RevMexAA (Serie de Conferencias), **17**, 144–144 (2003)

MINOR MERGER OF GALAXIES: THEORY VS. OBSERVATION

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High-Resolution simulations of cosmological structure formation suggest the formation of dark matter halos with strong substructure. These small clumps can spiral into the center of the massive halo on a short timescale and be accreted in a minor merger. If a stellar disk is already present this disk will be heated and puffed up. We compared N-body simulations of these minor mergers with observations of the velocity distribution of a sample of Milky Way stars.

Using the special purpose hardware GRAPE (Okamura et al. 1993), the models of a galactic disk in a live halo (Hernquist 1993) and a realistic density profile for the satellite (Hernquist 1990) we conducted a large set of N-Body simulations with different impact angles, impact velocities and numerical resolution with up to 400.000 particles to follow the evolution of the satellite while merging with the galactic disk, and analyzed the changes of structural parameters presented by a local sample of disk particles. The simulated time spans from 3 billion years up to 10 billion years. We then compared the results with data from a local sample of old disk stars (Quillen, Garnett 2000) and white dwarfs (Torres et al. 2001).

Quillen and Garnett used the velocity dispersion together with the age of a local sample of disk stars to identify a "jump" in the velocity dispersions roughly 9 billion years ago (Quillen, Garnett 2000). We found that a minor merger with a satellite of 20% disk mass could explain this increased velocity dispersion of stars in the so called "thick disk" of our Milky Way.

Torres et al. conducted Monte Carlo simulations to trace the impact of a merger episode in the galactic disk white dwarf population by artificially adding different kinematical kicks to the observed velocity distribution of white dwarfs and by this mimicking a minor merger (Torres et al. 2001). They compared this to the observed distribution of tangential velocities of white dwarfs and found their simulations consistent with observation for the case of a minor merger 6 billion years ago with a mass of 4% of the disk mass. A more massive minor merger came out to be inconsistent with observed values of white dwarf velocity distributions. We can support this result with our numerical simulations within the error bars of the velocity distribution (see Fig.1).

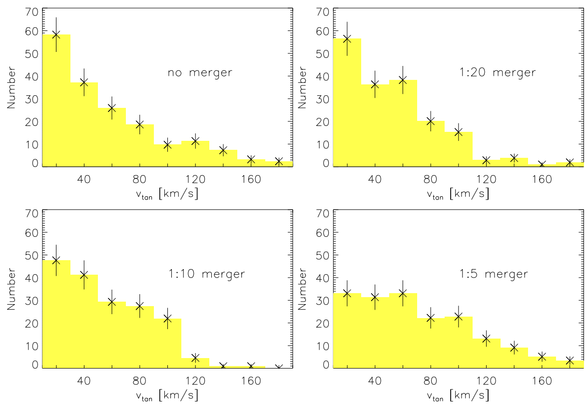

Fig. 1. These histograms show results from N-body simulations aquivalent to the Monte Carlo simulations of (Torres et al. 2001). We have here the distribution of tangential velocities in dependence of different merger events. One can clearly see a change - more objects with higher velocities - with increasing accreted mass. The 1:20 merger is consistent with observations mentioned in (Torres et al. 2001)

We can conclude that N-Body simulations are capable of following the merging history of a disk galaxy, e.g. our Milky Way, over several billion years. Comparing this results to observations of velocity dispersions and distributions one can constrain the mass which could have been accreted by the Milky Way in a minor merger event in the past billion years. Future simulations should increase the resolution of particles and include gas and self-consistent initial conditions.

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Galaxy Evolution: Theory and Observations (Cozumel, Quintana Roo, México, 8-12 April 2002)
Editors: Vladimir Avila-Reese, Claudio Firmani, Carlos S. Frenk & Christine Allen