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What we learn from TGAS about the moving groups of the Solar neighbourhood

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Abstract. We use the TGAS proper motions and parallaxes as well as published and new radial velocities to study the dynamics of nearby moving groups. In particular we try to determine their age using backtracing of the individual members to a common origin. We find that the current data, probably the radial velocities, do not allow to reach a successful conclusion.

Keywords. Galaxy: kinematics and dynamics, open clusters and associations: general

1. Introduction

Moving groups were originally detected as groups of stars sharing a common motion, generally showing sign of youth making them easier to distinguish against the stellar background (Zuckermann & Song 2004). In recent years, moving groups have become popular because membership allows to assign an age to nearby stars (useful to study stellar evolution, search for young, still warm extrasolar planets) (Gagné *et al.* 2015); and because they represent the end stage of open cluster evolution and dispersion of young stars out of their stellar nursery into the field. Comoving stars may also be the result of resonances within the Milky Way and trace its heterogeneous potential (Famaey *et al.* 2008). The ages of moving groups are based on evolutionary models, so it would be useful to obtain an independent determination, e.g. based on the dynamics of the groups.

2. Photometric selection

TGAS parallaxes allow to update the colour-magnitude diagrams of our moving groups, with a fraction of candidates shifting significantly. We reject the red points from the further kinematic analysis (Fig.1 *left*). The green dots nicely fall between the 50 and 100-Myr CIFIST isochrones (Allard, 2016).

3. Kinematic aging

Propagating back in time the motions of the group members until a point of minimum extension would allow to kinematically measure the group age, giving a

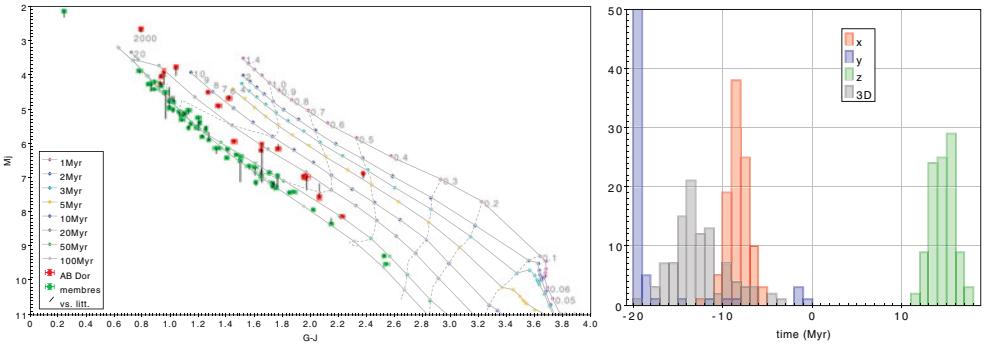

Figure 1. *left)* M_G vs. $G_{\rm Gaia}J_{\rm 2MASS}$ for AB Dor members. We reject the red points from the kinematic analysis. *right)* Histograms of the times of minimal extension along the 3 directions and the 3-D RMS extension. Along the y direction most realisations have a minimal extension more than 20 Myr ago. The histograms clearly disagree.

model-independent age and a strong constraint on the stellar evolutionary models. For instance Ducourant *et al.* (2014) used 30 members of the TWA moving group to recover its birth place and age. This methodology requires good radial velocities as the 1km/s uncertainty translates in 10 Myr into a 10 pc positional uncertainty, a distance comparable to the expected size of the original cluster.

We selected members and member candidates from the literature of various moving groups with presumed age ranging from 8 Myr (TW Hydrae) to 100 Myr (AB Dor), and adopted TGAS proper motions and parallaxes as well as radial velocities from the literature or obtained by us using the CAFE spectrograph in Calar Alto. We propagate back in time using a epicyclic orbit the group member positions, for a number of realisations according to the current measurement uncertainties. We derive histograms of time of minimal extension, which can vary strongly in all three directions (Fig.1 *right*).

This analysis, even after removing the discrepant members, returns large minimal extension and incompatible times at maximal compression. We obtain similar inconsistent results for other moving groups, including for TWA (Ducourant *et al.* (2014) only present a 3-D analysis, which does not reveal these inconsistencies).

This work has made use of data from the European Space Agency (ESA) mission *Gaia* (`https://www.cosmos.esa.int/gaia`), processed by the *Gaia* Data Processing and Analysis Consortium (DPAC, `https://www.cosmos.esa.int/web/gaia/dpac/consortium`). Funding for the DPAC has been provided by national institutions, in particular the institutions participating in the *Gaia* Multilateral Agreement.

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