

# MEMBERSHIP SURVEY OF THE ALPHA PERSEI OPEN STELLAR CLUSTER

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## Introduction

- Alpha Persei ( $\alpha$  Per) is a young Stellar Open Cluster.
- Open clusters are groups of stars that formed at the same time from the same interstellar molecular cloud.
- Cluster ages can be determined by fitting stellar evolution models to the measured properties of cluster's evolved stars.
- These are used to calibrate measurements of other stellar properties.
- $\alpha$  Per is relatively close which gives it large proper motion, or movement relative to other stars in the plane of the sky.
- We can use these measurements of position and proper motion to identify other members of  $\alpha$  Per.
- We need to identify more members in order to better determine the age of the cluster.

## Spatial Distribution

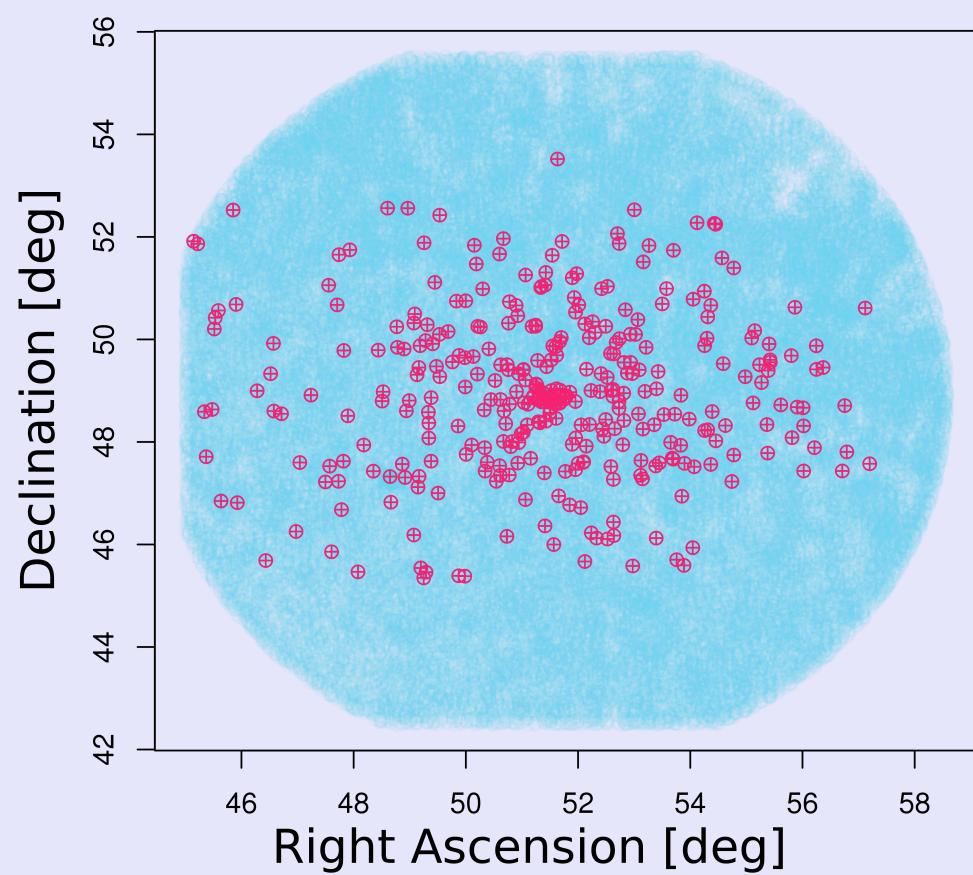


Fig. 2: Spatial distribution in right ascension and declination of catalog stars and known members, see symbols from Fig. 1. Cluster members show some preference towards center, however field stars are for the most part uniform.

