

points that he described in his letter must appear, and I thank him for using the words "luminosity-distance" which is what the distance actually is, and also the mistake that he pointed out in a formula on page 25.

I did not use the concepts of cosmological models and I did not intend to use them for good physical reasons. In his letter Professor McVittie failed to inform us of one important fact about the present status of cosmological theories; perhaps he is more enthusiastic about this present status than I am. *There does not yet exist any data to reveal to us that even a curvature exists in the structure of our universe.* From all galaxies observed, the most one can say is that there exists a linear relation such as I gave in my paper. Hence all familiar noncosmological concepts of distance, etc., may be used. Cosmological effects become noticeable when the red shift is large. For 3C273, the red shift is 0.16 and the relativistic correction in converting it to velocity, using a linear relation, is around 0.01, hardly significant. For 3C48, the red shift is 0.37 and the relativistic correction is 0.07, around 25 percent. These corrections are not significant, since Hubble's constant has fluctuated by more than a few decibels in the past few years. The same, however, cannot be said for quasars with a larger red shift.

I am not pessimistic about cosmological theories. It is well known that the ability of the 200" telescope to resolve world models by using galaxies is limited to a distance of around 2 billion light years, where a poor physicist's concept of space and time (which he is used to) is still valid. With the high luminosity of quasars (100 times that of galaxies), the range of the 200" telescope is extended roughly ten fold (the exact number depends on what cosmology one believes in). If good statistics and a knowledge about the structure of quasars can be obtained, there is a good hope that even the modest 200" telescope we now have on earth may give cosmological theories an experimental boost, which they badly need.

After my article on gravitational collapse was published, I received a letter commenting on W. H. Jefferys'

measurements on the motion of 3C273 (which were discussed on page 26 of the May issue). Dr. W. J. Luyten of the University of Minnesota, an expert in the measurement of proper motions of stars, remarked that the measurement that Jefferys made on old plates may contain larger errors than that quoted in his work. The Harvard plates have a scale of 180 seconds of arc to one millimeter, and to achieve the accuracy quoted by Jefferys one needs to measure the position of a star to an accuracy of 1/35 micron. During these years of storage, the Harvard plates may have suffered shrinkage, rendering such accuracy impossible.

Dr. Luyten has measured the proper motion of four quasars (3C48, 3C196, 3C273, 3C286) using different techniques. He found that their proper motions are not larger than their mean errors of measurement. His result was published in *Publ. of the Astron. Obs. of the Univ. of Minn.*, Vol. III, #13, July, 1963.

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Teacher exchange

The COPFIC Report (*Physics Today*, May 1964, p. 36) was both gloomy and stimulating. In general, it should have a beneficial effect. It might be especially effective if reprints were put into the hands of administrators in the same way as the "Five Colleges" Report.

I wish to make two comments about recommendation (e) in the COPFIC report.

1. I have seen only two requests associated with the summer job Placement Service of AIP but both of these were requests for PhD's with considerable experience. If this is generally true, the service is of little help to the beginning teacher with the PhD or to any teacher with the master's degree only.

2. In a letter to Dr. Brode, Chairman of the Committee, dated October 9, 1963, I made a suggestion which I still believe would be useful. With very moderate NSF support, the summer job Placement Service could extend its service to the deliberate exchange of beginning teachers between

colleges for the summer session. The only cost involved would be transportation and, perhaps, a small removal sum. The advantage to the teacher of limited experience would be the association with experienced teachers other than those of his home institution. Although it is recognized that there are other problems involved, it would still seem a relatively inexpensive method for a fairly rapid diffusion of innovations in teaching, student evaluation, demonstration techniques, etc., through the college physics community.

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General exam

With the increased interest in graduate study, it is surprising that the general examination (sometimes called the preliminary or qualifying examination) for the doctorate has received so little attention. The general examination may be described as ranging from superficial to sadistic. It appears that many graduate students are so exhausted when they pass the examination that they never regain their drive to do really creative work.

The writer has taken four such examinations, failing twice (University of Chicago) and passing twice (Northwestern University and Western Reserve University). In my opinion, there is an urgent need for reform with respect to the general examination. I should like to correspond with anyone who has specific criticisms of the examination or suggestions for its improvement.

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Underdeveloped countries

Two articles in recent months have discussed research in underdeveloped countries. In the first (*Physics Today*, August 1963) David Tabor criticizes the efforts of some underdeveloped countries to undertake fundamental research on the grounds that such activities are not in line with the state of technological development in these countries and that the primary purpose of such research is national