1992AAS...180.1702H

[CI] Emission in the z = 2.286 Protogalaxy IRAS F10214+4724 Observed in the J = 2-1 (869 GHz) and J = 1-0 (492 GHz) Transitions

P. A. Vanden Bout and R. L. Brown (NRAO)

We have detected both ground state fine structure lines of neutral atomic carbon in the IRAS source F10214+4724. The lines are seen at the same redshift (z=2.286) as the optical and CO lines seen previously. The observations were made using the NRAO 12 m and IRAM 30 m telescopes in December 1991. CI is a photodissociation product of CO, its discovery in IRAS F10214 confirms the presence of an intense source of ultraviolet radiation distributed within the source. The [CI] lines appear to be optically thin and to originate in 1E12 to 1E13 M☉ of molecular gas. This estimate of the molecular gas mass is comparable to that derived earlier from the CO observations. IRAS F10214 must be forming from an enormous gas reservoir bathed in ultraviolet starlight. A comparison of the CI data from the two telescopes, and mapping done with the 30 m telescope, suggests that the emitting region is structured and the CI is distributed over an angular extent of at least 10°. However, the CI filling factor is small compared to either telescope beam. This is consistent with IRAS F10214 being fragmented and not yet dynamically relaxed: a galaxy in the process of formation. The National Radio Astronomy Observatory is operated by Associated Universities, Inc., under cooperative agreement with the National Science Foundation.

Session 17: Solar Oscillations and Interior
Oral Session, 2:00–3:30 pm
Union A/B

17.01
Intermediate Degree p Mode Frequency Splittings Near Solar Maximum

R.S. Ronan, B.J. LaBonte (UB/IFFA)

We report on full disk observations of the Sun taken in the Ca II K line during twelve consecutive days in May 1991 from Mees Solar Observatory, Hawaii. We measure p mode frequency splittings for modes of spherical harmonic degrees between 20 and 129 averaged over the radial order of the modes. Our measurements of the antisymmetric component of the splittings do not deviate significantly from previous measurements. They are thus consistent with a decrease in the latitudinal differential rotation with depth into the convection zone. The symmetric component of the splittings are of the same order as those reported from the previous solar maximum and are an order of magnitude larger than has been measured near solar minimum. From the degree dependence of the symmetric component of the splittings we find evidence for an effective fractional sound speed perturbation Δc/s = 9 x 10⁻⁴ which is concentrated at low latitudes and between about 0.8 to 0.9 solar radii. It is unlikely that an internal global magnetic field is the dominant source of the observed symmetric component of the splittings since this would require global fields of order 10⁵ Gauss in the convection zone. A sound speed perturbation confined to near surface layers may also contribute to the symmetric component of the splittings but this is a much smaller effect than the buried sound speed perturbation.

17.02
Total Absorption of Sound Waves by Solar Magnetic Flux Tubes

J.V. Hollweg (UNH), M. Goossens (KU Leuven)

We consider a cylindrical magnetic flux tube imbedded in a field-free plasma. Conditions are uniform inside and outside the flux tube, but we allow for a thin boundary at the edge of the flux tube; all parameters vary smoothly inside the thin boundary. Sound waves impinge on the flux tube from outside, and are partially absorbed via resonance absorption. We find surprisingly large absorption coefficients. In particular, the absorption coefficient can be 100% if there is a match between two impedances: the impedance associated with resonance absorption, and the impedance associated with the radiation of sound by eigenoscillations of the flux tube. We will discuss how these results apply to the observed absorption of solar p-modes by sunspots and magnetic regions.

Prospects in Acoustic Holography of the Solar Interior
C. Lindsey (National Solar Observatory), D. C. Braun and Y. Fan (Institute for Astronomy, University of Hawaii), S. M. Jeffries (Bartol Research Institute, University of Delaware)

Acoustic power maps of the solar surface show strong evidence of magnetic structure crossing the solar equator not far below the photosphere to connect the active latitude bands. These maps, generated using the Bartol-NSO-NASA South Pole Observations show long finger-like acoustic shadows we think are caused by absorption of acoustic energy by the submerged magnetic structure. These features suggest a solar interior magnetic structure quite different from any previously expected. These new results open the prospect of a new and powerful solar interior diagnostic based on acoustic holography.

17.04
Giant Cell Convection and Helioseismic Linewidths

J.F. Kelly (University of Colorado), M.H. Ritzwoller (University of Colorado), E.M. Lavelle (University of Colorado)

We predict that a detectable signature of solar giant cell convection should exist as a systematic pattern of linewidth broadening in the the spectra of solar acoustic oscillations. Using the giant cell convection model provided by G. Glatzmeier, we have constructed a suite of synthetic helioseismic images. When spatially filtered, these images display a pronounced widening of lines with azimuthal order near m = 0 of the spatial filter. Sectoral, or |m| > 1 lines, in contrast, experience no such broadening, producing a linewidth pattern dominantly parabolic in m/l. For selected multiplets, simulations show that central lines can be twice the width of their sectoral partners. This effect is manifest also as an overall broadening of the degenerate linewidth. Parameters characterizing the degenerate linewidth and the contrast of central to noncentral linewidths display a smooth, nearly linear dependence on harmonic degree l in synthetic data. These effects should be detectable, given current level of this linewidth pattern is not due to intrinsic damping, but is an apparent broadening traceable to the solar differential rotation rate, which dominates the modal frequency splitting, shifting unevenly the multiplet modal peak frequencies. The near degeneracy of central modes permits strong convective coupling, producing wide, highly hybridized central lines. In contrast sectoral lines are left as nearly purely Lorentzian functions in the frequency domain. Attempts to detect a contrast in multiplet linewidths are complicated by the multiplicative noise that is imposed on real data as a result of the solar source's stochastic character. We have developed a new spectral estimation technique to overcome this difficulty. Multiplet contrast parameters are recovered to within ~ 20% of their noiseless values; degenerate parameters to within ~ 5%. The technique recovers trends in these parameters along a branch with great accuracy despite the addition of strong additive noise levels, and shows promise to reveal the existence of and constrain the characteristics of solar giant cell convection from helioseismic data.

17.05
Global Observations of Chromospheric Oscillations

J. Harvey (NSO), S. Jeffries, M. Pomerantz (Bartol), T. Duvall, Jr. (NASA/GSFC)

Nearly 30 years ago, observations of Doppler velocities from small areas of the solar disk showed both ~300-s period oscillations of the photosphere and ~200-s period oscillations of the chromosphere. Theoretical models of the solar

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