



A Study and Comparison of Andromeda Galaxy Mass Estimates Using Cepheid Variable Stars and Central Spectroscopic Analysis

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Abstract

The objective of this project is to 1) compare the effectiveness of studying the total mass of the Andromeda Galaxy (M31) by analyzing the Period-Luminosity Relation data of 9 Cepheid variable stars using the VStar program, together with constructing a Galaxy Rotation Curve graph and using the redshift of the spectrum at the galactic center to avoid interference from the internal rotation of disk galaxies, in order to obtain the distance modulus, which is then used with Hubble's Law to calculate distance, radius, and mass; 2) to develop a Python program for measuring the redshift of the spectrum; and 3) to determine the average total mass of this galaxy.

The analysis of the average period of the Cepheid variable stars found that the distance is approximately 796,000.7 parsecs, and the internal rotational velocity at this radius is 212.3 kilometers per second. Based on this variable, the mass of the Andromeda Galaxy was found to be approximately 2.417×10^{27} kilograms. In the case of using the spectrum, the radial velocity was found to be approximately -414.0 kilometers per second, with an absolute distance of approximately 6.042×10^6 parsecs. Since the radial velocity has a negative direction, it does not align with the theory of the expansion of the universe. This suggests that the Andromeda Galaxy is significantly affected by other factors. It can therefore be concluded that using the Cepheid variable star relation to study the mass of the Andromeda Galaxy is more appropriate than using the central spectrum.

Keywords: Andromeda Galaxy, Cepheid variable stars, Spectrum