SPECTRAL LINE-PROFILE VARIABILITY AS A PROBE FOR L AND M

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We investigate the observable spectroscopic characteristics of non-radial pulsation for stars with rotation rates large enough to resolve the stellar surface by Doppler imaging. We show that the intensity variations in time series of theoretical spectra, at each position in the line profile, cannot be described by a single sinusoid: at least one harmonic sinusoid needs to be included to describe the data. Across the line profile the relative amplitudes and phases of both these sinusoids vary independently.

We use a model of adiabatic pulsations that accounts for stellar rotation effects and includes parameters to simulate non-adiabatic temperature effects. From extensive Monte-Carlo simulations of time series of line-profiles and the subsequent Fourier analysis we derive the following. The blue-to-red phase difference found at the main pulsation frequency turns out to be an indicator of the degree ℓ, rather than the azimuthal order m; the phase difference of the variations with the first harmonic frequency is in many cases (especially for p-modes) an indicator of m. Hence, the evaluation of the variability at the harmonic frequency can improve the results derived from an analysis of observed line profiles.

We conclude that it is possible to derive the ℓ value of the mode(s), if the rotational velocity is high enough to resolve the stellar surface. For p-modes an m-value can be derived as well, if the line-profile variations are non-sinusoidal due to the contribution of the surface-velocity fields. For detailed description of the model, the analysis, and some applications to stellar data we refer to Schrijvers et al. (1997), Telting & Schrijvers (1997ab) and Schrijvers and Telting (1998).

References

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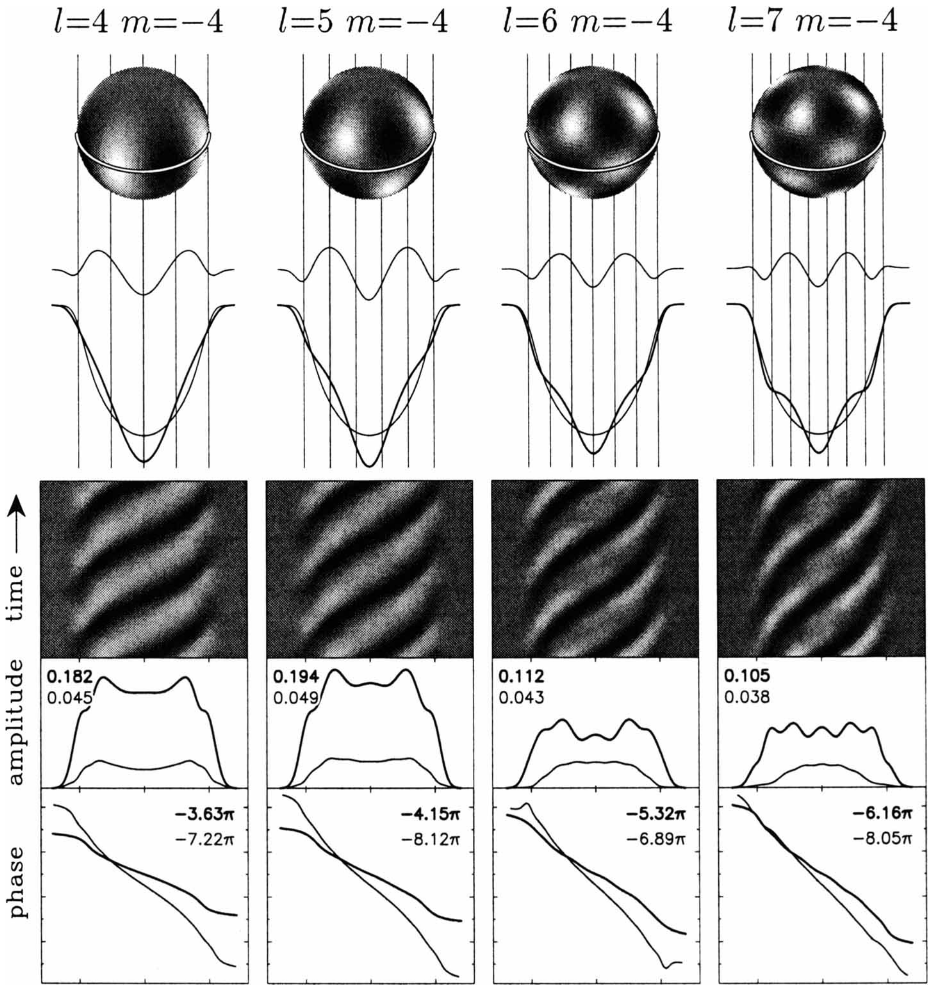

Figure 1. Line-profile variations due to Doppler shifts caused by the three dimensional velocity field of non-radial pulsations. For different values of the pulsation degree ℓ we show (from top to bottom): radial part of the eigenfunction V_r — difference of line profiles of pulsating and non-pulsating case — superposed line profiles of pulsating and non-pulsating case — gray scale representation of residual spectra of 3 pulsation cycles — distribution of the amplitudes of the variations with observed pulsation frequency (thick line) and first harmonic (thin line); the numbers express the maximum values in units of average central line depth — distribution of the phase of the variations with input pulsation frequency (thick line) and first harmonic of the pulsation frequency (thin line); numbers refer to the blue-to-red phase differences.

In the top part of the figure $V_e \sin i$ is indicated by the outer vertical lines, and in the bottom part by the tick marks on the horizontal axis. The stellar and pulsation parameters for this example are: inclination i=55°, intrinsic line width W=0.15*$V_e \sin i$, order m=−4, ratio of horizontal to vertical pulsation amplitudes $k^{(0)}$=0.3 and the pulsation amplitudes were chosen such that the maximum vector velocity due to the pulsation V_{max}=0.15*$V_e \sin i$. Note that at any instant the line profile has more bumps for higher values of ℓ. The main phase distribution changes as a function of ℓ, while the slope of the harmonic phase distribution stays rather constant