

Towards the Consistent Dark Matter exploration

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The nature of Dark Matter (DM) is one of the greatest puzzles of modern particle physics and cosmology. Although overwhelming observational evidences from galactic to cosmological scales point to the existence of DM, after decades of experimental effort only its gravitational interaction has been experimentally confirmed. Currently, we do not have any clue on DM properties, such as its spin, mass, interactions other than gravitational, symmetry responsible for its stability, number of states associated to it, and possible particles that would mediate the interactions between DM and the standard model (SM) particles.

If DM is light enough and interacts with SM particles directly or via some mediators with a strength beyond the gravitational one, its elusive nature can be decoded or constrained through combined searches: a) from direct production at colliders b) via the relic density precisely measured through the observations of cosmic microwave background (CMB) anisotropies by WMAP and PLANCK collaborations; c) from DM direct detection (DD) experiments, which are sensitive to elastic spin independent (SI) or spin dependent (SD) DM scattering off nuclei; d) from DM indirect detection searches, that look for SM particles produced in the decay or annihilation of DM present in the cosmos, both with high energies observables (gamma-rays, neutrinos, charge cosmic rays) produced in the local Universe, and by studying the effects of energy produced by DM annihilation in the early universe on the properties of the CMB spectrum.

Decoding of unknown underlying theory of DM requires systematic approach. Therefore we suggest the classification of Dark Matter models with mediator multiplets of different spins charged under the weak group. This classification allows to identify models which are already excluded and those models and signatures which can be tested and possibly discovered at the LHC, future colliders and non-collider experiments. Systematic exploration of DM models and their signatures at present creates the ground for the discovery of DM and its identification in the near future.

Several classes of those models are discussed.

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