*Massive Stars Near and Far*
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# Revisiting the Cygnus OB associations

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**Abstract.** We have studied the validity of the historical Cygnus OB associations and have found that many do not show the kinematic coherence expected for true OB associations. We have revisited these groups by photometrically identifying thousands of OB stars across the region with an SED fitting process which combines photometry, astrometry, spectral and evolutionary models. We applied a flexible clustering method and identified seven kinematically-coherent new OB associations. We observe a distinct correlation between position and velocity for two sets of these associations that suggests an expansion pattern. Tracing the motion of the stars back in the past we find that the sets were at their closest around 7.9 and 8.5 Myr ago. We discuss whether this expansion is a natural by-product of the commonly observed size - velocity dispersion relation of molecular clouds, or requires feedback to initiate the dispersal.

**Keywords.** stars: early-type, (Galaxy:) open clusters and associations: general, Galaxy: kinematics and dynamics

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## 1. Introduction

OB associations are unbound and low-density ($< 0.1 M_\odot$ pc$^{-3}$) groups of young stars containing many OB stars (Ambartsumian 1947). As an intermediate step between the star-forming regions and the field population of stars (Wright 2020), they are fundamental to understand stellar formation history and how the Galactic field is built up (Armstrong et al. 2020). They have been listed and analysed for decades (see e.g. Humphreys 1978), but most of them remain poorly characterised. This motivates us to revisit them with modern data and survey. To do so we start with the Cygnus OB associations, located within a massive star-forming region (Reipurth & Schneider 2008), with the reddened Cyg OB2 as most prominent (Wright et al. 2015; Berlanas et al. 2019).

## 2. New OB associations

Most of the historical associations in Cygnus lack kinematic coherence that genuine associations should have (Quintana & Wright 2021, 2022a). We thus built an SED fitting process that we apply on SEDs compiled from photometry and astrometry from several surveys in order to estimate physical stellar parameters. In doing so we identify over 4000 candidate OB stars across Cygnus. Subsequently, we apply a flexible clustering algorithms and find seven new kinematically-coherent OB associations. All associations are expanding in the $l$ direction and three are expanding in the $b$ direction. We observe two large-scale kinematic patterns between position and proper motion in Galactic longitude exhibited by three associations each. This modulation is similar to the pattern observed by Drew et al. (2021) in Carina, with a velocity-scale of $\sim 25$ km s$^{-1}$ and a length-scale of $\sim 150$ pc.

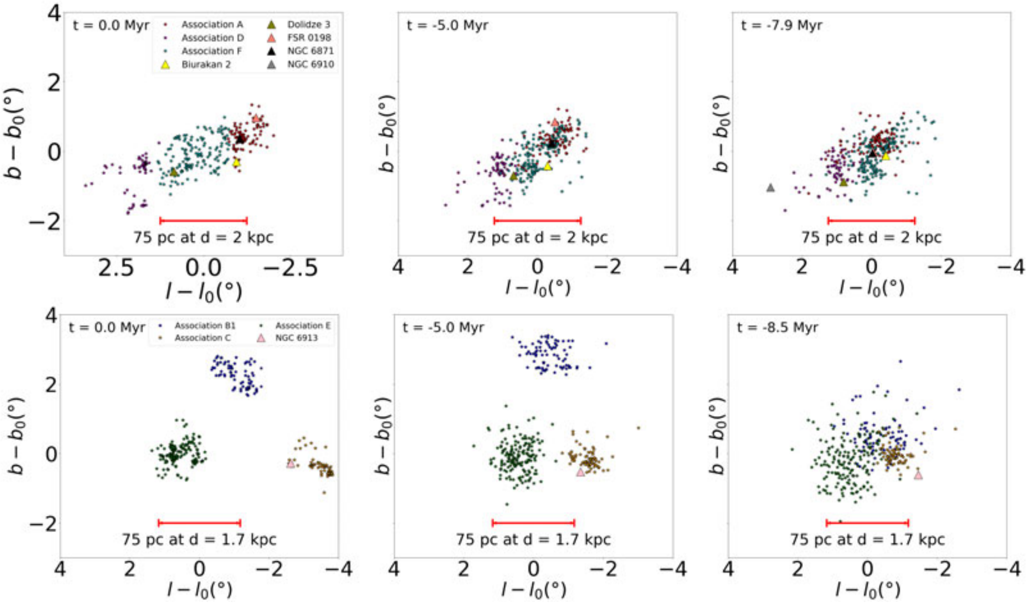


**Figure 1.** Relative galactic coordinates of all stars and open clusters at various times in the past derived from traceback calculations in their reference frame. Presents results from Quintana & Wright (2022b).

## 3. Kinematic traceback

We perform a trace back on the associations and possibly related open clusters using 3D kinematics and the epicycle approximation from Fuchs et al. (2006). The two sets of three associations respectively reached their most compactness $7.9^{+3.0}_{-1.8}$ and $8.5^{+0.8}_{-2.8}$ Myr ago, as shown in Fig. 1. A possible explanation for the driver of this expansion is the feedback from a previous generation of stars. This scenario has been notably suggested by Kounkel (2020) and Großschedl et al. (2021) in Orion. However, we find that the observed expansion velocities are completely consistent with arising from the turbulent motions in primordial cloud, as previously observed by Larson (1981); Solomon et al. (1987), and others in the form of the size - linewidth relation. A similar conclusion is reached for the motions of stars in Orion. This implies that, while it is tempting to attribute these kinematic patterns to feedback, turbulence is probably the most likely scenario.

## Supplementary material

To view supplementary material for this article, please visit http://dx.doi.org/10.1017/S1743921322002587.

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