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Frontiers of Astronomy: In Venice

Sir Fred Hoyle celebrated his 60th birthday this year, and a symposium was held to mark the occasion in Venice, 15 to 19 July. Many of Hoyle's colleagues and former students presented current work in some of the fields Hoyle helped to found, including cosmology, the nature of the interstellar medium, and the early history of the solar system. The following is a report from a participant.

There is no longer really anything to be said about the original steady-state picture of the universe, in which matter is continuously created at just the right rate to keep all average properties constant for all time, except that it is a beautiful idea which turned out not to agree with observations. Hoyle has recently suggested an alternative picture, in which our universe changes with time, not because it is expanding, but because the masses of the stable fundamental particles are increasing with time. Our universe is then just one of many patches in a space-time continuum, each with its own properties, which may have started its life with very large place-to-place fluctuations in the density of matter. S. E. Woosley (Caltech) has calculated the nuclear reactions that should occur early in such a universe, and finds that a large fraction of the material in the densest clumps should be converted to elements with atomic numbers near that of iron. Conventional big-bang universes produce only hydrogen and helium early in their history. Besides providing an additional site for the synthesis of heavy elements, this picture has the attractive property that if the center of our sun is made of material processed in this way, the discrepancy between predicted and observed fluxes of solar neutrinos largely goes away. The chief difficulty may well be to avoid having all the iron so produced get trapped in black holes. In more conventional cosmology, two of the classic tests, which it was once hoped would tell us whether our universe will expand forever or turn around and recontract, now no longer seem able to tell us this. The first of these tests is the relation between the red shift and the apparent brightness of galaxies. Since the apparent brightness of a galaxy decreases with its distance from us, and distant objects are seen as they were in the past, observations of the recession velocity (red shift) versus apparent brightness should tell us whether the expansion of the universe is slowing down enough for it eventually to stop and begin to contract. The number of available red shifts has increased considerably in the past few years (particularly due to the work of Oke and Gunn at Hale Observatories), but the interpretation has become more difficult. In order to determine the distance to a galaxy from its apparent brightness, we need to know how its real brightness changes with time. It was once assumed that such changes were small, but this no longer seems to be the case. On the one hand, B. Tinsley (Yale University) has shown that the general tendency of the aging of the stars in bright, massive galaxies is to make them grow significantly fainter with time, while on the other, J. P. Ostriker and S. D. Tremaine (Princeton) have pointed out that such galaxies will gobble up material from other, nearby galaxies, which will make them grow brighter with time. It does not, at present, seem possible to decide which of the two effects dominates and thus to interpret the red shift-apparent brightness data. The other classic test is to measure the apparent (angular) diameter of objects whose real size you think you know, as a function of their distance. Because the structure of space-time (within the framework of general relativity) is

determined by the amount of matter present, this test should also distinguish an ever-expanding universe from a recontracting one. The optical data on this problem have always been difficult to interpret, but there had been great hopes for using radio sources. R. Ekers and others at the Westerbork Radio Observatory in the Netherlands have recently measured angular diameters of a large number of faint (hence distant) radio sources. Their data, in combination with previous results, say only that the real sizes and brightnesses of radio sources change with time. Since we have no theory of what the changes ought to be, we cannot now do cosmology with angular diameters. Hoyle was among the first to predict the composition of the dust grains that pervade interstellar space. In the intervening years, his heretical suggestion (graphite) has become part of the conventional wisdom. N. C. Wickramasinghe (Cardiff) has proposed a new heresy, suggesting that polymers of formaldehyde and similar organic molecules may be important components, responsible for the observed ultraviolet absorption features. Even more controversial is the question of what fraction of the interstellar medium's supply of heavy elements is, in fact, locked up in the grains. Analysis of ultraviolet absorption lines in the spectra of distant stars, obtained with the Copernicus satellite, has normally been thought to imply considerable depletion of heavy elements from the gas onto the grains. G. Steigman (Yale University) now points out, however, that most of the absorption probably takes place in ionized regions around the stars themselves, so that the data tell us very little about the heavy element content of the general interstellar gas. An increasing body of data may require us to rethink our ideas on the history of the solar system during the period when the planets and meteorites condensed and cooled. The traditional view requires a homogeneous gaseous medium to condense quickly and without outside interference. We now know of a variety of place-to-place variations in the ratios of isotope abundances of various elements in meteorites, which require some modification of this picture. D. D. Clayton (Rice University) has suggested that interstellar grains condense in the immediate vicinity of the supernovae where the heavy elements are made and preserve their identity through the condensation process.

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