30.08  
Effects of Interstellar Gas on the Oscillations and the Stability of Galaxies

P. O. Vandervoort (U. Chicago)

The modes of oscillation that would occur in galaxies that are purely stellar systems can be substantially modified in galaxies that contain interstellar gas. Thus the number of modes of a given kind is generally greater when gas is present than when it is absent. Moreover, the conditions under which a galaxy is unstable with respect to certain modes in the absence of gas are modified and complicated by the presence of gas. In particular, interstellar gas can induce instability with respect to certain modes that would otherwise be stable. In the present investigation, such effects of the gas are illustrated for modes of oscillation in homogeneous spheroids composed of uniformly rotating subsystems of stars and gas. It is known that systems which the critical values of the Ostriker-Peebles parameter for the onset of instability with respect to the formation of a bar are a function of the eccentricity of the spherical figure, the fraction of the system that is gas and the ratio of the angular velocities of the stellar and gaseous subsystems. It is also shown that slowly rotating systems of this kind are unstable with respect to a radial mode of pulsation if the ratio of specific heats of the gas is less than a determinate critical value which depends on the eccentricity of the figure, the fraction of the system that is gas and the ratio of the angular velocities of the two subsystems. This work is partially supported by NSF Grant AST-8609082.

30.09  
Gas observations tell us anything about motion in bars?

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We attempt to reconstruct the velocity field of the gas in the barred galaxy NGC 1393 from radial velocity observations. We then use the fluid equations to find a potential and pattern speed that produces the velocity field.

The radial velocities are obtained from Fabry-Perot interferometry on the Hα line. We have data on a full two-dimensional grid. If the velocity field within the bar has a certain symmetry, then the projection onto the sky can be reversed uniquely, thereby recovering the velocity field. The symmetry requirement is that all even azimuthal Fourier modes are in phase, and that all odd Fourier modes are in phase. The even and odd modes need not have the same phase.

We have tested this procedure on "observations" of gas flow in a bar created with the TREESPR B N-body / smooth-particle hydrodynamics program. We find that the inversion of the velocity field is fairly stable against uncertainties in the projection parameters and deviations from our symmetry requirement.

The use of the continuity equation to determine the bar pattern speed has been suggested by Tremaine and Weinberg (1984). We also use the force equation to calculate the potential and to provide an additional constraint on the pattern speed.

30.10  
Analysis Of The Distribution Of Pitch Angles In Model Spiral Galaxies.

W. S. Russell and W. W. Roberts, Jr. (U. Virginia)

A method is developed for analyzing the distribution of pitch angles exhibited by global and local spiral structures in model spiral galaxies. From existing numerical results on the morphalogy of the cloudy gaseous component and the distribution of young stellar associations (Roberts, Lowe and Adler, 1989), a Voronoi polyhedron approach is applied to capture regions of high population density associated with global and local spiral arm segments, spurs, feathers and secondary features. The length, width and pitch angle of each of these features are calculated using a least squares estimate in (ln r, G) space. The spectrum of pitch angles for various spiral galaxy models is analyzed and discussed. This work was supported in part by the National Science Foundation under Grant AST-87-12084 and NASA under Grant NAGW-929.

30.11  
Self Gravitational Effects In The Formation Of Giant Cloud Aggregations, Spurs, And Feathers In Global Spiral Structures

W. W. Roberts, Jr. (U. Virginia), S. A. Lowe (M.I.T.), and D. S. Adler (U. Illinois)

Theoretical-computational studies are carried out to address open questions spanning: (i) global spiral structure in galactic disks on the large scale, (ii) the clumpy cloudy interstellar medium, giant molecular clouds, and star formation on local scales, and (iii) spurs, feathers, arm branchings, and secondary features on intermediate scales. Gaseous self gravity is found to act on the large scale in galactic disks to enhance the overall collective gravitational field driving the gaseous response and thus help maintain the global spiral structure. At the local and intermediate scales, gaseous self gravity is found to aid the formation and assembling of massive aggregations of clouds into giant cloud complexes, spurs, and feather-like features. Striking is the local raggedness and patchiness of the computed distributions of gas clouds and young stellar associations formed from the gas. Local spurs, feathers, arm branchings, and secondary features continually break apart and reform as the loosely-associated aggregations and giant complexes of clouds continually disassemble and reassemble over time. Such transient features give rise to local disorder within the global spiral structure and blur the global coherence. Of paramount importance are: (1) the self gravitational effects, (2) the dissipative character, and (3) the resultant nonlinear effects of the cold, cloudy gaseous component, which largely distinguish it from the stellar component. Without the presence of a cold, dissipative gaseous component, galactic disks would be hard pressed to produce and exhibit sharp, clear-cut spiral structure on the global scale. Likewise, the presence of a cold, dissipative gaseous component is essential for the formation of giant aggregations of cloud complexes, corresponding active star formation regions, prominent spurs, feathers, arm branchings, and secondary features on local and intermediate scales. This work was supported in part by the National Science Foundation under Grant AST-87-12084 and NASA under Grant NAGW-929.

30.12  
Blue Ellipticals in Compact Groups

S.E. Zepf (STScI/Johns Hopkins University), B.C. Whitmore (Space Telescope Science Institute)

We examine the hypothesis that mergers of spiral galaxies make elliptical galaxies by studying galaxies in compact groups. We combine dynamical models of the merger-rich compact group environment with simple stellar evolution models and predict that roughly 15% of compact group ellipticals should be 0.15 mag bluer in B−R color than normal ellipticals. The published colors of these galaxies suggest the existence of this predicted blue population, but a normal distribution with large random errors can not be ruled out based on these data alone. However, we have new data which confirm the blue color of several of the ellipticals with blue B−R colors. This confirmation of a population of blue ellipticals indicates that interactions are occurring in compact groups, but the B−R color alone does not require that these blue ellipticals be recent products of the merger of two spirals. We show how the addition of photometry in the U band helps distinguish an elliptical which is blue because it is the product of the merger of two spirals from an elliptical which is blue because it recently swallowed a gas-rich system. We demonstrate that optical spectroscopy is an even more powerful discriminator of the origin of the blue ellipticals. We also note that although a wide range of models of the evolution of compact groups successfully fit the optical colors, the standard models do not adequately explain the greater fraction of early-type galaxies in compact groups relative to the field.

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