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# YOUNG PULSATING STARS IN THE BÖHM-VITENSE DECREMENT

A half dozen variable stars with periods near one day and temperature near 7000°K have recently been reported:

Table 1

| HD | ΔV | Reference |
|---|---|---|
| 27290 | 0.10 | Balona et al., 1994 |
| 32537 | 0.10 | Krisciunas et al., 1993 |
| 164615 | 0.07 | Abt et al., 1983 |
| 218396 | 0.08 | Rodriguez and Zerbi 1995 |
| 224638 | 0.08 | Mantegazza et al., 1994 |
| 224945 | 0.06 | Mantegazza et al., 1994 |

The available Strömgren photometry is, listed in Table 2, together with log $T_e$ and $M_V$ derived from Eggen (1995a):

$$\log T_e = 0.53\ (\beta - 2.800) + 3.881$$
$$M_V = -12(\beta - 2.800) + 2.05 - F\Delta[c_1]$$

where

$$\Delta[c_1] = [c_1] - 2.60(\beta - 2.800) + 0.792$$
$$F = -18.5(\beta - 2.800) + 7.25$$

HD 27290 ($\gamma$ Dor) is a member of the IC 2391 supercluster (Eggen, 1995b) with an age near 5x$10^7$y and HD 218396 (HR 8799) is a member of the Pleiades supercluster (Eggen, 1995c) with an age near $10^8$y. HD 164615 (V2118 Oph) and HD 32537 (9 Aur) are young disk population stars with (U, V, W) = (+28, −13, −16) and (0, −16, −16) km/sec, respectively. HD 224638 and HD 224945 are almost certainly in the young disk because the proper motions are very small.

The periods of HD 27290 are 0.73 and 0.75 d with a beat period of 23.5 d. HD 164615 has a period of 0.81 d and HD 218396 has 0.51 d. The periods of HD 32537, HD 224638 and HD 224945 are unclear but appear to be near 1.25 d. The supercluster parallax of HD 27290 and HD 218396 give luminosities of +2.85 and +2.77 mag, respectively, agreeing well with photometric values in Table 2.

These stars are shown as open circles in the ([u−b], $M_V$) plane of Figure 1 where the main sequence AF stars in the Pleiades and $\alpha$ Persei clusters are represented by a straight line. This cluster main sequence has a pronounced gap between [u−b] = 0.97 and 1.12 mag (Eggen, 1992, 1995c, Eggen and Iben, 1988) which contains no cluster stars. The values of [u−b] = 2[$m_1$] + [$c_1$] are reddening free.

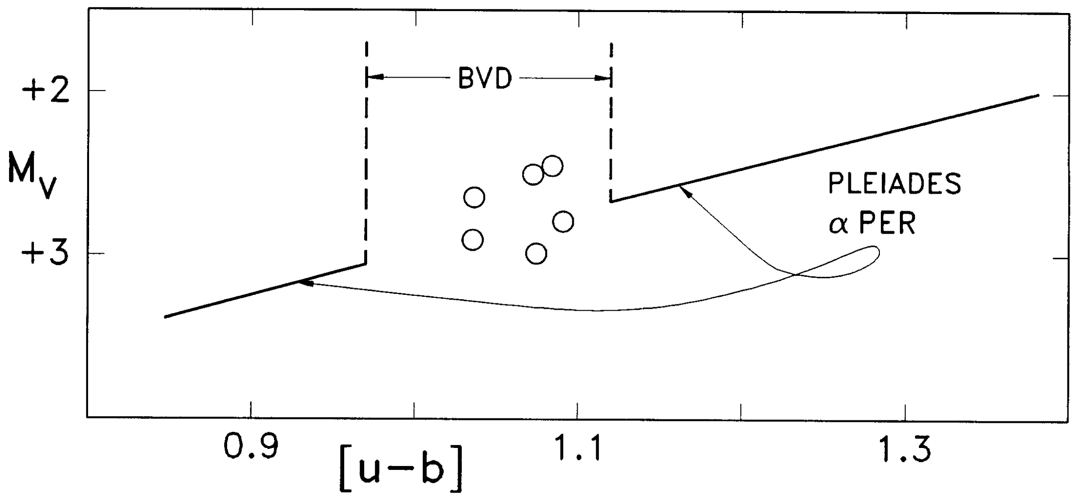


Figure 1. The Pleiades and $\alpha$ Persei cluster main sequence in the ([u−b], $M_V$) plane. The stars in Table 2 are represented by circles.