## Proper Motion Distribution

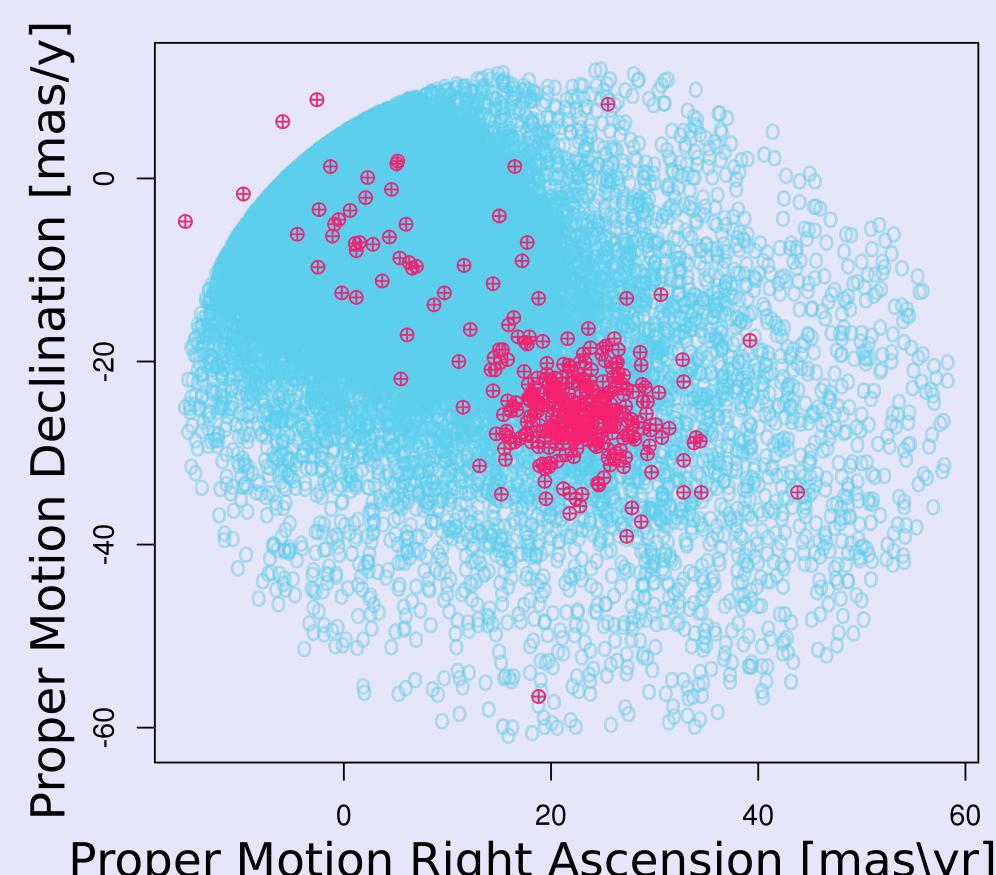


Fig. 3: distribution in proper motion right ascension and proper motion declination. Member stars heavily localized, while field stars heavily localized elsewhere

## Spatial Probability

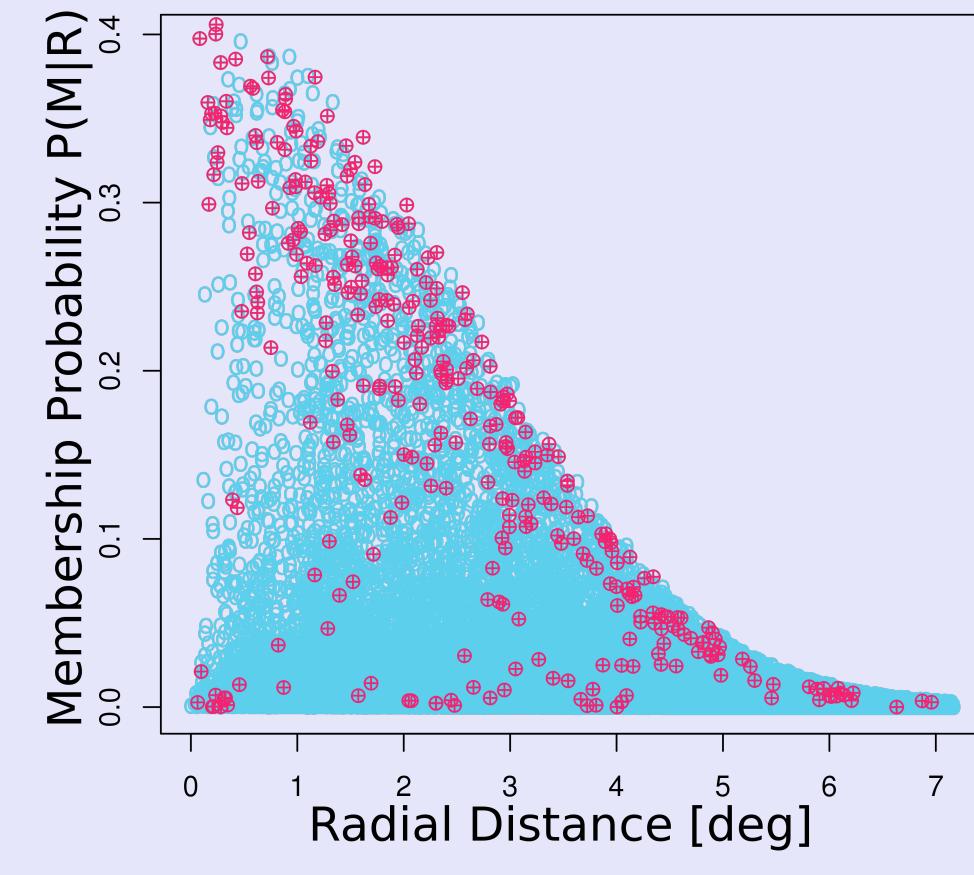


Fig. 4: Membership Probability over radial distance. Members show high probability at their distances relative to the catalog stars, due to high proper motion probability.

