25.19

Properties of Solar Gravity-Mode Eigenfunctions in the Photosphere

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It has been predicted by Provost and Berthomieu (1988, Symposium on Seismology of the Sun and Sun-like Stars, Tenerife, Spain) that the distribution of observed amplitudes of the temperature eigenfunction of low degree gravity modes should exhibit a minimum for eigenfrequencies corresponding to frequencies of divergence-free f-mode like oscillations at the surface. These frequencies, assuming an adiabatic oscillation in the photosphere, are 17, 108, 141, 170 and 196/23 for \( n = 1 \) to 3, respectively. The amplitudes of the gravity modes classified by Hill and Ou (1988 Scientia Sinica A, in press) have been examined for a minimum at the above frequencies where possible, namely the \( n = 2, 3 \) and 4 modes. The plot of power density versus frequency for the \( n = 3 \) modes has a well defined minimum at \( \nu = 146.9/23 \) while the plots for \( n = 2 \) and 4 modes have changes in slope at \( \nu = 155/23 \) and \( \nu = 180/23 \), respectively. The presence of these 3 observationally obtained frequency features near the theoretically predicted locations of Provost and Berthomieu gives support to the interpretation that the observed signals are due to oscillations in the solar atmosphere and that the \( n \) classifications of the signals are correct. The frequency locations of the observed changes in slope may be of value in refining pulsation theory boundary conditions.

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Session 26: Hot Stars, Astronomy & Stellar Dynamics
Display Session, Exhibit Hall

26.01

NLTE Analysis of the Luminous Blue Variable R71

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Luminous Blue Variables are evolved, massive (M > 10 \( M_\odot \)) stars undergoing brightness variations in the visual of about two magnitudes on time-scales of years. These variations can be related to episodes of high mass loss. We present a detailed NLTE analysis of the energy distribution and the line spectrum of the Luminous Blue Variable R71 from 1200 to 36000 \( \AA \). Our models are based on self-consistent radiation-hydrodynamic calculations for the stellar atmosphere. The effects of sphericity, velocity fields, and line-blanketing are taken into account. We derive photospheric and wind parameters of R71 for both the minimum and maximum states. Our analysis indicates that R71 is currently in a post-supergiant phase evolving to the left in the Hertzsprung-Russell diagram. We discuss the importance of Luminous Blue Variables for the evolution of massive stars.

26.02

The Steady Solutions for a Radiation-Driven Stellar Wind Not Based on the Sobolev Approximation

C.H. Poe (HAO/NCAR), S.P. Owocki (Bartol/U. Del.), J.L. Castor (LLNL)

In the recent time-dependent simulations of line-driven stellar winds by Owocki, Castor, and Rybicki (Ap. J., 335; OCR) the steady state approached by an unperturbed wind was found to differ markedly from both Sobolev theory models like CAK and comoving frame calculations by Pauldrach, Puls and Eddin (A.A., 184, 96). In an effort to understand these differences, we have investigated the general solution topology for such line-driven flows when one does not rely on the Sobolev approximation to compute the line force.

We find that the solution topology near the sonic (critical) point is of the nodal type (cf. Holzer, J.G.R., 38, 23), with two positive slope solutions. This nodal critical point is different than the more common 'x' or saddle critical point of the solar wind, in that there is a range of mass-loss rates that produces solutions with a finite slope at the sonic point. Thus, accurately determining the unique values of the mass-loss rate is difficult. We discuss these complications and propose methods to overcome them. We show the dependence of the mass-loss rate on various stellar parameters and compare these solutions with the CAK model and with the OCR time-dependent model.

26.03

Detection of Supergiant Variability with the HAO/Lowell/AFGL Solar Stellar Spectrophotometry Project (SSSP)

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A bright star is routinely used to perform alignment and performance verification tasks for the HAO/Lowell/AFGL Solar-Stellar Spectrophotometer system. In early September, 1989, variations in the \( H_\alpha \) line of HD 107245 (\( \alpha \) Cyg), which exhibits a classic P Cygni profile, were detected using data collected during these adjustment observations. The red-shifted emission feature initially broadened by a factor of four (from \( I_{\text{continuum}} \) to 1.08 \( I_{\text{continuum}} \) ) over three days and then decayed in intensity over the next two days to a level close to that of the initial observation. The minimum of the absorption feature remained at a more-or-less constant depth of about 0.32 - 0.38 \( I_{\text{continuum}} \) throughout the period of observation.

Empirical studies of the \( H_\alpha \) profile of \( \alpha \) Cyg (Kunntas and Morrison, 1989) indicate that the emission feature in the profile is sensitive to the choice of the extension parameter \( \beta \) in the assumed stellar wind velocity profile \( v(r) \). The basic structure of the wind is then inferred by the assumption of mass flux continuity, \( \dot{M} = \rho v(r) \) \( v(r) \). The short time scale observed for the variation of the bright emission feature in \( \alpha \) Cyg calls into question the validity of the assumption of mass flux conservation in the case of this star, since the typical wind speed of 200 km sec\(^{-1}\) and the estimate of the radius of the stellar envelope (20 \( R_\odot \)) imply a characteristic flow time of 100 days in the case of \( \alpha \) Cyg.

To investigate further other kinds of temporal variation in the spectra of supergiants over the range of the H-R diagram, spectra of two other stars, \( \epsilon \) Cas and \( \alpha \) Ori, have been monitored through the 1989 fall observing season.

26.04

Can the Winds From Wolf-Rayet Stars Be Driven by Line Radiation Pressure Alone?

D.B. Friend (Williams Coll.), C.H. Poe (HAO/NCAR), J.P. Cassinelli (U. Wisconsin)

We wish to bring into sharper focus the issues involved in explaining the fast, massive winds from Wolf-Rayet stars by line-driven wind theory. In the last few years the basic line-driven wind theory of Castor, Abbott, and Klein has been modified by several authors so that it is now in excellent agreement with the observations of most classes of early-type stars. The theory fails, however, to explain the winds from Wolf-Rayet stars, if the usual stellar parameters for these stars are adopted. In particular, there is a "momentum problem", in that the momentum flux carried away by the wind is roughly an order of magnitude larger than the momentum flux in the stellar radiation field. Many authors have suggested that this proves that the winds cannot be driven by line radiation pressure alone. We will show that this claim is false, and will examine what is required to explain the observed properties of Wolf-Rayet winds within the framework of the line-driven wind theory. In particular, we will investigate the dependence of the mass loss rate and terminal velocity on the mass, luminosity, and radius of the star, and on \( k \) and \( \alpha \), the two basic parameters of the line-driven wind theory.