The Distribution of Mass within Spiral Galaxies: Unique Solutions from Gas and Stellar Kinematics

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Measurements of the mass distribution of dark matter in spiral galaxies from rotation-curve decompositions have been highly uncertain due to the marginal constraints placed on the baryonic contribution to the mass budget. Here, we present recently published results from the DiskMass Survey, where stellar-kinematic observations from the PPak integral-field unit have been used to uniquely determine the disk mass in a sample of 30 nearly face-on spiral galaxies, thereby breaking this degeneracy between the baryonic disk and the dark-matter halo. A detailed rotation-curve mass decomposition analysis demonstrates that the galaxies in this sample are sub-maximal; the ratio between the calculated baryonic rotation curve and the observed rotation curve is on average 0.57 ± 0.07 at 2.2 optical disk scale lengths (h_R), with a K-band stellar mass-to-light ratio that is only 0.31 ± 0.07 on average. This implies that the visible components of spiral galaxies on average contribute approximately 30% to the total mass within $R = 2.2h_R$; the remaining 70% of the mass is dark. The luminous mass of spiral galaxies is thus typically one third of what has previously been assumed on the basis of most stellar-population-synthesis models. As a consequence, scaling relations involving stellar mass should be reconsidered.