## Proper Motion Probability

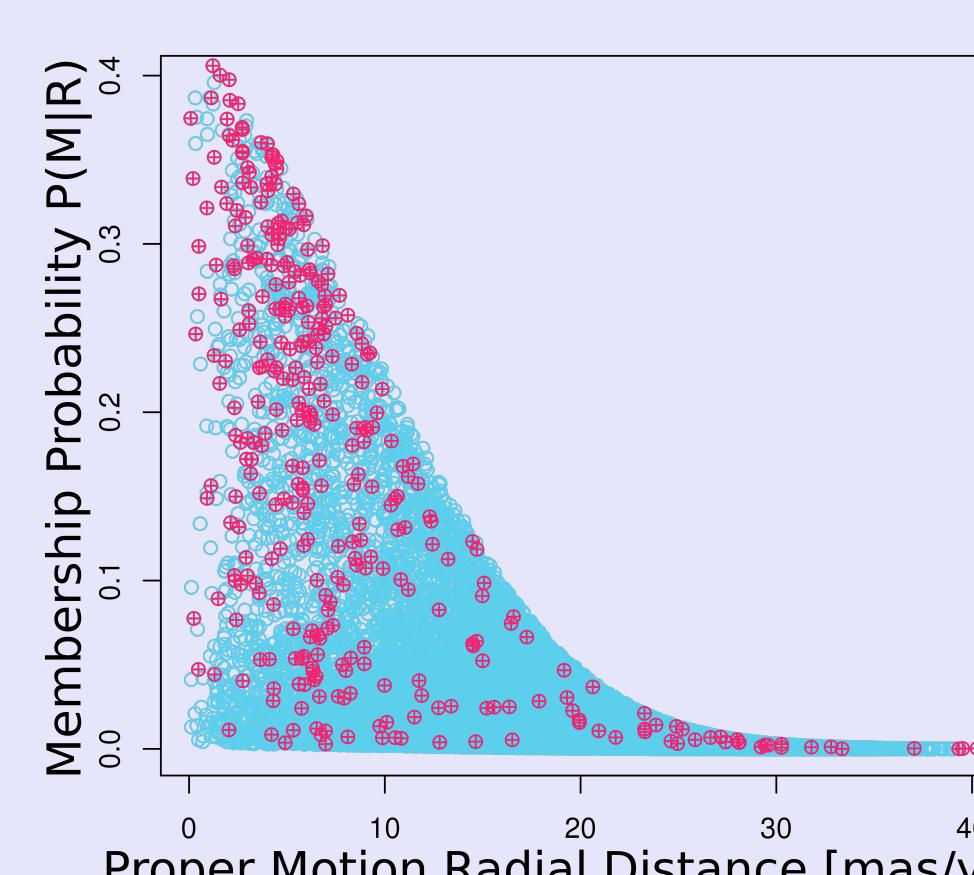


Fig. 5: Membership Probability over proper motion distance. Member stars localized at low differences from the mean proper motion.

