BARRED GALAXIES: INTRINSIC OR EXTRINSIC?

M. NOGUCHI
Astronomical Institute, Tohoku University
Aoba, Sendai 980-77, Japan

A unified picture is presented of the formation of bar structures in disk galaxies of various morphological types. In order to discuss bar formation in the context of galactic disk formation, a simple analytic model is constructed of the growth of galactic disks by infall of primordial gas from haloes and subsequent star formation in the disks. It is monitored during the course of disk growth whether or not the condition for spontaneous bar formation (i.e., bar instability) is fulfilled for the stellar disk component.

It is found that the infall timescale is a key parameter which controls the dynamical property of the resulting stellar disk. Disks which grow fast by rapid infall experience gas-rich phases, in which massive gas clumps arising from gravitational instability in the gas disk dynamically heat the stellar disk component. When the disk has fully grown and becomes mostly stellar, it has already acquired enough random motions to suppress bar instability. On the other hand, when the gas infall from the halo region proceeds slowly, star formation (though less intense than in rapid infall cases) keeps gas mass in the disk low, leading to a dynamically cold stellar component due to lack of strong heating by massive gas clumps. Therefore the stellar disk becomes unstable and forms a bar once its mass fraction relative to the total galaxy mass reaches a critical value.

Based on this result, we propose that late-type barred galaxies, the disks of which are considered to have formed by slow accretion of the halo gas, have intrinsic origin whereas the bars in early-type galaxies, whose disks are likely to have grown quickly, have been formed in tidal interactions with another galaxies. This formation scenario, coupled with the numerical result which reveals a striking difference in structure between tidal and spontaneous bars, can explain the observed dichotomy that early-type galaxies generally have a flat bar while late-type galaxies have a bar of exponential type.