CS-IS DARK MATTER IN THE GALACTIC DISK?

Title: The Tully-Fisher relation and the Bosma effect.
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In a nutshell

In a recent study, a group of researchers at CREF, led by Francesco Sylos Labini, introduced the dark matter disk model, reshaping our interpretation of the dynamics of disk galaxies. This model offers a fresh perspective on the long-standing puzzle surrounding the flat rotation curves observed in spiral galaxies and opens new avenues to our understanding of galactic dynamics.

For decades, scientists have tried to explain the inconsistency between flat rotation curves observed in spiral galaxies and the expected Keplerian decline based on the luminous matter in the galactic disk. They concluded that massive spherical dark halos dominate the gravitational dynamics of spiral galaxies. In a recent study, however, Francesco Sylos Labini and his collaborators proposed an alternative scenario suggesting that dark matter primarily resides within the galactic disk.

This hypothesis is supported by the observed correlation between dark matter and the neutral hydrogen (HI) gas distribution, initially noticed by Albert Bosma in 1981. Recent research has revealed that in nearby disk galaxies, a crucial ratio - the total disc surface density ratio derived from rotation curve measurements to the gas surface density measured from HI observations - remains roughly constant beyond a certain distance from the galactic centre.

This correlation implies that rotation curves at larger radii can be interpreted as rescaled versions of those derived from the HI gas distribution. Consequently, the dark matter is hypothesised to follow the gas distribution and be confined to a disk. However, direct observation of the dark matter distribution within this model is yet to be achieved.

Sylos Labini et al.'s study showcases the accurate description of rotation curves for 16 nearby disk galaxies, including our own Milky Way, within the dark matter disk model's framework.

"*Our results enable the rescaling of rotation curves across these galaxies to conform to a universal, slowly decaying profile*," - says Sylos Labini - "*offering further compelling evidence supporting the dark matter disk model*."

Furthermore, the dark matter disk model allows for deriving a new version of the Tully-Fisher (TF) relation, an empirical relationship linking the mass of a disk galaxy to its rotational velocity. The derived TF relation within the dark matter disk model exhibits excellent agreement with observational data. Consistent with this model, galaxy mass estimates are systematically lower than those obtained assuming a spherical dark matter halo.

"*In our paper, we discussed several potential tests that can help distinguish between the dark matter disk model and the traditional spherical dark halo model*", - says Sylos Labini - "*These findings present theoretical challenges in understanding the dynamical evolution of disk galaxies promises to reshape our understanding of the universe*".

The left panel illustrates the standard halo model, where dark matter is distributed in a spherical halo that surrounds and encompasses a galactic disk. In this model, the dark matter extends throughout the halo region. The right panel depicts the dark matter disk model, where dark matter is confined primarily to the galactic disk and its distribution is traced by the distribution of neutral hydrogen. In this model, the dark matter is concentrated within the disk, and its presence is inferred from the observed properties of neutral hydrogen. These two panels visually represent the contrasting assumptions and distributions of dark matter in the two models: the standard halo model assumes a spherical distribution around the galactic disk, while the dark matter disk model proposes that dark matter mainly resides within the disk.

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