Table 2. Pulsating Variables in the Böhm-Vitense Decrement

| HD | Name | V | $[M_1]$ | $[c_1]$ | [u−b] | $\log T_e$ | $M_V$ | Sp.T | vsini |
|---|---|---|---|---|---|---|---|---|---|
| 27290 | $\gamma$ Dor | 4.25 | $0^m.235$ | $0^m.620$ | $1^m.090$ | 3.848 | $+2^m.81$ | F0V | 50km/s |
| 32537 | 9 Aur | 5.00 | 0.217 | 0.599 | 1.033 | 3.840 | +2.91 | F1Vp* | 14 |
| 164615 | V2118 Oph | 7.02 | 0.247 | 0.578 | 1.072 | 3.836 | +3.00 | F2V | 60 |
| 218396 | HR 8799 | 5.97 | 0.193 | 0.651 | 1.037 | 3.850 | +2.66 | F0V* | 45 |
| 224638 | | 7.45 | 0.205 | 0.681 | 1.085 | 3.850 | +2.42 | F0 | 24 |
| 224945 | | 6.70 | 0.213 | 0.650 | 1.076 | 3.842 | +2.50 | F0 | 55 |

* Abt and Morrell (1995). HD 32537 has weak 4481 and HD 218396 is of type A5 from the metal lines.

Böhm-Vitense (1970) has suggested that an abrupt onset of convection in a stellar atmosphere will cause a gap in the distribution of stellar temperatures (B−V). Böhm-Vitense and Canterna (1974) found such a gap in the distribution of B−V values for field stars but failed to find it in the Pleiades and $\alpha$ Persei clusters. This failure is partly due to a deviant reddening in a small area of the Pleiades near Merope (23 Tau) and uncertainties in the observed values of (B−V) for the cluster stars. The gap is obvious in the ([u−b], $M_V$) plane and from stellar parameters for zero age main sequence stars with (X, Y) = (0.70, 0.28) (Maeder and Meynet, 1991) we find log g = 4.3, $M_V$ = +2.9 and a mass of 1.65 $M_\odot$ for the mean temperature (7000°K) of the stars in Table 2. The mean luminosity in the table, +2.7 mag, is in close agreement. The stellar atmospheres by Lester et al. (1986) give $T_e \sim$ 7000 to 7500°K for the gap of [u−b] = 0.97 to 1.12 mag. Böhm-Vitense and Canterna found that the conversion to convection in the stellar atmosphere occurs at $T_e \sim$ 7700°K, in close agreement. We will therefore refer to this gap in Figure 1 as the Böhm-Vitense decrement, BVD, and the variables in Table 2, that lie in this gap, as BVDS. These are main sequence variables cooler than the red edge of the instability strip and with periods considerably longer than the USPC ($\delta$ Scuti) variables.

It should be noted that a mass of 1.65 $M_\odot$ is very close to that which divides the old disk and young disk populations (Eggen, 1995a), with the former forming Hyades-like giant sequences and the later M67-like subgiant and giant sequences. We should therefore expect the BVDS to be young disk stars. Candidates that should be monitored for light variation include the following stars in Table 3:

Table 3

| HR | [u−b] | M(sub)V | Sp.T | vsini | HR | [u−b] | M(sub)V | Sp.T | vsini |
|---|---|---|---|---|---|---|---|---|---|
| 571 | $1^m\!.23$ | $+2^m\!.95$ | F0V | ... | 4616 | $1^m\!.046$ | $+2^m\!.56$ | F0IV | 65 |
| 1981 | 1.017 | +2.80 | F3V | ... | 4623 | 0.987 | +2.79 | F2V | 16 |
| 3649 | 1.047 | +2.96 | F0IV | 21 | 4971 | 1.076 | +2.70 | F0V | 70 |
| 3874 | 1.056 | +2.75 | F2V | ... | 5817 | 1.086 | +2.53 | F0V | 60 |
| 4324 | 0.991 | +2.93 | F2IV | 11 | 6449 | 1.060 | +2.78 | F3V | 18 |
| | | | | | 7877 | 1.040 | +2.92 | F2V | 10 |

Olin J. EGGEN
NOAO (CTIO)[1]
Casilla 603, La Serena
Chile 225415

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