

Secular Evolution of Disk Galaxies

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Accretion and interactions are important drivers of galaxy evolution, particularly at early stages, but internal processes drive evolution too, and have an important role in the equilibrium configurations of the disks we see today. Internal torques from disk irregularities, asymmetries, and clumps drive radial motions and disk heating for the first several Gyr in Milky Way size galaxies, forming a bulge and a thick stellar disk with an exponential profile. When the gas accretion rate slows at a redshift of 1 to 2, and the gas fraction drops with continued star formation, the instabilities and torques decrease and a thinner disk begins to form. Bars and spiral arms appear at this stage. The transition from clumpy disks to spiral disks can be observed in a few intermediate cases at moderate redshift. Local galaxies with relatively massive clumps show some of these processes still in action; examples are Blue Compact Dwarfs, local Tadpole galaxies, and some fraction of uv-bright massive galaxies. The exponential profiles common to all galaxy disks could result from stellar scattering.