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Modern Cosmology: Foundations, Challenges, and the Search for Solutions

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Modern cosmology provides a powerful framework for describing the Universe, from the Copernican principle to Einstein's general relativity and the standard cosmological model, ΛCDM. Despite its remarkable success, however, this model now faces serious challenges, most notably the Hubble tension: a persistent mismatch between early-Universe predictions and late-Universe observations. In this talk, we will introduce the foundations of modern cosmology, discuss why current cosmological tensions may point to missing physics, and outline some of the ideas being explored in the search for possible solutions. Particular emphasis will be placed on the possibility that the dark sector may be richer than assumed in ΛCDM, motivating a rethinking of the cosmological constant and the search for a new concordance model.

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