Colloquium 60th Anniversary of Karpacz Winter Schools of Theoretical Physics
16. May 2024, 17 c.t., Rzewuski Hall (room 60), plac Maxa Borna 9, 50-204 Wrocław

The fate of the Universe – new results from JWST and outlook

Prof. Dr. Günther Hasinger
Designated founding director of the German Center for Astrophysics in Görlitz, university professor at the Technical University of Dresden, and senior scientist at DESY Zeuthen.

Abstract

Knowledge about the formation and evolution of our universe has increased dramatically in recent years. The galaxy recession velocity, the structure of the microwave background radiation and the cosmic abundance of light elements can be explained in a self-consistent model in which the universe was created 13.8 billion years ago in an extremely hot fireball - the "Big Bang". The further development of the universe - the cooling through various phase transitions, the formation of large-scale structure, of galaxy clusters, galaxies, stars and planets can be described on the one hand through detailed cosmological simulations, and on the other hand can be measured with increasingly sensitive telescopes and detectors, as well as increasingly sophisticated observation techniques. By comparing observations and theory, the parameters that determine the universe such as mass, energy and the geometry of space can be derived. In recent years there have been paradigm shifts in several areas of cosmology: The existence of “dark matter”, a previously unknown type of particle that makes up around 85% of the total mass of the universe, has become more concrete. Completely surprising was the discovery of a “dark energy” that dominates the universe and accelerates the expansion of galaxies even further. Another paradigm shift occurred with the massive black holes located at the center of practically all larger galaxies - including, of course, our Milky Way. Gravitational waves provide information about black hole mergers and have enabled amazing discoveries both with the LIGO/Virgo/Kagra interferometers on Earth and with pulsar timing arrays. The discovery of the earliest quasars and the deepest observations with the James Webb Space Telescope (JWST) reveal galaxies and black holes in the earliest universe whose rapid formation and evolution are not yet understood. A possible explanation is the speculation that the currently unknown dark matter consists of primordial black holes, which also act as heavy seeds for the formation of galaxies and their supermassive black holes.

Vita

Günther Hasinger, born in 1954 in Oberammergau, is a world-leading X-ray astronomer. He was director of the Leibniz Institute for Astrophysics in Potsdam, the Max Planck Institutes for extraterrestrial physics and plasma physics, the astronomical institute at the University of Hawaii, and science director of the European Space Agency. His research focuses on the cosmological evolution of black holes and the nature of dark matter, among other topics. He has received numerous awards for his research and scientific achievements, including the Leibniz Prize from the German Research Foundation and the COSPAR Award for outstanding contributions to space research. He is a member of several scientific academies. In addition to numerous scientific papers, Dr. Hasinger is the author of the award-winning book "The Fate of the Universe," which explains astrophysics and cosmology to a broader audience.