on P when we observe P depends upon the state of Q at a time 2×10^9 years before Q was in the state in which we observe Q. But the universe is not static, and so we know nothing from observation about the state of Q when Q influenced the state of P in which we observe P.

Were the universe a finite system, we could overcome the situation by continuing our observations for a sufficiently long, but finite, time and then making predictions for still later times. But we almost certainly have to regard the universe as unbounded. Therefore, even in principle, we cannot predict the behaviour of a remote part of the universe with as much assurance as we can predict that of a nearer part.

This reveals a feature that ought to be built into any satisfactory theory of cosmology. Moreover, it agrees completely with our intuitive notion that we should be able to make predictions about sufficiently small parts of the universe, sufficiently near in space and time, but that we should be able to do no more than describe when we come to deal with regions so large that the uniqueness of the universe becomes relevant.

It thus appears that there is an uncertainty in cosmology, which may be said to be occasioned by the fact that the speed of light is not infinite, that is complementary to the uncertainty in atomic physics, which may be said to be occasioned by the fact that the quantum of action is not zero.

This feature is not in fact incorporated in current cosmological theory. But, if what has been said is significant, we seem to be driven to infer that the unavoidable uncertainty in any prediction about the part of the universe out to any particular distance is measured by $1 + z$, where z is the cosmological red-shift at that distance. (The usual definition is $1 + z$ = wave-length observed ÷ wave-length emitted.)

Now the difference between the predictions of evolutionary and steady-static cosmologies is only in factors $(1 + z)$, as was recently shown explicitly by P. S. Florides and me[1]. Thus an immediate consequence of the present view is that the difference between these theories loses any meaning. In fact, all problems concerning the creation of matter as hitherto formulated appear to lose significance. It is suggested that this is basically why all efforts to reach a decision between the two types of theory by observational tests have failed.

Following these ideas, the 'cosmological principle' would now assert that the universe as seen by a distant observer is like the universe as seen by us only to within a factor of uncertainty $(1 + z)$ in the description. Thus we should be asserting almost nothing about what the universe is like at great distances (in space or time). This provides a view of cosmology that essentially leaves room for endless observational surprises. It seems more satisfactory than the recent trend towards a belief that the nature of the 'whole' universe has already been discovered.

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[1] Florides, P .S., and McCrea, W. H., *Z. Astrophys.*, **48**, 52 (1959).

ASTROPHYSICS

Solar Limb Surges accompanied by X-Ray Emission

Sudden enhancements of atmospherics are recorded during solar flares[1]. The extra ionization of the lower D region at these times is brought about by X-rays emitted from the disturbed solar region[2].

The simultaneous observations in H_α line and records of atmospherics (27 kc./s.) carried out at our observatory indicate a pronounced coincidence in time

Table 1

	Limb surge		Sudden enhancements of atmospherics (disturbance of D region)			
Date	Time (U.T.)	Position	Time (U.T.)	Importance	Reliability	Note
May 8, 1959	6.58—(7.26)+7.53—(8.02)	N. 16 E. 90	7.18—7.25—7.47	2	5	1
May 13, 1959	8.56—9.01—(9.23)	S. 12 E. 90	8.56—9.02—(9.27)	2+	5	2
May 13, 1959	(9.25)—(9.36)—?	S. 12 E. 90	9.28—9.40—(10.30)	2	5	3
June 9, 1959 (4)	∼ 16.52 ∼ 17.40	N. 18 E. 90	16.38—16.56—(18.30)	2+	5	4
July 10, 1959	(15.02)—15.05—(15.30)	S. 20 E. 90	14.56—15.08—(15.50)	1+	4	
July 11, 1959	12.47—12.48—13.35	N. 15 W. 90	(11.30)—12.40+13.50—(14.17)	1+	3	5
Aug. 8, 1959	14.05—14.09+14.36—?	N. 13 W. 90	(14.00)—14.22—(14.48)	1	4	6

Second column: beginning (approximate)—maximum—end of surge. Fourth column: beginning—maximum—end of sudden enhancements of atmospherics. Sixth column: degrees of reliability; fifth the highest reliability. Seventh column: notes refer to eventual accompanying radio events. (1) 231 Mc./s. (Ondřejov), 200 Mc./s. (ref. 5); (2) 536 Mc./s. (0); (3) 536 Mc./s. (0); (4) 69,760 Mc./s. (ref. 4), 9,400 Mc./s. (ref. 6), 2,930 Mc./s. (ref. 5); 2,800 Mc./s. (ref. 4), 1,500 Mc./s. (ref. 6), 545 Mc./s. (ref. 5), 200 Mc./s. (ref. 5); (5) 808 Mc./s. (0); (6) 200 Mc./s. (ref. 5).

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