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Physical Parameter Determination for the δ Scuti Star HD 200925

J. H. Peña[1], M. Paparó[2], R. Peniche[1], M. Rodríguez[1,3], M. A. Hobart[4,5], C. de la Cruz[4]

1. Motivation

HD 200925 is an unusual star: the period is stable on a time scale of many years, yet it shows variations which are either large and irregular, or small, suggesting a possible Blazhko effect (Poretti 1984; Joner & Johnson 1985); it has larger values of $T_{\rm eff}$ and $\log g$ derived from $uvby\beta$ than those of dwarf Cepheids of similar period; and it has a somewhat higher metal abundance, [Fe/H], than the Hyades. Furthermore, in conflict to what Joner and McNamara (1983) determined – that m_1 index shows no variation with temperature – HD 200925 shows a definite variation, unlike that predicted in Crawford (1979). No explanation of this has yet been found. Johnson & Joner (1986) also derived an unusual and unexpected value of [Fe/H]. Finally, with respect to the pulsation periods of this star, Mantegazza & Poretti (1986) determined the existence of two periods: one definite, 0.26730 d and a possible second one of 0.2138 d which yield a ratio of $P_2/P_1 = 0.800$, the theoretical ratio expected between the first and the second overtones, found in other pulsating variables. All of these facts make HD 200925 an interesting star, motivating the present study.

2. Observations

The photometric system utilized has the advantage that the *uvby* photometry is acquired simultaneously and, for the N and W filters of Hβ, almost simultaneously. All the observations were carried out at the Observatorio Astronomico Nacional at San Pedro Martir, México. The data were acquired in 1997 July at the 1.5-m telescope.

3. Analysis

The analysis of HD 200925 was carried out with Fourier analysis and least squares fitting methods. The computing packages utilizing AnaFre, PERIOD

[1]Instituto de Astronomía, UNAM, Ap. Postal 70-264, Mexico D. F. 04510, México

[2]Konkoly Observatory, Box 67, H-1525 Budapest XII, Hungary

[3]Facultad de Ciencias, UNAM, Cd. Investigacion Mexico D. F. 04510, México

[4]Facultad de Ciencias, Universidad Veracruzana, Xalapa, México

[5]Instituto de Astrofísica de Andalucia, Apartado 3004, Granada, España

and MUFRAN have been described in Peña et al. (1998). One of the first conclusions we can reach is the existence of one stable period of pulsation that corresponds to the frequency of 3.741 d^{-1} and the associated values of $2f = 7.482$ d^{-1} and $3f = 11.223$ d^{-1}. The presence of another apparently independent frequency can be assumed to be at around 4.67 d^{-1}, clearly present in the best observational season (that of Johnson & Joner 1986). A comparison of the photometric unreddened indexes $(b-y)_0$ and c_0 with models such as those of Relyea & Kurucz (1978) allows the determination of the effective temperature, $T_{\rm eff}$, and surface gravity, $\log g$, over the cycle of pulsation. What is immediately evident, when comparing the physical parameters obtained from $uvby\beta$ photometric data with those reported in the literature, is the significant spread of values determined for the physical characteristics. The metallicity found by all the authors corresponds to a Pop I star. Because of the large discrepancy in the $M_{\rm bol}$ values, and since its accurate determination fixes this star to be either a δ Scuti or an RR Lyrae star, the application of the prescriptions provided by McNamara (1997) was done. He derived a semi-empirical $P-L$ relation for SX Phe and high amplitude δ Scuti stars and, equivalently, the absolute magnitude for RR Lyrae stars. The results yield absolute magnitudes of 0.20 for δ Scuti stars and of 1.08 and 1.14 for [Fe/H] of 0.263 and 0.456 for RR Lyrae stars, respectively. In all cases the results indicate that this star is pulsating in the fundamental mode.

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