## Membership Probability

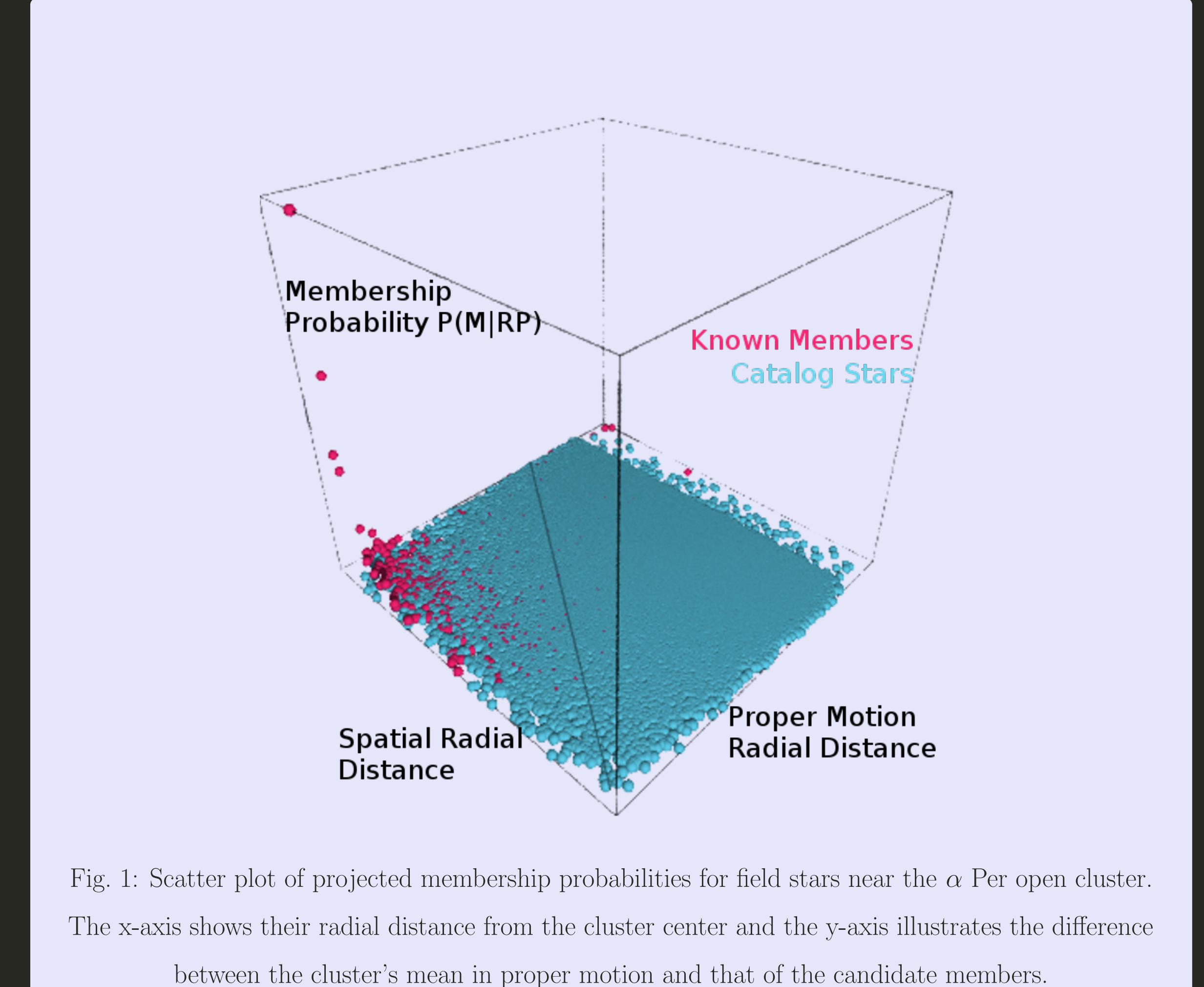


Fig. 1: Scatter plot of projected membership probabilities for field stars near the  $\alpha$  Per open cluster. The x-axis shows their radial distance from the cluster center and the y-axis illustrates the difference between the cluster's mean in proper motion and that of the candidate members.

## Selection Methods

- Cluster properties (mean proper motion, central position, etc.) adopted from previous surveys[1-3] to determine membership.
- We used Data for field stars within a small rectangle centered on  $\alpha$  Per, taken from the URAT1 catalog.
- The spatial distribution of known members is densest towards the cluster center, but exhibits a considerable spread [see Fig. 2 & 4]. Field stars in the same region are distributed relatively uniformly on the sky, however.
- URAT catalog includes  $\approx 700$  more stars in this region than expected based on extrapolating the uniform distribution of field stars across the whole region; we adopt this estimate of  $\approx 700$  total cluster members to calculate the membership probability  $P(M)$  for each star in this region.
- Members of  $\alpha$  Per have high proper motion due to the cluster's proximity, which produces large angular velocities.
- More distant field stars tend to have much smaller proper motion than members.
- We modeled the probability of a star being a certain distance from the cluster mean in position or proper motion given membership,  $P(R|M)$ , from previous members.
- We calculated the probability of being a distance from the mean,  $P(R)$ .
- We calculate the probability of being a member given a certain difference from the mean in either position or proper motion using Bayes' Theorem:

$$P(M|R) = \frac{P(R|M)P(M)}{P(R)} \quad (1)$$

[see Fig. 4 & 5].

- We still need to acquire data on the parallax of member stars and determine their spatial distribution in three dimensions including distance.
- We will then calculate a model of the light emitted by these stars, and find an age that would produce an isochrone that best matched.

## References

1. Deacon, N. R., Hambly, N. C. (2004). "Proper motion surveys of the young open clusters Alpha Persei and the Pleiades" *Astronomy and Astrophysics*. Vol 416. 125-136.
2. Prosser, Charles, F. (1992, February). "Membership of low-mass stars in the open cluster  $\alpha$  Persei" *The Astronomical Journal*. Vol. 103(2), 488-513.
3. Shiekh, N., Hasheminia, M., Khalaj, P., Haghi, H., Hasani Zoonozi, A., Baumgardt, H. (28 July 2015) "The binary fraction and mass segregation in Alpha Persei open cluster" *Monthly Notices of the Royal Astronomy Society*. Vol. 457, 1028-1036.