

Metallicity and $v \sin i$ of B Stars in Galactic Open Clusters: is there any Correlation ?

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Abstract. We discuss the $v \sin i$ distributions of main sequence B stars in galactic clusters in relation to stellar luminosity and to cluster metallicity. We show that evolutionary effects and/or dependence of initial $v \sin i$ distribution on stellar mass are important, so that a much larger sample and a wider metallicity range are required to detect any possible metallicity effect beyond doubt.

1. Introduction

We have observed clusters towards the galactic center and anticenter, chosen from the list of Maeder et al. (1999), in order to test these authors' suggestion that main sequence B stars rotate more rapidly when their metallicity is lower. Due to the small number of clusters we have observed so far (h and χ Per, NGC 3293 and NGC 4755, see North et al. 2003), and to the very short metallicity range they represent, it remains extremely daring to attempt to answer the question raised in the title. Observations of many more stars in both Magellanic Clouds are planned with the GIRAFFE spectrograph. Only then will we be in a position to answer the question on more solid grounds.

These preliminary results are interesting, however, to draw the attention on precautions needed to tackle the question and to explore how far it can be answered with the present data.

2. Rotation and Metallicity

Since there are neither homogeneous nor accurate enough abundance analyses in all clusters studied, we follow Maeder et al. (1999) and rely on the [O/H] gradient. The resulting metallicities (which are only valid in a statistical sense) are: [O/H] = -0.11 , -0.13 , $+0.02$ and $+0.07$ dex for h , χ Per, NGC 3293 and NGC 4755 respectively.

There are several possible criteria to define the “rotational state” in a cluster. The most straightforward is the simple average, but it is sensitive to the queues of the distribution. A second one is the maximum $v \sin i$ value, which may be too sensitive to exceptional cases. A more robust estimator is e.g. the average of the highest $v \sin i$ values, the latter consisting in 20% of the sample (e.g. the average of the 10 most rapid rotators in a sample of 40 stars). Finally, the frequency of stars with $v \sin i > 200 \text{ km s}^{-1}$ can also be considered.

Table 1. Some cluster characteristics (in km s^{-1}) and criteria for fast rotation defined above (see text)

cluster	M_V range	#	$\langle v \sin i \rangle$	$v \sin i_{\text{max}}$	$\langle v \sin i \rangle_{20\%}$	$\frac{\#v \sin i > 200}{\#v \sin i}$
<i>h</i> Per	−4.4/−2.9	27	140	307	261	22.2%
<i>h</i> Per	−2.9/−1.4	25	145	338	292	28.0%
<i>h</i> Per	−1.4/+0.1	30	182	352	330	40.0%
χ Per	−4.6/−3.1	19	107	238	195	10.5%
χ Per	−3.1/−1.6	25	140	354	285	24.0%
χ Per	−1.6/−0.1	29	205	353	336	44.8%
NGC 3293	−6.2/−1.5	25	151	416	336	28.0%
NGC 4755	−7.0/−2.6	13	91	296	204	7.7%
NGC 3293	−4.5/−2.8	12	85	187	215	1.0%
NGC 4755	−4.5/−2.8	7	89	171	158	0.0%

In *h* & χ Per, the “faint” stars rotate more rapidly on average than the “mid” and “bright” ones. This might be an evolution effect, since the bright stars lie at the turnoff and have a lower surface gravity than the fainter stars: mere conservation of angular momentum may account for this difference. However, the $v \sin i$ distribution may also depend on mass for stars on the ZAMS, so it is not possible to decide for sure which of the two effects explains our results.

Only the bright part (or the two brighter parts) of the *h* & χ Per sample may be considered comparable to the two other clusters. The last two lines of Table 1 show how the results differ when the same luminosity range is selected as in *h* & χ Per : the results are significantly different, and tend to confirm the suspicion of Maeder et al. (1999), though a larger sample is clearly needed. Therefore, it is very important to consider exactly the same luminosity range when $v \sin i$ distributions of different clusters (but contemporaneous ones, as they are here) are to be compared.

References

- Maeder, A., Grebel, E. K., Mermilliod, J.-C., 1999, *A&A* 346, 459
 North, P., Royer, F., Melo, C., de Medeiros, J. R., do Nascimento Jr., J. D., Mermilliod, J.-C., Grebel, E. K., Maeder, A., Mathieu, R. 2004, in A. Maeder & P. Eenens (eds.), *Stellar Rotation*, Proc. IAU Symp. No. 215 (San Francisco: ASP)