Central mass concentrations of disk galaxies: the nuclear spiral connection

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Abstract

The currently favored cosmological model, Lambda+ Cold Dark Matter (LCDM), is remarkably successful at reproducing the large scale structure of the Universe. However, small-scale observations have proven harder to explain. N-body simulations of LCDM structure formation predict that the central density profiles of dark matter halos should be very cuspy. Yet observations of rotation curves of late-type galaxies are consistent with a constant density core. This could be due to a fundamental problem with LCDM (which may be solved using warm dark matter), or late-type galaxies may be biased due to their late epoch of formation, whereas more typical galaxies will conform to the expectations of LCDM. Recent theoretical work has shown that the structure of nuclear spirals is directly connected with galaxy mass distributions on sub-kpc scales. Simulations by Maciejewski (2004a, b) demonstrate that the pitch angle of nuclear spirals is determined by the central mass concentration of a galaxy. Also, within ~100 pc the nature of the spiral depends upon whether the density profile has a cusp or a constant density core. These simulations open up the possibility that nuclear spiral structure can be used as a novel and unique diagnotsic of the mass distributions and concentrations in the inner regions of disk galaxies. The goal of this proposal is to quantify the morphology of the nuclear spiral structure in a large sample of disk galaxies over a wide range of Hubble types (from Sa to Sm), and to apply the models to derive the very central mass concentrations and constrain the types of density profiles found in disk galaxies.

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