

## Do the Pre-Main Sequence $\delta$ Scuti Stars Really Exist ?

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### 1. Open cluster with $\delta$ Scuti variables

Recently, new views of the current status of  $\delta$  Scuti stars have been developed by Rodríguez & Breger (2001) who carried out an excellent review, listing 8 pre-main-sequence (PMS)  $\delta$  Scuti candidates and examined the possibility of the existence of PMS  $\delta$  Scuti variable stars. Here we discuss the nature of 4 stars from their list: 2 said to be members of *NGC* 2264 and 2 of *NGC* 6823.

### 2. Results

*Open Cluster NGC 2264.* The photometric results were already presented in Peña et al. (2000), who concluded that the early-type stars belong to an association at a distance between 600 and 800pc, whereas the late-type *F* stars show a maximum at a closer distance, 350 pc, and that the presumed PMS  $\delta$  Scuti stars do not belong to either. The derived results were supported by the results of an analogous study of the open clusters  $\alpha$  Per and the Pleiades. The same conclusion about the two clusters at different distances is found in HIPPARCOS and Tycho I measurements; from the reported parallax, distances were calculated and two groups at around 300 and 700pc were found. In a region of  $3 \times 2$  degrees centered at 6hr 38m and  $10^\circ$ , HIPPARCOS lists 23 stars and Tycho I 237 stars. For the Tycho measurements the majority of the stars lie closer than 150pc. Given the derived photometric or parallactic distances for these stars, we conclude that the variables cannot belong to any of the two clusters. Even so, the distances derived from Tycho I measurements locate them as two very close stars, (at  $\approx 13$  and 11pc, for V588 Mon and V589 Mon, respectively). At this stage we might wonder which set of distances for the variables is correct but, at any rate, they cannot belong to the clusters. This fact of the two distances to the clusters, derived through two completely different methods and the distances to the variable stars solves the, up to now, apparent paradox of the presence of  $\delta$  Scuti stars in such a young open cluster like *NGC* 2264 (Breger, 1972; Kurtz, 2000 and Breger & Rodríguez, 2001).

*Open Cluster NGC 6823.* A compilation of the bulk characteristics has been presented by Lang (1991). *NGC* 6823 (C1941+231) presents a small diameter, 6.1pc, and its distance is reported as 3470pc. According to this compilation it is a very young cluster, of  $5 \times 10^6$ yr, making it one of the youngest clusters

Table 1. Mean photometric values.

Star	$m_V$	$b - y$	$m_1$	$c_1$	$\beta$	$[m_1]$	$[c_1]$	DM	dist
BL 50	14.600	0.690	0.036	0.746	2.659	0.157	0.344	13.1	4100
HP 57	14.833	0.494	-0.103	0.052	3.118	-0.020	-0.053		

as *NGC* 2264. Furthermore, two short period variable stars, BL 50 and HP 57 have been found (Pigulski et al., 2000) and have been assumed to belong to the cluster, making them, as those in *NGC* 2264, PMS  $\delta$  Scuti stars candidates. The observations were carried out at the Observatorio Astronómico Nacional (OAN) of UNAM; the mean photometric values of these variables are presented in the Table 1. By direct inspection of their positions in the  $[m_1] - [c_1]$  diagram we immediately can see that at least HP 57 cannot be a pre-main sequence  $\delta$  Scuti star since it lies in the region of early type stars, around the early *B* type stars. BL 50 can be, and most likely is, a  $\delta$  Scuti stars since it shows short-period variation and has a spectral type of F5. From the photometry we do not see a large accumulation of stars at the assumed distance of the cluster but merely a small clustering of stars to which the variable BL 50 does not belong.

### 3. Conclusions

Although this is not an exhaustive study of PMS  $\delta$  Scuti stars, we have found strong indications that at least the stars that we have discussed here either cannot belong to young clusters or are of an earlier spectral type than that which would be expected for a variable within the instability strip limits.

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