COLLISIONS OF SPHERICAL GALAXIES

M.M. Vergne and J.C. Muzzio

Facultad de Ciencias Astronómicas y Geofísicas
Universidad Nacional de La Plata, Argentina

We used a self-consistent N-body code to simulate encounters of spherical, non-rotating galaxies. The galaxies were represented by Plummer sphere with isotropic velocity distributions and both parabolic and hyperbolic orbits were considered for the encounters; the mass ratios used for the colliding galaxies were 1:1, 1:2, 1:4 and 1:8.

We analyzed the effects on the internal structure of the galaxies caused by collisions that did not result in merger after a Hubble time (1.5×10^{10} y). From the simulations we obtained estimates for the changes in mass, energy and size, as well as spin and flattening parameter. We discussed possible correlations among these galactic properties and the orbital parameters. Mass profiles were also obtained to investigate the structure of galaxies that suffered collisions.

Our main conclusions can be summarized as follows:

1. The maximum mass loss is about 32% for encounters with mass ratios 1:1, 1:2 and 1:4 (21% corresponds to true loss, and 11% is swapped between the galaxies); for mass ratio 1:8 the maximum loss is about 24% (16% truly lost and 8% swapped). The mass loss correlates strongly with the orbital parameters of the collision. The mass profiles show that the galaxies lose mass mainly from their outer envelopes.
2. After the encounters the galaxies are more tightly bound than before.
3. After the head-on encounters the galaxies tend to be "prolate", but in non head-on encounters the final galaxies are "oblate".
4. Our results show that the final galaxies have more extended envelopes than their progenitors. Only the smaller galaxies of the models, with mass ratio 1:8, have a different behavior. In general, the mass profiles show that the final galaxies are deformed.

MERGERS OF SPHERICAL GALAXIES

M.M. Vergne and J.C. Muzzio

Facultad de Ciencias Astronómicas y Geofísicas
Universidad Nacional de La Plata, Argentina

We present the results of self-consistent N-body simulations of collisions of galaxies that ended up in mergers. The galaxies were initially represented by non-rotating Plummer sphere with isotropical velocity distributions, and set up in both parabolic and hyperbolic orbits.

We investigated the structure of the merger products and obtained estimates for the changes in energy, mass and size, as well as spin and flattenig parameters. We also obtained the density profiles and estimated the time scales of the different stages that led to merging.

Finally, the analysis of collisions that ended up in mergers and those that did not, allowed us to establish a range of initial velocities and impact parameters that serves as a merging criterium.

Our main conclusions can be summarized as follows:

1. Two galaxies in a hyperbolic orbit may lose ≈ 16% of their mass for mass ratio 1:1, for 1:2 ≈ 13%, for 1:4 ≈ 5.3% and for 1:8 ≈ 3%. These values correspond to the case of highly energetic encounters. On the other hand, the parabolic encounters lose less mass than the hyperbolic encounters (≈ 5.3% for 1:1 and 1:2 and ≈ 2.9% for 1:4). The mass lost correlates strongly with the orbital energy of the collision.
2. The encounters with large angular momentum orbits produce remnants which rotate as rapidly as $\lambda = 0.16$. The λ parameter increases with the mass ratio.
3. Remnants resulting from head-on encounters are "prolate". When the pericentric distance increases, the remnants flatten to the orbital plane ("oblate"). The flattening of the system increases as galactic mass ratio decreases.
4. The merger times are very long, particularly for the models with low mass ratio, and depend on how the merging process carries out.
5. Profiles of the merged remnants from collisions between Plummer galaxy models ($\rho \propto r^{-5}$) are well described by an $r^{-\delta}$ low profile with $-3 < \delta < -3.6$.

THE RIEMANN SPHERE AS SURFACE OF REFERENCE IN CELESTIAL MECHANICS

Carlos A. Altavista

Universidad Nacional de La Plata, Argentina

Andoyer (1923, Cours de Mécanique Celeste, Gauthier-Villars) and Poincaré (1905, Leçons de Mécanique Celeste, Gauthier-Villars) have shown tha the surface of the sphere of unitary radius can be used to represent planetary motions. It is possible to show that the 10 classical integrals of the N-body problem can be extended to the field of analytic functions by using the theory of infinitesimal contac transformations.

Since a canonical transformation has a Jacobian unitary matrix (the roots of which are the roots o the unity) we can operate on the matricial forn of the 10 classical integrals expressed in terms o