Radial and Nonradial Pulsations as Probes of Stellar Physics
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New Observations of the Pulsating PMS Star V351 Ori

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Abstract. We present new photoelectric observations of the Pre–Main-Sequence δ Scuti star, V351 Ori. These new data suggest that V351 Ori could be a multiperiodic variable. The comparison between observations and detailed pulsational models allows us to put independent constraints on the mass and luminosity of the star. The predicted distance is 210 pc, indicating that V351 Ori is much closer than the Orion star forming region. With an inferred mass of $\sim$1.8 $M_\odot$ and an uncertain evolutionary stage, V351 Ori represents an excellent candidate for future asteroseismological studies that will assess whether it is a young PMS star ($\sim$6 Myr) or an evolved object ($\sim$1 Gyr) leaving the main-sequence.

1. Observations, Data Reduction and Analysis

The observations were carried out with the 152 cm "Cassini" telescope, located in Loiano, Italy, during three nights from December 15 to 17, 2000 (for details see Marconi et al., 2001, M01). The resulting photometry is presented in Fig. 1 (left panel). Inspection of the figure reveals the presence of multi-periodic oscillations.

The frequency analysis was performed independently for each filter, using the program Period98 (http://www.astro.univie.ac.at/~dsn/). We have identified 6 periodicities, but results are affected by the 1/day alias problem and higher frequencies could be combinations of the lower ones. Further observations are required in order to remove these problems and better constrain the periodicities of V351Ori. On the basis of the two lowest frequencies, which are probably the most reliable, we conclude that V351Ori is pulsating in at least two modes with periods P_1=0.0647 d and P_2=0.0368 d.

2. Discussion

By applying a linear nonadiabatic pulsation analysis to PMS models we have succeeded in matching the observed frequencies for a single combination of

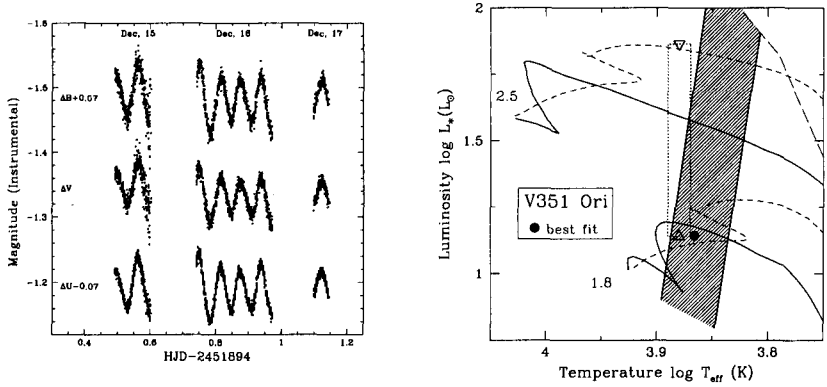

Figure 1. Left panel: *UBV* photometry of V351 Ori. For clarity, the *B* and *U* data have been shifted by ±0.07 mag. Also, the HJD for the second and third night are shifted by −0.65 day and −1.3 day, respectively. Right panel: the position of V351 Ori in the H-R diagram (see text for details).

mass (M_* =1.8 $M_\odot$), luminosity (L_* =13.87 $L_\odot$) and effective temperature (T_{eff} =7350 K). The position of the best-fit model in the H-R diagram is shown in Fig. 1 (right panel, filled circle). In the figure we also display the PMS instability strip predicted by Marconi & Palla (1998) for the two lowest-order radial modes. Moreover, the PMS and post-MS evolutionary tracks are shown, for 1.8 $M_\odot$ and 2.5 $M_\odot$, as solid and dashed lines, respectively. The dotted box indicates the luminosity range corresponding to the empirical distance determinations available in the literature, with the two triangles marking lower and upper limits (see M01 for details). The predicted distance is 210 pc, indicating that V351 Ori is much closer than the Orion star forming region. With an inferred mass of ∼1.8 $M_\odot$ and an uncertain evolutionary stage, V351 Ori represents an excellent candidate for future asteroseismological studies that will assess whether it is a young PMS star (∼6 Myr) or an evolved object (∼1 Gyr) leaving the main-sequence.

References

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