

ASTRON 1221 Dark Matter Report

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Introduction

The study of the Milky Way's rotation curve is fundamental in estimating the galactic mass distribution. By analyzing how the rotational velocity of stars and gas changes with distance from the galactic center, we can infer the mass distribution of the Milky Way and better understand its structure and composition.

Motivations

The primary motivations of this study are:

To estimate the mass distribution within the Milky Way.

To understand the relationship between this mass distribution and the observed rotation curve.

To determine the contribution of various galactic components, such as the bulge, disk, and halo, to the overall mass distribution of the galaxy.

Methods

The rotation curve provides the velocities of objects within the galaxy at varying radii. From this, mass distribution is inferred using a model that relates velocity to enclosed mass. The mass within a radius R can be

modeled by considering three components:

1. Galactic Bulge: Assumed to have a constant enclosed mass within the bulge.

2. Galactic Disc: Modeled as a thin cylinder, with the mass increasing quadratically up to the edge of the disc.

3. Galactic Halo: Modeled as a sphere, with the mass increasing cubically with radius.

To estimate the mass, a linear regression model is applied, using these equations to make the calculation process straightforward.

Results

The model provides estimates for the mass of the Milky Way's bulge, disk, and halo components. When compared with observational data, the model aligns reasonably well, suggesting that the mass is indeed distributed across these components. However, there remains unexplained mass, often attributed to dark matter, that cannot be accounted for solely by the visible mass of stars and gas.

Conclusions

The mass distribution model aligns well with observational data but points to the presence of additional unseen mass, likely dark matter.

The galactic bulge, disc, and halo all contribute to the Milky Way's mass,

with the disc's contribution dominating at intermediate radii and the halo becoming significant at larger radii.