Dilaton could affect abundance of dark matter particles

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The amount of dark matter left over from the early universe may be less than previously believed. Research published in the open access journal *PMC Physics A* shows that the "relic abundance" of stable dark matter particles such as the neutralino may be reduced as compared to standard cosmology theories due to the effects of the "dilaton"', a particle with zero spin in the gravitational sector of strings.

Nikolaos Mavromatos of King's College London and colleagues in Athens and Texas obtained their result by studying a special "off-shell" time-dependent term (due to the dilaton) in the Boltzmann equation that describes the evolution of hot matter density as the Universe cooled down. "The formalism that this work used was developed in partial collaboration with John Ellis of CERN and Vasiliki Mitsou of IFIC, Valencia, and is a version of 'non-critical string theory'", said Mavromatos.

All the matter and radiation in the universe is thought to have been created by the Big Bang. The radiation stopped interacting with the matter some 400,000 years later -- when the universe had cooled down enough for electrons and protons to form hydrogen atoms. The density of dark matter particles such as the neutralino (a dark matter candidate favoured by many of the current "supersymmetric" approaches to particle physics) was therefore "frozen" at this time -- the so-called relic abundance.

The researchers say that the neutralino relic abundance is reduced by as much as a factor of ten in their models due to dilaton effects, as compared to standard cosmology theories. In contrast, the relic abundance of "ordinary" matter, which makes up stars, planets and humans, is only slightly diluted. The new model also agrees with the established model of nucleosynthesis (the way in which light elements were created during the first few minutes of the universe).

The new result is important for both cosmology and particle physics, says Mavromatos. Indeed, such non-equilibrium string cosmology models are on an equal footing with the standard cosmological cold dark matter model (called Lambda-CDM). For particle physics, the findings are relevant for future supersymmetric searches in colliders such as the Large Hadron Collider, due to come on-line at CERN early next year. The supersymmetric theory, one of the facets of string theory, postulates that every particle has a massive "shadow" particle partner.

Dark matter is fundamentally different from normal, luminous matter and is invisible to modern telescopes, giving off no light or heat. It appears to interact with normal matter only through gravity. Most cosmologists believe dark matter, currently thought to make up 95% of all matter in the universe, plays a crucial role in how large structures such as galaxies emerged after the Big Bang.

Citation: Dilaton and off-shell (non-critical string) effects in Boltzmann equation for species abundances, A.B. Lahanas et al. *PMC Physics A* (in press)
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