Propulsion Laboratory - The symplectic property of the state transition matrix is very often used as an accuracy check of the numerical solution to the variational equation of a dynamical system. Because of the way in which it is usually applied, the test tends to be overly pessimistic. This paper discusses the problem in general and presents an algorithm for more reliable accuracy estimates.

A Dynamical Model With A "3 kpc Arm." W. L. Peters, U. of Texas, W. W. Roberts, Jr., U. of Virginia - A dynamical model based on the concepts of the density wave and galactic shock wave has been considered for the bar structure in barred spiral galaxies (1971, W. W. Roberts, Jr., A.A.S. Meeting, Amherst). Possible applications of this dynamical model to the inner regions of our own Galaxy is investigated here. The model galaxy considered is a thin disk consisting of gaseous and stellar components whose base state of motion is a circular motion about the galactic center in the plane of the disk. Superimposed on this disk is a stellar density wave, which, together with the gaseous response, represents a bar structure in the inner regions but which comprises only a small gravitational perturbation on the disk as a whole. Numerical calculations of the dynamics of the gas in this model have been carried out based on an asymptotic analysis. The 21 cm line profiles which would be observed in our Galaxy from neutral hydrogen having the velocity and density distributions predicted in the model have been determined. The equation of transfer was applied assuming only a uniform spin temperature and turbulent dispersion speed. The results show that such a gas flow would produce a so-called "3 kpc arm" for one orientation of the bar with respect to the sun. The fit is promising in view of the fact that the orientation was the only parameter adjusted to achieve the fit, the other parameters being fixed by prior considerations.

The Gas Content of Galaxies. William J. Quirk, Hale Observatories, Carnegie Institution of Washington, California Institute of Technology. - The following hypothesis is suggested: "If the gas in a galaxy is Jeans unstable, efficient star formation results." One consequence of this hypothesis is that if the gas density of a galaxy is large enough to be Jeans unstable, star formation will proceed until it is just barely Jeans unstable. Providing one knows the rotation curve for a galaxy, it should be possible to use the Goldreich and Lynden-Bell criterion to predict the peak density of gas as a function of radius, assuming there are no other efficient mechanisms for star formation.

An attempt is made to compare the densities calculated in this way with the densities observed in external galaxies. The hypothesis is found to predict the decrease in gas concentration and the thinning in the outer half of most galaxies, but to overestimate the densities in the inner half of the galaxies; this may be due to some very efficient star formation process which becomes important when the average gas density reaches a certain limit.

The above hypothesis may explain the rough correlation between Hubble type and gas content. It predicts that the galaxies, which according to the Lin-Shu dispersion relation should have tight arms, should also have a low percentage of their mass in gas.

Evidence for Density Wave Stream—ing in Three Spiral Galaxies. D.H. Kogstad and G.S. Skostrab, Owens Valley Radio Observatory, California Institute of Technology. - Aperture synthesis studies of the neutral hydrogen in several spiral galaxies have yielded moderate resolution maps of their velocity fields. In the galaxies NGC 2403, M101 and NGC 6826 we find significant deviations from circular rotation. These peculiar velocities, typically on the order of 10 km/s, tend to be systematic along arcs coinciding with optical spiral arms, and are in qualitative agreement with the streaming motions predicted by the density wave theory of spiral structure.

Clusters of Galaxies and the n-body problem. D.G. Saari, Northwestern University. - Clusters of galaxies are studied using the quantitative behavior of solutions of the n-body problem. (Saari, 1971 Astrophys. J. 165, 399-407). It follows from this work that it is not surprising that galaxies are grouped into clusters. In one classification of clusters the behavior of the velocities is such that it would be difficult to observationally determine whether the system is bounded or disintegrating. This may be a partial answer to the question of whether the Virial Theorem is measuring "hidden mass." Furthermore, the centers of mass of the galaxies tend toward well-defined configurations. These configurations depend on the masses and in some cases could be used to determine the completeness of a cluster or to determine the individual masses of the galaxies up to proportionality parameters. Clusters satisfy a (functional) "Hubble's constant" where the "constant" has two distinct values. Finally there is a motion called oscillatory where in general some of the velocities would be too large to satisfy a Hubble's relationship. However I doubt if the velocities would be large enough to explain quasars via dynamics (nor would it explain the occurrence of blue shifts). From the dynamics one would expect this motion to be separated from clusters of galaxies. This seems to be true for quasars as reported by Arp (1971, Science 174, 1189-1200).

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