Contribution ID: **526** Type: **Parallel Sessions**

Dynamical Dark Matter: A Theoretical Overview

Saturday, 7 July 2012 09:30 (15 minutes)

In this talk, we introduce a new framework for dark-matter physics which we call "Dynamical Dark Matter". Rather than focus on one or more stable dark-matter particles, we instead consider a multi-component framework in which the dark matter of the universe comprises a vast ensemble of interacting fields with a variety of different masses, mixings, and abundances. Moreover, rather than impose stability for each field individually, we ensure the phenomenological viability of such a scenario by requiring that those states with larger masses and Standard-Model decay widths have correspondingly smaller relic abundances, and vice versa. In other words, dark-matter stability is not an absolute requirement in such a framework, but is balanced against abundance. This leads to a highly dynamical scenario in which cosmological quantities such as Omega_{CDM} experience non-trivial time-dependences beyond those associated with the expansion of the universe. Although it may seem difficult to arrange an ensemble of states which have the required decay widths and relic abundances, we present one particular example in which this balancing act occurs naturally: an infinite tower of Kaluza-Klein (KK) states living in the bulk of large extra spacetime dimensions. Remarkably, this remains true even if the stability of the KK tower itself is entirely unprotected. Thus theories with large extra dimensions — and by extension, certain limits of string theory — naturally give rise to dynamical dark matter. Such scenarios also generically give rise to a rich set of collider and astrophysical phenomena which transcend those usually associated with dark matter.

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Session Classification: Room 216 - Particle Astrophysics and Cosmology -TR11

Track Classification: Track 11. Particle Astrophysics and Cosmology