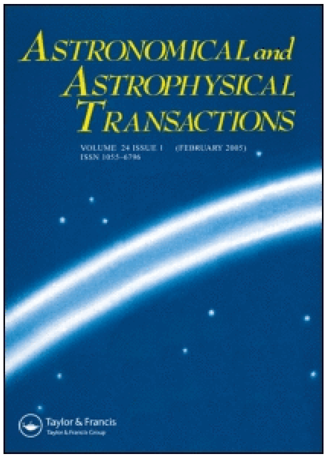

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Distant galaxy encounters and the formation of long-lasting structures

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DISTANT GALAXY ENCOUNTERS AND THE FORMATION OF LONG-LASTING STRUCTURES

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We analyze the influence of the perturbation of gravitational field connected to distant encounters of a spiral with dwarf galaxies. In the future, we shall describe the galaxy as a two component system composed of stars and gas and focus on ISM structures connected to star formation places.

KEY WORDS *N*-body codes; ISM: kinematics and dynamics; Galaxies: interactions

1 INTRODUCTION

Discs of spiral galaxies consist of two main components: stars and gas. Stars form a collisionless and non-dissipative system while the hierarchically structured interstellar medium (ISM) dissipates internal kinetic energy in supersonic shocks and inelastic collisions. Both components move in a common gravitational field and they are also connected through a mass and energy exchange cycle in which the stars form out of the ISM. A fraction of the mass returns from stars back to the ISM via stellar winds and also at the end of stellar evolution in supernova explosions. During the galactic evolution the amount of gas diminishes since a part of it remains in stars for a very long time. Another aspect is that the gas–stars mass exchange cycle brings to the ISM the heavy elements produced in stars. Mixing of heavy elements, building of metallicity gradients and the formation of subsequent generations of stars are important processes for galactic evolution. Our aim is to contribute to a more complex picture of galactic evolution including the interactions of galaxies. We would like to see the influence of the ram pressure gas stripping the ISM of some galaxies in clusters. We also analyze the influence of perturbations of the gravitational field connected to galaxy encounters on star formation and gas redistribution.

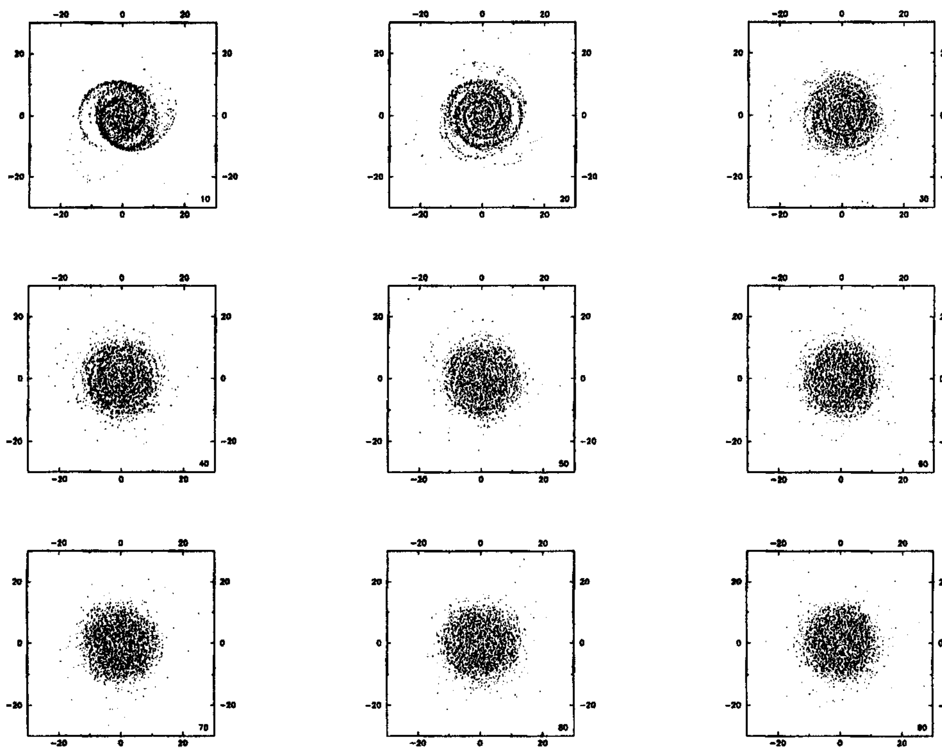

Figure 1 A distant encounter with a dwarf galaxy: time (low right) is given in 10^8 years.

