COLLISIONS AND MERGING OF DISK GALAXIES

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Collisions between disk galaxies embedded in massive halos have been studied by means of numerical experiments. The large three-dimensional n-body programs used for numerical experiments in the dynamics of galaxies and galaxy collisions (Miller 1978; Miller and Smith 1980) have been used in this investigation of the collision and merging of galaxies. The use of the large n-body code is important in a systematic study of the physical processes involved. There are enough particles (10^5) and the detail in the force field is sufficient to give the necessary resolution. Dynamical and relaxation time scales are well separated. This is particularly important in investigations of the merging process and of the nature of the merger product.

The stable disks that are required as initial states for an experiment were produced by embedding the (visible) disk in a(n invisible) halo. The disk is a luminous tracer that represents but 1% of the total mass of the system. Stability of the initial state of the model was experimentally confirmed. We have investigated collisions with various combinations of initial orbital energy and angular momentum and of disk orientations. Two initially parabolic cases with different impact parameters were followed long enough in time until the interactions led to a merger. The interpenetration of the two galaxies causes a contraction and subsequent disruption of the entire system. A variety of responses has been found for the visible disks ranging from stretched-out nearly linear features to rapidly propagating ringlike patterns. These forms depend critically on initial disk orientations, but do not depend strongly on the sense of disk rotation. The ringlike patterns were found even for collisions with significant impact parameters.

The cases that were followed to merger were parabolic collisions. One was head-on and the other had an impact parameter of the half mass radius of the initial galaxy. During the merger process material initially in one of the two galaxies continues to oscillate past that

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initially in the other for several complete oscillation cycles (5-10), long after gross features such as the external form seem to have quieted down. The time to a "complete" merger is long. For these cases it is roughly 20 crossing times of the original systems or about 2×10^9 years. The final galaxy in both cases is a prolate object. The projected density profiles fit well to an $R^{1/4}$ luminosity profile. For the off-center case the final merged system has a maximum V/σ of about 0.2 which is consistent with V/σ values observed in many large ellipticals.

REFERENCES

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