9.01 Spiral Density Waves Generated by Resonant Excitation: An Application to the 3-kpc Arm

Y. Cheng and C. Yuan (CCNY)

A linear and non-linear theory of spiral density waves has been developed for a gaseous disk with self-gravity and viscosity. The theory is based on the formulation of Shu, Yuan, and Lissauer (1985, Ap. J. 291, 356) and is an overall improvement of the theory proposed by Yuan (1984, Ap. J. 281, 600). The waves are generated by the resonant excitation mechanism at the Lindblad resonances, in response to an external periodic potential. We show that a minor oval distortion or an uneven distribution of mass in the central region of the Galaxy can excite an outgoing spiral density wave in close resemblance to the observed 3-kpc arm. An expansion velocity of 53 km/sec associated with the wave crest requires a perturbational field of 5% of the local mean gravitational field. We calculate for disturbances of both an oval distortion and an uneven distribution of mass, which, as expected, lead to two-arm and one-arm spiral patterns respectively.

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9.02 The Polarization of the Far Infrared Radiation from the Galactic Center


We report the first detection of the linear polarization of the far infrared emission from the dust ring surrounding the galactic center. The observations were made at a wavelength of 100 μm from the Kupfer Airborne Observatory, using the instrument described by Hillebrandt et al. (Ap. J. Lett., 266, L51, 1984) and Dragovan (Ap. J., 308, 270, 1986). The beam size was 55". The degree of polarization is between 1 and 2% at the position of the galactic center and at the lobes of maximum far infrared emission +/−45° away. The position angle of maximum electric vector is between 90 to 100 degrees (approximately east-west) at each position. We argue that the polarization is due to thermal emission from magnetically-aligned grains. The data suggest that the field in the dust ring is toroidal on the large scale but that there is a substantial random component. An upper limit of 30 μgauss is set to the field strength in the ring based on the assumption that gravitational forces have generated the toroidal configuration from the poloidal field which permeates the galactic center on a larger scale; a field strength of 10 μgauss can be estimated by equating magnetic and turbulent pressures in the ring. It is noteworthy that the peak polarization in the galactic center region at a distance of 0.5kpc, is as high as has been measured in any nearby molecular cloud source. This suggests a considerable spatial uniformity in the properties which determine the degree of polarization and that the grains in the region are aligned with the local magnetic field with nearly 100% efficiency.

9.03 Ambiguities in the Identification of Giant Molecular Cloud Complexes from 1-v Diagrams

D.S. Adler, W.W. Roberts, Jr. (U. Virginia)

A cloud/particle model has been developed to simulate the cloudy ISM in spiral galaxies. For application to the Milky Way, the observer's vantage point is placed in the disk, and a longitude-velocity diagram is generated for the distribution of gas clouds. Giant Molecular Cloud Complexes (GMCCs) are delineated by analytically picking out the clumps from the 1-v diagram. However, when these complexes are plotted spatially, it is apparent that what appears to be a GMC in the 1-v diagram may not be a physically associated complex. Models with varying degrees of clumpiness in the 1-v diagram are presented, and the implications on the overall mass spectrum of the model galaxy are discussed.

9.04 The Galactic Distribution of Wolf-Rayet Stars

N. Vacca and P. Conti (JILA, Univ. of Colo. & NBS)

Recent photometric measurements and an improved calibration have enabled us to determine more accurate distances to galactic Wolf-Rayet stars. We have examined the spatial distributions of "early" and "late" type WC and WN stars within 5 kpc. The WC and WN stars are more highly concentrated towards the galactic center; the WC and WN stars are found preferentially near the spiral arm near the Sun. Most stars are strongly concentrated towards the galactic plane but a few are found at considerable distances above or below it.

Using a multi-response permutation procedure (MRPP), we have also quantitatively compared the spatial distribution of WC stars with that of O stars of various masses. Estimates of the masses were determined using the recently provided evolutionary tracks of Maeder (1987, Astr. Ap., in press). The MRPP statistic provides a measure of the similarity of the two distributions while it avoids some of the problems inherent in multivariate Kolmogorov-Smirnov techniques. This analysis confirms earlier qualitative statements that the galactic distribution of WC stars is most similar to that of O stars with 40 M☉ < N < 60 M☉.

9.05 Radioactivity Age of the Galaxy

D.D. Clayton (Rice University)

I examine the solutions of eight radioactive-decay techniques* for determining the age of the Galaxy. The major uncertainty is shown to be the rate at which the total mass in the solar annulus grew by accreting low-metallicity matter during the galactic lifetime. To make this study I construct exact time-dependent models of the chemical evolution of the solar neighborhood in the face of time-dependent infall of low Z gas. The approximations are: (1) linear dependence of star formation rate on gas mass; (2) instantaneous recycling approximation with constant yield per stellar generation; (3) equal initial metallicity in galactic disk and in infalling matter. Radioactive and stable abundances are solved exactly. The eight methods indicate a most likely galactic age 15 Gyr < Tc < 20 Gyr, even though no single method is reliable on its own. An age Tc < 12 Gyr can be achieved only if the otherwise disfavored closed-box model for the solar neighborhood. Astar acceleration of 182Re decay lowers its most likely age from 19 Gyr to 15 Gyr. Radioactive Pb looks old; Tpd ≡ 20, but with substantial uncertainty. My accompanying manuscript shows the details of each method and how they interact with galactic chemical evolution. I stress the ways in which each method can be improved by contributions from astronomers on the one hand and by nuclear astrophysicists on the other.


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