Dark Matter in Galaxies
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Cores vs. Cusps: Dark Matter Density Profiles in Spirals

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Abstract. We use photometric, Hα and HI data to investigate the distribution of dark matter in spiral galaxies. A new technique for deriving the HI rotation curve is presented. The final combined Hα+HI rotation curves are symmetric, well resolved and extend to large radii. We perform the rotation curve decomposition into the luminous and dark matter contributions. The observations are confronted with different models of the dark matter distribution, including core-dominated and cusp-dominated halos as well as less conventional possibilities. The best agreement with the observations is found for the core-dominated halos.

1. Introduction

The problem of the distribution of dark matter in galaxies, as derived from rotation curves of dwarf and spiral galaxies, has triggered off a recent controversy: do the available data completely rule out the predictions of (Λ) Cold Dark Matter (ΛCDM) simulations? Some authors (e.g. Borriello & Salucci 2001) claim that only halos with constant density cores are consistent with the data, while according to others (e.g. Swaters et al. 2003) "cuspy" halos ($\rho \propto r^{-\alpha}$ with $1.0 < \alpha < 1.5$) are not in disagreement with the observations.

2. The data

The 5 spiral galaxies studied here were selected from the sample of Persic & Salucci (1995), on the basis of their low luminosity and of the quality and symmetry of their rotation curves. HI line observations were performed in order to extend these rotation well beyond the optical radius.

The HI rotation curves were derived following the WAMET method (Gentile et al. 2002), which miminised the errors due to projection effects and is able to

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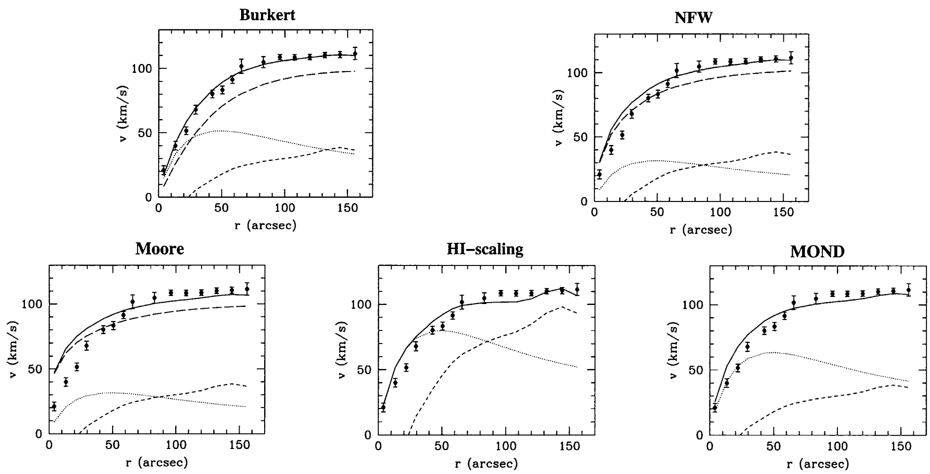

Figure 1. Mass models of the galaxy ESO 116-G12. The solid line represents the best-fit model, the long-dashed line is the contribution of the dark matter halo and the dotted and short-dashed lines are the contributions of the stellar and gaseous disks, respectively.

account for a position angle varyiong with radius, and further refined by means of 3-D modeling of the HI layer.

3. Rotation curve fitting

In Figure 1, we show an example of the decomposition performed on the galaxy ESO 116-G12. Fits were made using various core-dominated halos (we show here the Burkert halo, but other core-dominated halos yield similar results), cusp-dominated halos (the NFW and Moore halos), scaling-up of the HI surface density and MOND.

Figure 1 shows that the Burkert halo gives the best fit to the data, with a core radius of the same order as the optical radius. From the other galaxies we obtain similar results. In order to check this result, we also fitted the inner slope α as a free parameter, obtaining the lower χ^2 values for $\alpha \sim 0$. Moreover, values of α closer to 1 give halo concentration parameters that are too low.

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