A PANEL DISCUSSION OF "MAJOR UNSOLVED PROBLEMS OF COSMOLOGY"

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I would first like to ask my distinguished co-panelists to introduce themselves briefly. I will then ask each to make a five-minute comment on "major unsolved problems of cosmology". It will be followed by discussions among the panelists and also with the audience.

[The panel consisted of Holton Arp of Max Planck Institute for Astrophysics in Munich, Geoffrey Burbidge of the University of California at La Jolla, Menas Kafatos of the George Mason University, Yoji Kondo (Chairman) and John Mather of the NASA Goddard Space Flight Center, Philip Morrison of the Massachusetts Institute of Technology, Bruce Partridge of the Haverford College, Martin Rees of the University of Cambridge, and Michael Turner of the University of Chicago.]

I will lead off the discussion by stating what, in my view, are major unsolved problems in cosmology today. Since I am the first to speak, I wish to make it clear that this is not an attempt to preempt those topics from further discussions by my co-panelists.
(A) Is the universe closed or open? What is the value of omega? The resolution of this question may hinge upon the answer to the next question.
(B) Does dark matter exist? If it does exist, what is it or what are they? Is it true that a substantial fraction of the matter in the universe is dark so that it is not directly observable as luminous substance? The evidence for its existence consists primarily of the following three lines of argument.

(1) A number of galaxies -- that are sufficiently near so that we can determine their rotational velocities that are not consistent with the mass content as estimated from the stellar densities and spectral types in those galaxies. Up to some ninety percent of the mass in those galaxies may be non-luminous. This is perhaps the least model-dependent evidence for the presence of dark matter.

(2) If clusters of galaxies are to remain dynamically bound for a cosmological time scale -- say, for at least several billion years -- more mass than is observable in the form of luminous matter must be keeping those galaxies gravitational bound. More than ninety percent of the matter may be dark in such clusters.

(3) If the inflationary Big Bang Model is correct, omega must be close to unity. In order for that to be true, more than ninety-nine percent of the matter in the universe must be invisible. This is probably the most hypothetical of the three lines of arguments.
(C) What is the value of the Hubble Parameter? Is it truly a linear function of distance

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throughout the universe?
(D) What are the properties of large scale structures, such as the 'Great Wall' and the 'Great Attractor'? Are they real or are they simply artifacts of observation?

Throughout the millennia of human history, we have witnessed the birth, death and evolution of various cosmological models. Answers to those questions may help use select or develop a viable cosmological model.

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