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Secular evolution of galaxies and the formation of Hubble sequence

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Nearly a century ago, Edwin Hubble was among the first (including also Sir James Jeans) to notice a systematic trend of variation of galaxy properties along a morphological sequence, from highly flattened disk shapes to gradually more bulgy shapes, and onward to elliptical galaxies of varying ellipticity. It took the accumulation of observational evidence and the advance of theoretical understanding of the subsequent decades for us to learn that this morphological sequence, classified by Hubble in the eponymous Atlas edited by Sandage, was likely an evolutionary sequence, i.e., the so-called early-Hubble-types (bulgy or elliptical ones) are the results of the gradual central concentration of matter from the so-called late-Hubble-types (disky ones). Galaxies, thus evolve throughout the cosmic time along the (reverse) Hubble sequence from the late to the early Hubble types. In the past 25 years, we have gradually established a dynamical framework, built on the foundation of the density wave theory of galaxies, which demonstrated how this so-called secular morphological evolution of galaxies along the Hubble sequence can be accomplished through the nonlinear and collective interaction of the galaxy-disk matter with the density-wave modes (these modes are the intrinsic global instabilities on the parent galaxy disks, and they give galaxies the striking appearance of grand-design spiral arms and bars). The analytical predictions have received extensive confirmation from observations and from N-body simulations. The result of this work has important implications on the cosmological evolution of galaxies.

Biography

Xiaolei Zhang has obtained her PhD from the University of California, Berkeley in 1992. She was a Post-doctoral Fellow at the Harvard-Smithsonian Center for Astrophysics (CfA) from 1992-1995. She subsequently worked at the CfA as a Staff Scientist, at NASA's Goddard Space Flight Center as a Contractor, and at the US Naval Research Lab as a Civil Servant Astrophysicist. She took an early retirement in order to devote more time to her interests in the foundations of physics, in astrophysics, as well as in art. She is currently an Affiliate Faculty at the George Mason University, USA.

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