Session 3

3.1 The Accuracy Check in Numerical Integration of Dynamical Systems. T.-Y. HUANG* and K.A. INNANEN, Physics Dept., York Univ., Toronto, Canada.

The reasons why classical integrals or integral invariants of dynamical systems may not provide exact or reliable tests of numerical accuracy are examined, and a revised technique for the use of the integral invariant relations is suggested.

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A report will be given of a new numerical study of the gravitational escape/capture of satellites by Jupiter using both the classical, planar restricted 3-body and elliptic restricted 3-body approaches. Previous results for both direct and retrograde orbits near the stability boundary have been refined, and some interesting new results will be presented.

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3.3 Planar Four-body Problem with or without Collisions. M. J. VALTONE, S. MIKKOLA, Turku Univ. Obs., Finland. In order to simulate the dynamical evolution of a fragmenting disk we have solved numerically the planar four-body problem with equal masses. The system was composed initially of two circular binaries whose centers of mass also have circular relative orbits. About 20% of the systems break up into two escaping binaries, 27% form a stable triple system after one particle escapes and 42% form a binary with two escapers. Subsequently the possibility of mergers between the particles was included, when the particles come close to each other. Now the end result in 43% of all systems was an eccentric binary, each component of which is made of two mass units. In 7% of the cases a stable triple system formed, and in 1% the two binaries escaped from each other. The remaining systems were still evolving at the end of the computed time interval.

If further binary-fusions should take place in the eccentric binary systems which have been formed in the above process, then a more loosely bound four-body system is born. These four-body systems break up symmetrically in nearly 100% of all cases. These results suggest that if a fast rotating body is susceptible to binary fission, then after some dynamical evolution the fission products will fly apart from each other, usually in two equal clumps. The asymptotic speed of separation is comparable to the rotation speed of the original body.

3.4 Gas-Star Interactions in Spiral Galaxies. W.W. ROBERTS, Jr., and K.A. HANSON, Univ. of Virginia We develop fluid dynamical equations to describe gas-star interactions in an interstellar medium. The equations assume that stars are formed when clouds collide with one another or are perturbed by expanding supernova remnants. Clouds that participate in star formation events are rendered susceptible to further star formation for probabilistically-selected delay times. When steady-state is assumed, the equations may be spatially averaged to give a galaxy-wide star formation rate. The poorly-known physics of real star formation processes is incorporated into two parameters which measure the relative importance of the cloud collision and supernovae-sparking mechanisms. This theory is compared to a numerical, N-body model of spiral galaxies in which the interstellar medium is simulated by a system of ballistically-orbiting, inelastically-colliding clouds. Despite the small-scale stochastic variations and the large-scale density inhomogeneities of the particulate, numerical model, its star formation rate is well described by the fluid-dynamical theory. This work was supported in part by the National Science Foundation under grants AST-7909935 and AST-8204256.

3.5 Evolving N-Body Simulations of Disk Galaxies. N.F. COMINS, Univ. of Maine at Orono. Two numerical models of two dimensional N-body dynamics in which particles of different masses evolve, explode and create new stars out of an interstellar medium (ISM) are presented. In one model the ISM is stylized as essential square clouds in 50 concentric, equal width rings and is restricted to circular orbits. Mass in the entire star-cloud system is conserved; the mass of a star cluster created from the ISM is removed from the ISM and exploding stars deposit their mass (but not their momenta) in the ISM. Although the gravity of the ISM is felt by the N-bodies, the ISM does not respond to gravitational effects. Results using Kalmijn radial mass distributions will be presented (Comins, 1983). The second model, which is work in progress, uses the clouds to move as N-bodies. The cloud-cloud and cloud-star interactions take place between nearby particles in between integration steps of the equations of motion.