Modeling the Distribution of Dark Matter in the Milky Way Based on the Galaxy's Rotation Curve

Kallberg, Tuva (School: Sven Eriksonsgymnasiet)

Most of the Milky Way’s stellar mass has been observed to be located in the inner parts of the galaxy which, for larger radii, should give a rotational velocity inversely proportional to the square root of the distance to the galactic core. However, the velocity has repeatedly been shown to be approximately constant with radius, suggesting that there is a hidden source of mass, commonly referred to as dark matter, contributing to the mass of the galaxy. The aim of this study is to investigate the possibility of confirming the Milky Way’s constant rotational velocity using a small (d=2.3 m) radio telescope, and modeling the implied distribution of dark matter. Radio observations of neutral hydrogen were made between galactic longitudes 25° and 85°, and from the collected data a rotation curve of the galaxy was determined. As expected, the velocity remained relatively constant with radius which is consistent with the theory of dark matter. Analysis of the rotation curve suggests a total mass of 1.00*10^11 solar masses inside a radius of 8.46 kpc. Based on these results, four different models of the Milky Way’s mass distribution were developed. All models assumed an exponential decrease in stellar matter with radius, but used different distributions of dark matter: zero, constant, linear decrease and linear increase of dark matter density with radius. The model with increasing dark matter density best fits the observations. However, due to limited radial range of observations and measurement uncertainties, no distinct conclusions about the dark matter distribution could be made. To do so, a more advanced telescope, allowing for observations at larger radii, would be required.

Awards Won: