

# Effect of Prior Information on Bayesian Membership Calculations for Nearby Young Star Associations

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**Abstract.** We present a refined moving group membership diagnostics scheme based on Bayesian inference. Compared to the BANYAN II method, we improved the calculation by updating bona fide members of a moving group, field star treatment, and uniform spatial distribution of moving group members. Here, we present the detailed description of our method and the new results for Bayesian membership calculation. Comparison of our method with BANYAN II shows probability differences up to  $\sim 90\%$ . We conclude that more cautious consideration is needed in moving group membership based on Bayesian inference.

**Keywords.** open clusters and associations, stars: kinematics and dynamics, stars: statistics, stars: pre-main-sequence

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## 1. Introduction

It is difficult to determine the memberships of moving groups, i.e., stellar groups that are young ( $< 100$  Myr), nearby ( $< 100$  pc), and gravitationally unbound. However, the youth and proximity of their members provides the opportunity to understand the characteristics and evolution of young late type stars and planetary systems.

Malo *et al.* (2013) developed a tool to assess moving group memberships based on Bayesian inference, and Gagné *et al.* (2014) improved this tool (BANYAN II). Since the Bayesian probability is obtained based on prior information, one has to carefully select priors and understand the effect of chosen priors.

## 2. Method

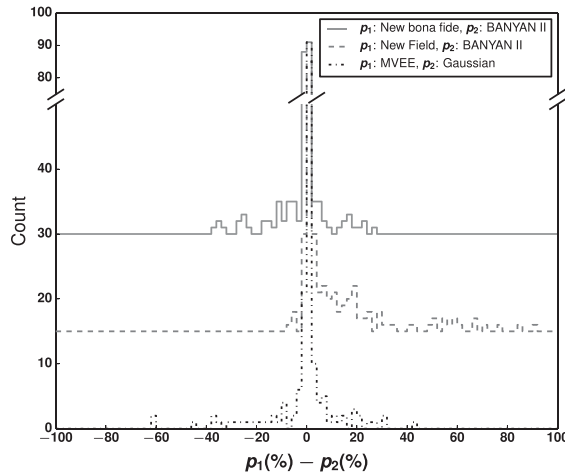
Following Gagné *et al.* (2014), we consider kinematical observables such as RA, Dec, proper motion, distance, and radial velocity inside of the Bayesian inference scheme.

## 3. Improved priors and their effects

Here we suggest some improvements and investigate their effects. We test the effect of different priors using a set of bona fide moving group members as listed in Malo *et al.* (2013).

### 3.1. Bona Fide Members for Group Properties

Since bona fide members of moving groups represent 3-D ellipsoidal structures in  $XYZ$  and  $UVW$  space, different selections of “bona fide” stars change the group properties and have effects on membership probabilities of new stars. We improved on previous lists of bona fide  $\beta$  Pic Moving Group (BPMG) members based on kinematics and unambiguous youth indicators. Our selection criteria and the list of selected stars will be presented in Lee & Song (in prep.). Figure 1 shows the effect of our new treatment on



**Figure 1.** Effects of our new treatment on membership probabilities.

membership probabilities. Even using identical parameters for the BPMG stars included for consideration as members, the difference in membership probability produced using different assumed sets of bona fide members can be as large as  $\sim 40\%$ .

### 3.2. Field Star Treatment

Based on Skuljan *et al.* (1999), we populated four groups of field stars in  $UVW$  space. Since we consider the local Galaxy ( $< 100$  pc), we assumed that the four field star groups are distributed uniformly in  $XYZ$  space. We compare the effect of our field star treatment to that of BANYAN II based on the Bensaçon model. Figure 1 shows that the probability difference between the two calculations can be up to  $\sim 90\%$ .

### 3.3. Minimum Volume Enclosing Ellipsoid (MVEE)

The discussion in Ortega *et al.* (2002) - that the BPMG might have formed as an unbound star system with a large initial volume - indicates that assuming a Gaussian distribution around a spatial center in  $XYZ$  for BPMG may be unrealistic. We compare the effect of the Gaussian distribution and the uniform distribution inside of the Minimum Volume Enclosing Ellipsoid (MVEE) of BPMG. The effect is up to  $\sim 60\%$  (Figure 1).

## 4. Conclusion

BANYAN II is a very useful and effective tool to quantitatively calculate the membership probability of candidate young star within a given moving group. However, we should be careful in using the calculated membership probability since the Bayesian probability is highly sensitive to prior information. Use of an updated list of bona fide members of BPMG, a uniform distribution inside of the MVEE, and a new field star treatment can change membership probabilities up to  $\sim 90\%$ . This indicates that we should be cautious when interpreting membership probabilities based on Bayesian inference.

## References

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