The "Standard" Model of Cosmology ... and Open Questions

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Abstract: Experiments and observations over the last two decades have provided strong support for a "standard" model of cosmology that describes the evolution of the universe from an early epoch of inflation to the complex hierarchy of structure seen today. I review the basic physics, astronomy, and history of ideas, on which this model is based. I describe the data which persuade cosmologists that (as yet not directly detected) dark energy and dark matter are by far the main components of the energy budget of the universe. I conclude with a list of open cosmological questions.

Bharat Ratra, distinguished professor of physics, works in the areas of cosmology and astroparticle physics. He researches the structure and evolution of the universe. Two of his current principal interests are developing models for the large-scale matter and radiation distributions in the universe and testing these models by comparing predictions to observational data.

Biography: In 1988, Ratra and Jim Peebles proposed the first dynamical dark energy model. Dark energy is the leading candidate for the mechanism that is responsible for causing cosmological expansion to accelerate. The discovery that cosmological expansion is accelerating is one of the most significant scientific discoveries of the last quarter of a century.

Ratra currently advises one graduate student. He has mentored 12 graduate students, five postdoctoral fellows and three visiting faculty members in the past. Ratra's research has appeared in 140 scholarly publications, which have been cited more than 18,000 times in scientific literature. In the last five years he has given more than 100 invited presentations at conferences, workshops, national laboratories, academic institutions and public settings around the world.

Ratra has received more than $10 million in individual and collaborative grants, largely from the Department of Energy and the National Science Foundation. Ratra was a National Science Foundation CAREER award winner in 1999. He was named a fellow of the American Physical Society in 2002 and a fellow of the American Association for the Advancement of Science in 2005. He received the 2012-2013 Commerce Bank Distinguished Graduate Faculty Award at Kansas State University. He was awarded the 2017 Olin Petefish Award in Basic Sciences. In 2020 he received the Kansas Science Communication Initiative (KSCI) Science Communication Award.

Ratra is a founding member of the North Central Kansas Astronomical Society and of the Kansas State University Center for the Understanding of Origins. He also is actively involved in various other science outreach efforts, including the National Science Foundation QuarkNet program for Kansas (and some Arkansas and Missouri) high school science teachers, as well as outreach efforts with various Manhattan-Ogden USD 383 elementary, middle and high school science teachers and schools.