

Dark energy

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In physical cosmology and astronomy, dark energy is a proposed form of energy that affects the universe on the largest scales. Its primary effect is to drive the accelerating expansion of the universe. It also slows the rate of structure formation. Assuming that the Λ -CDM model of cosmology is correct, dark energy dominates the universe, contributing 68% of the total energy in the present-day observable universe while dark matter and ordinary (baryonic) matter contribute 27% and 5%, respectively, and other components such as neutrinos and photons are nearly negligible. Dark energy's density is very low: 7×10^{-30} g/cm³ (6×10^{-10} J/m³ in mass-energy), much less than the density of ordinary matter or dark matter within galaxies. However, it dominates the universe's mass-energy content because it is uniform across space. The first observational evidence for dark energy's existence came from measurements of supernovae. Type Ia supernovae have constant luminosity, which means that they can be used as accurate distance measures. Comparing this distance to the redshift (which measures the speed at which the supernova is receding) shows that the universe's expansion is accelerating. Prior to this observation, scientists thought that the gravitational attraction of matter and energy in the universe would cause the universe's expansion to slow over time. Since the discovery of accelerating expansion, several independent lines of evidence have been discovered that support the existence of dark energy. The exact nature of dark energy remains a mystery, and many possible explanations have been theorized. The main candidates are a cosmological constant (representing a constant energy density filling space homogeneously) and scalar fields (dynamic quantities having energy densities that vary in time and space) such as quintessence or moduli. A cosmological constant would remain constant across time and space, while scalar fields can vary. Yet other possibilities are interacting dark energy (see the section Dark energy § Theories of dark energy), an observational effect, cosmological coupling, and shockwave cosmology (see the section § Alternatives to dark energy).