2 EVOLUTION OF GALAXIES

The evolution of galaxies from late-type spirals to early-type and from unbarred galaxies to barred and vice-versa has been reviewed by Combes (2000). The bar creates radial flows by its gravitational torques and concentrates a part of the mass to the galactic center. Once there is enough mass accumulated towards the center, the bulge is formed, and the bar is destroyed. The gas is replenished in the disc through mass loss from the stars and through accretion from the external gas reservoir, and in encounters with other galaxies. The ratio of the total gas mass to the total stellar mass in the galactic disc changes and the bar forms again closing the self-regulating cycle.

Galaxy evolution including their encounters and subsequent merging events are reviewed by Pfenniger (2000). Galaxy interactions enhance the mixing of matter, and trigger violent relaxation and star formation. Long gaseous tails are created removing a fraction of HI gas from galaxies, where the stars and molecular gas concentrates. All these processes can be traced in N-body simulations.

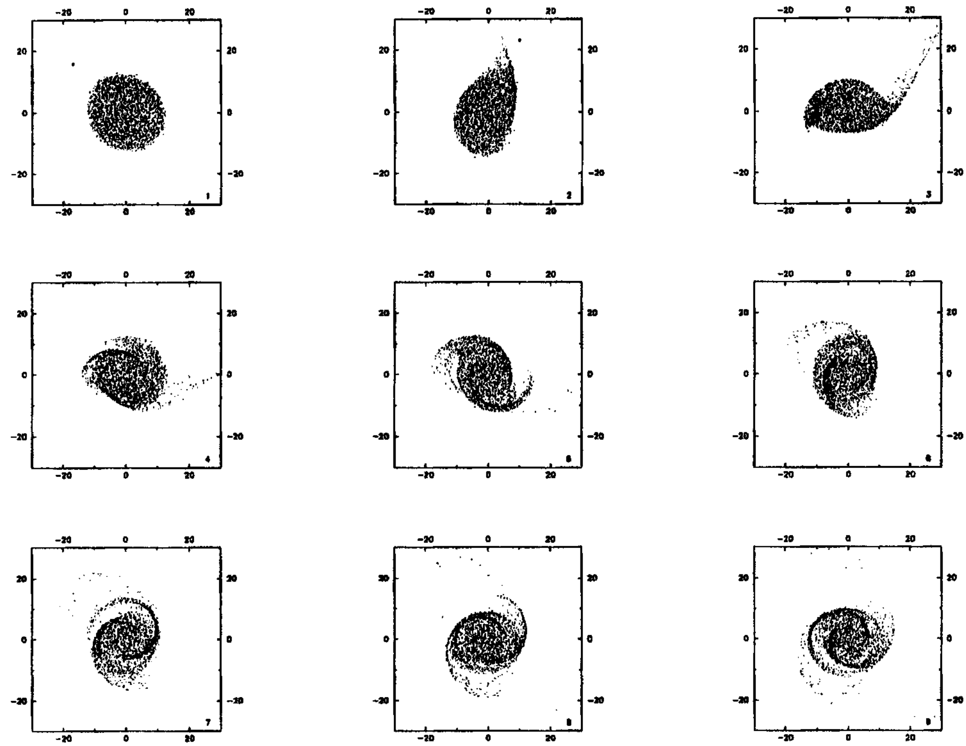

Figure 2 Continuation of Figure 1.

3 NUMERICAL SIMULATIONS

In the N-body code (Jungwiert, 1998) that we will use for future simulations, the spiral galaxies are described as composed of stars and gas that are coupled via gravity, star formation and stellar mass-loss which is modeled as non-instantaneous.

In this preparatory contribution, we show a simplified model: evolution of test particles moving in the gravitational field of the Milky Way composed of disc, bulge and halo as given by Palouš and Zheng (1998), which is perturbed by a point mass of $10^{11}M_{\odot}$ moving on a hyperbolic orbit. The response to this perturbation of the gravitational field is shown in Figures 1 and 2. The perturber passes the perigalactic distance of about 20 kpc at $\sim$ 200 Myr after the beginning of simulation, but the large-scale spiral and ring-like structures are detected up to 3 Gyr.

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