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Are pre-MS stars older than we thought?

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Abstract. We present a consistent age ordering for young clusters and groups determined using the contraction of stars through their pre-main-sequence phase. We compare these with ages derived from the evolution of the upper main-sequence stars, and find the upper MS ages are older by a factor 1.5 to 2. We show that increasing the binary fraction and number of equal-mass binaries amongst the O-stars compared to the rest of the MS cannot remove this discrepancy.

Keywords. methods: statistical, stars: formation, open clusters and associations: general

In Mayne *et al.* (2007) and Mayne & Naylor (2008) we developed an age-ordering for young stars and groups based on the luminosity of the pre-main-sequence. Table 1 shows the resulting ages, including those derived in subsequent papers. In Naylor (2009) we derived ages by fitting the change position in the colour-magnitude diagram of upper-MS stars as they evolve from the zero-age MS to the terminal-age MS. We found that the MS ages are a factor 1.5 to 2 longer than the ages derived from the PMS.

After my presentation Gaspard Duchêne pointed out that binarism amongst O-stars is much higher than in the rest of the MS. A higher binary fraction will shift the centroid of the combined single-star and binary-star sequences redwards, mimicking an older age and perhaps explaining the older MS ages. As the mass-ratio distribution is equally important, we tested this idea using the most extreme assumption we could reasonably make, the strong hypothesis of Lucy (2006), which we approximated as 25% of binaries evenly distributed over $0.95 < q < 1.0$, and 75% evenly distributed over $0.2 < q < 0.95$. Using this, and a binary fraction (restricted to $q > 0.2$) of 75% (e.g. Sana *et al.*, 2009) for all O-stars we find the ages of the clusters change by less than 5% compared with the results of Naylor (2009). Thus the discrepancy between the MS and PMS ages remains.

References

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Table 1. Ages from PMS contraction

1Myr	2Myr	3Myr	4-5Myr	5-10Myr	10Myr	13Myr	40Myr
IC5146	ONC NGC 6530	λ Ori, σ Ori, NGC2264	IC348 Cep OB3b[1] NGC2362	γ Vel[2]	NGC7160	h & χ Per	NGC2547

[1] Littlefair *et al.* in prep. [2]Jeffries *et al.* (2009)