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The invisible structuring of galaxies: a story from the Big Bang up to current times where Dark Matter is the hero.

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Abstract :

When measuring the speed of stars in the outskirts of galaxies such as our own Milky Way we notice that it is significantly higher than what we can expect from our current knowledge of gravity and of the matter content of galaxies. This effect points to the fact that either Einstein's equation of gravity is incomplete at these scales or that there exists another, unknown, massive and invisible kind of matter lying in halos surrounding the galaxies - and that we call Dark Matter (DM). Several other observations on larger scales suggest that the missing matter hypothesis might be favoured and that DM should make around 85% of the total matter content of the Universe. Consequently our current paradigm for the evolution of the Universe from the Big Bang up to current times - the ΛCDM model - relies on the existence of DM in the form of Cold Dark Matter (CDM). When used in numerical simulations this model proves its robustness as it reproduces all the large scale features that we observe (e.g. rough structures of galaxies, their gathering in clusters and super clusters, etc.). I will briefly introduce the concept of DM and CDM and explain how it shapes the Universe as we know it today.

Even though cosmological numerical simulations are efficient to deal with the large scale structuring of the Universe they cannot resolve scales much below the size of galaxies. However it is predicted that CDM forms very small structures (called clumps or subhalos) that are present within the galactic halos as well. Since the smallest subhalos are to small to contain stars they have never been detected either and their properties are not well constrained while they can be of significant importance for CDM detection experiments. This talk will be focused on one DM candidate called the WIMP particle and will show the different theoretical tools we use in order to tackle this issue and how the proposed solutions involve different fields such as particle physics, cosmology and astrophysics.

References

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