

Vacuum Energy: A Naturalness Challenge

Established theories of particle physics make contributions to the cosmological vacuum energy that are many orders of magnitude greater than its possible value. The latter can only be calculated within a complete quantum theory of gravity, to which the vacuum energy poses a naturalness challenge orders of magnitude more acute than the hierarchy of mass scales in particle physics. No convincing mechanism for cancelling the vacuum energy has been formed in string theory, the only persuasive candidate for a quantum theory of gravity. Perhaps string theorists have been barking up the wrong tree, and should shift their attention to calculating the small non-zero value suggested by observation. However, it is still possible that the vacuum energy is relaxing gradually towards zero. In either case, the existence of a cosmological event horizon would pose a challenge to conventional formulations of field and string theory.

For all these reasons, clarifications of the magnitude of the vacuum energy and its equation of state are of crucial importance for fundamental physics, as well as for cosmology.

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