

This paper is an introduction to the following papers, which were presented at a colloquium entitled “The Age of the Universe, Dark Matter, and Structure Formation,” organized by David N. Schramm, held March 21–23, 1997, sponsored by the National Academy of Sciences at the Beckman Center in Irvine, CA.

The age of the universe, dark matter, and structure formation

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The National Academy of Sciences (NAS) sponsored a 2-day colloquium titled “The Age of the Universe, Dark Matter, and Structure Formation,” March 21–23, 1997, at the Arnold and Mabel Beckman Center of the National Academies of Science and Engineering in Irvine, CA. Eighty-eight cosmologists who represented a wide range of individual scientific disciplines attended the colloquium. Also present were two science reporters. The purpose of the colloquium was to address the three interconnected problems that have the center stage in modern physical cosmology today. They are: (i) the age of the universe, (ii) the dark matter of the universe, and (iii) the formation of structures in the universe. In the last 2 years, new experimental and observational data have dramatically changed the nature of each of these problems and have more sharply defined the issues. This NAS colloquium brought together the experts on these specific topics to present the cutting-edge developments in each and to emphasize their interdependence and interdisciplinary nature.

The detections by COBE, South Pole, balloon, and other experiments of microwave background radiation anisotropy have provided a powerful tool for probing structure-formation scenarios in the universe. Similarly, dark matter developments including the Massive Compact Halo Object and Earth Resources Observation Satellite microlensing results have come about recently, as has the recent “age of the universe” controversy driven by the new Hubble Space Telescope (HST) results in comparison with stellar evolution and radioactive dating as age-determination methods. Also, most recently, the

use of gravitational lensing and the so-called Sunyaev-Zeldovich effect have led to a renewal of age–Hubble constant constraints. New dark matter searches for nonbaryonic particle candidates are underway, and constraints from satellite x-ray gas observations and from gravitational lensing of clusters of galaxies are growing. There have been new reports on actual, direct searches for axions and other nonbaryonic dark matter candidates.

The controversy of how to form structures rapidly in the universe continues and interrelates the microwave anisotropy and dark matter problems with the observed distributions of galaxies. In the standard big bang scenario, the higher the amount of dark matter, the shorter the age, which thereby exacerbates the age problem. The dark matter issues themselves revolve around cosmological nucleosynthesis and the abundances of the light elements, where, again, new observations (including some with the 10-m Keck Telescope and the HST) have altered the situation.

The interrelationship of structure formation scenarios with the established parts of the cosmological framework, as well as the plethora of new observations and experiments, made this high-level, international, scientific colloquium on the subject quite timely. This colloquium provided a useful update to the previous NAS cosmology colloquium, which was held in 1992. The nature of this field has dramatically changed in this time, with the current situation being heavily driven by experiments and observations as opposed to speculation.