Simulations of the growth of structure in our Universe

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The last 25 years have established a standard paradigm for the growth of cosmic structure from a hot and near-uniform Big Bang. The Cosmic Microwave Background allows us to map the initial conditions for this growth at a time when the Universe was only 380,000 years old. Our understanding of how the complexity of today's Universe emerged from this almost formless early state has been established almost entirely by computer simulations of cosmic evolution. Gravity is the dominant factor, leading to the hierarchical formation of galaxies, stars and planets, as well to patterns in the galaxy distribution which extend over scales of up to a billion light-years. Dramatic growth in processing power and in simulation algorithms has made possible greatly improved interpretation of observations, which have themselves improved remarkably in quality in recent years. The combination of better computers and better telescopes has taught us that ordinary matter is a small fraction of the content of today's Universe. Most of the gravitating matter is Dark Matter, apparently a new type of elementary particle yet to be observed on Earth. Most of the energy is Dark Energy, which is currently making the Universe expand ever faster. More precise simulations of cosmic structure formation are suggesting new ways to determine experimentally the nature of these mysterious dark components[1].

References

[1] V. Springel, C. S. Frenk and S. D. M. White Nature **440**, 1137 (2006).