Session 10: 1500–1700 (Room 264)

Galaxy Dynamics and Kinematics

01.10.08 Numerical Integration of the Fokker-Planck Equation and the Evolution of Star Clusters R. COHN Harvard-Smithsonian CFA - A new numerical method for studying the evolution of spherical star clusters is presented. Direct numerical integration of the orbit-averaged Fokker-Planck equation in energy-angular momentum space is used to advance the stellar distribution in time. The gravitational potential of the cluster is treated self-consistently. Detailed numerical results from a study of the evolution of Plummer's model are reported. These results are in generally good agreement with those of earlier Monte Carlo studies but show far less statistical noise. As core collapse proceeds the central regions of the cluster approach a self-similar structure. The late stages of evolution cannot be accounted for by a simple evaporation model but instead are consistent with the gravothermal instability picture.

02.10.08 Gas Dynamics and Wave Phenomena in Barred Spirals. W. W. ROBERTS, JR., U. of Virginia, J. M. HUNTLEY, IBM T. J. Watson Res. Ctr., G. D. VAN ALBADA, U. of Virginia - The bar structure in barred spirals may very well be a wave manifestation; large-scale gaseous density waves and shocks are identified as important phenomena in the gas flow. Steady-state gas-dynamical studies, previously limited to tightly-wound normal spirals, are generalized to include barred and open-armed normal spirals. The steady-state response of the gas to a 5% to 10% perturbing potential that is bar-like in the inner parts and spiral-like in the outer parts is strong with shock formation along the bar and spiral arms. Highly oval streamlines characterize the gas circulation in the inner regions of the disk where large non-circular motions are of the order of 50 km s\(^{-1}\) to 150 km s\(^{-1}\). Strong velocity gradients in the gas flow are particularly pronounced across the bar. This analysis constitutes a complement to recent time-evolutionary, numerical hydrodynamical calculations which lack the resolution necessary to compute the detailed structure of the shock and the gas streamlines in the bar region. The present study provides this resolution together with the critical forcing amplitude required to produce offset shocks along the bar. The dark, narrow dust lanes observed along the leading edges of the bar structure in many barred spirals are identified in this study as tracers of such shocks. A shock-focusing phenomenon is found in this work which accounts in part for the enhanced star formation activity observed at the ends of the bar structure in many barred spirals. Comparison is made between the observed velocity field of one sample barred spiral - NGC 3383 - and the theoretical velocity field derived in this steady-state gas flow study. This work was supported in part by the National Science Foundation under grant AST72-05124 A04.

03.10.08 Self-Gravitating Gas Flow in Barred Spiral Galaxies. HUNTLEY, J. M., I.B.W. Watson Research Center - A series of 2-dimensional numerical experiments is performed in order to test the response of an isothermal, self-gravitating gas disk to a uniformly-rotating, barlike gravitational potential. In the bar-dominated, central regions of the disk, a gas bar whose phase depends primarily on the location of principal resonances in the disk is formed. This response can be understood in terms of orbit-crowding effects. In the gas-dominated, outer regions of the disk, 2-armed, trailing, linear spiral waves are formed. The local pitch angle of these waves increases with increasing fractional gas mass. These self-gravitating waves are not self-sustaining. They are driven from the ends of the stellar bar and their phase does not depend on the location of resonances in the disk. It is concluded that these waves and their associated ringlike structures may be consistent with the morphological distribution of gas features in barred spiral galaxies.

04.10.08 Nonlinear Waves and Solitary Waves in a Self-Gravitating Medium. T. Y. Yueh, Peking University—In order to provide a background for the study of the evolution of density waves to finite amplitudes, exact solutions of nonlinear waves and solitary waves are studied in an extremely simple case. The waves are traveling in the direction of the axis of rotation of a homogeneous and uniformly rotating self-gravitating medium. It is found that the wavelengths of some neutral waves with fairly large amplitudes may be larger than the Jeans length. The nonlinear dispersion relation for periodic waves is obtained. No solitary waves have been found. It is shown that the phase speeds of the periodic waves are always less than the sound speed of the basic state; and, generally speaking, the larger the amplitude, the smaller the phase speed. Comparison is made with nonlinear waves in a homogeneous plasma.