ABSTRACTS OF CONTRIBUTED PAPERS

WAVES OBSERVED BY THE *GALILEO* SPACECRAFT IN THE IO TORUS

X. Blanco-Cano,[1] C. T. Russell,[2]
R. J. Strangeway,[2] D. E. Huddleston,[2]
M. G. Kivelson,[2] and K. K. Khurana[2]

Galileo magnetic field data show the existence of ion cyclotron waves in the near-Io torus. These waves are generated by anisotropies in the pickup ion distributions present in the region. To zeroth order the waves grow at the sulfur dioxide gyrofrequency, are left-hand polarized and propagate along the magnetic field. A more detailed study reveals that in some regions the waves grow over a finite bandwidth, propagate at an angle to the field and are elliptically polarized. In this work we perform a kinetic dispersion analysis for parameters consistent with the Io torus and show that while the parallel propagating SO_2^+ cyclotron mode has the largest growth, oblique cyclotron waves can also grow with a significant rate in the multicomponent plasma near Io. We find that decreasing the sulfur dioxide pickup ion density can lead to the observed bandwidth of frequencies.

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AN OLD BIPOLAR SHELL ASSOCIATED WITH η CARINAE

Joaquín Bohigas,[1] Mauricio Tapia,[1] María Teresa Ruiz,[2] and Miguel Roth[3]

Continuum subtracted dereddened images in several emission lines reveal the existence of an extended bipolar shell around η Carinae. It is best seen in the light of [O III]5007. The geometrical disposition and mass of the shell—between 5 and 7 $M_\odot$—suggest that it was produced by mass outflows from this star. The approximate size and dynamic age of the bipolar shell are 100 × 45 arcsec (1.3 × 0.5 pc) and $13000/V_7$ yr, where V_7 is the mean expansion velocity in 100 km s^{-1}. Spectroscopic observations show that the bipolar shell is mildly excited, photoionized and composed of material that has not been through nuclear processing. Several nitrogen-rich knots, obviously made of material that has been through the CNO cycle, were also discovered. These are between 64 and 100 arcsec away from η Carinae, which implies that they were either ejected at approximately the same time as the Homunculus (during the $\sim$ 1840 brightening of this star) but with much larger velocities, or centuries before this event. The bipolar shell and the distant nitrogen-rich knots should provide important clues regarding the time elapsed between the last pre-LBV and the first LBV eruption of η Carinae, as well as on the dynamics of mass ejections from this object. This information can be consequential in the understanding of the last evolutionary stages of the most massive stars. A full account of this work can be found in Bohigas et al. (2000; MNRAS, 312, 295)

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INTERNAL VARIATIONS OF ELECTRON DENSITY IN GALACTIC H II REGIONS

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A study of the internal variation of the electron density in Galactic H II regions has been conducted on a sample of objects of different sizes and evolutionary stages. The [S II] λ6716/λ6731 line ratio was adopted as electron density indicator. Long slit spectrophotometry of high signal-to-noise ratio with spectral dispersion of 0.75 Å/pixel and spatial scale of 0.9 arcsec/pixel were obtained at different slit positions and orientations. In some regions, we

have found radial gradients with the electron density decreasing from the centre to the edges. The H II regions with no systematic density variations detected were found to be diffuse with mean electron densities of the order of Ne: 20–140 cm^{-3}, indicating that these are evolved objects. The region M 20 shows a systematic non-radial variation of electron density with maximum values occurring at its prominent dark lanes. The present work supports the common assumption that classical and evolved H II regions generally have low electron densities, so that collisional de-excitation processes play a minor role on the observed spectra.

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ON THE PROBLEM OF SELF-ORGANIZATION IN MAGNETIZED PLASMAS

J. Herrera-Velázquez[1]

During the past two decades, non-linear dynamics and out of equilibrium thermodynamics have developed along with plasma physics, providing qualitatively new approaches to complex problems. It is thus widely accepted nowadays, for instance, that non-equilibrium may be a source of order in dissipative systems, allowing the emergence of self-organization. Evidence of self-organization has actually been observed in laboratory magnetically confined systems, and probably in ball lightnings. The basis of this research was actually established in the context of astrophysical plasmas by Chandrasekhar and Woltjer in the fifties. Most plasma systems are forced and dissipative systems far from equilibrium, which share some essential features with other complex non-linear systems that show spatial and temporal coherence. When the system, which may be described by dissipative non-linear partial differential equations, relaxes towards such a self-organized state, it takes advantage of instabilities that lead it, for instance, to a minimum energy state, under certain constraints that prevent it from falling into a trivial unconfined state. Such constraints appear as quadratic or higher order quantities, which are conserved in the absence of dissipation. The relevant feature is that, in the presence of dissipation, one of these quantities decays faster than the others. In general, it remains to be clarified which is the relevant variational principle underlying the relaxation mechanisms described above. Some alternative possibilities that have been explored beyond the simple minimization of energy are the maximization of entropy, minimization of energy dissipation rate, or of entropy production. All these approaches imply the existence of approximate conservation laws for a dissipative system, so that dynamic evolution is sustained long enough, before the plasma is driven by dissipation into an uninteresting uniform state.

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THE SPIRAL DENSITY WAVE IN A THICK GALACTIC DISK

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Models of the thick galactic gaseous disk in magnetohydrostatic equilibria are presented. The observational evidence of the vertical structure in our Galaxy and other spirals is briefly discussed. Then, the disk response to different large scale perturbations is described. Finally, the action of the spiral density wave (SDW) in such a disk is calculated. It is found that the inclusion in the models of the extended Galactic warm ionized layer alters the conventional view of the SDW scenario: the shock, and a prominent structure of large column density extend well above the spiral arm. It is argued that if the SDW triggers star formation, it should do it not only at midplane, but at high Galactic latitudes as well. The resulting structure resembles a hydraulic jump, or bore, in which gas entering the arm rises, accelerates above the arm and lands onto a large downfall region downstream of the arm. For more details of this work see Martos et al. 1999, ApJ, 526, L89.

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ASTROPHYSICAL X-RAY SPECTROSCOPY WITH *XMM* AND *ASTRO E*

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The upcoming launches of the major X-ray space observatories *XMM* and *Astro E* will provide some of the first high sensitivity, high resolution X-ray spectra of a wide range of astrophysical sources. The two missions are actually quite complementary in their attributes. *XMM*, which is an ESA mission planned for launch in December 1999, will carry a high throughput reflection grating spectrometer optimized for the energy band 0.3–2 keV, while the Japanese/US mission, *Astro E*, planned for launch in January 2000, will carry a nondispersive microcalorimeter experiment optimized in the energy band 1–10 keV. In addition, both missions will carry large area imaging CCD experiments for spectroscopy of very faint sources with more modest spectral resolution. I will review the essential characteristics of these missions, and will provide some examples of the types of astrophysical investigations which are planned.

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