The Stellar Velocity Ellipsoid and the Multi-Component Stability of Galaxy Disks

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Dynamical theory provides a basic expectation for the shape of the stellar velocity ellipsoid (SVE) of galaxy disks. However, few estimates of the SVE in extragalactic disks exist, such that our current empirical knowledge of its shape is largely based on the velocity distribution of stars in our own solar neighborhood. To address this limitation, we have modeled the SVE shape for the disks of 30 galaxies in the DiskMass Survey, which triples the number of existing measurements. Using a Bayesian approach, we estimate the SVE shape of each galaxy disk by fitting an analytic model to our two-dimensional kinematic data. The deprojection of the three-dimensional SVE is accomplished by assuming that the stellar and gas dynamics adhere to both the epicycle approximation and the asymmetric-drift equation. Using synthetic observations of disk-galaxy N-body simulations, we verify our approach by successfully recovering the known SVE shape of the disk-star particles. I will discuss two further results from our analysis. First, we confirm a previous claim that the meridional shape of the SVE is more isotropic in disks of early-type (Sa) galaxies than of later types. This may imply a change in the dominant stellar-scattering mechanism or disk-formation process with Hubble type. Second, we calculate the two-component (gas+stars) stability of each galaxy disk and find that more stable disks have less star-formation activity. This is expected if gravitational instabilities drive star formation, and is successfully predicted by propagating our stability calculations through a series of empirical scaling relations. The dynamical measurements we provide here result in an important empirical reference point for future theoretical and observational studies of secular evolution in disk galaxies.