A Polarimetric Method for Identifying Member Stars in Open Star Clusters*

(*a case of NGC 1817 and NGC 7380)

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1. INTRODUCTION

Polarimetric observations serve as an effective diagnostic tool for studying the interstellar medium and identifying stellar membership of an open star cluster. Starlight becomes linearly polarized due to the dichroic extinction from aligned asymmetric interstellar dust grains (Andersson et al. 2015). The resulting polarization signatures differ for member and non-member stars of the cluster (Medhi & Tamura 2013). This makes polarimetry a valuable tool for separating member stars from the foreground or background field.
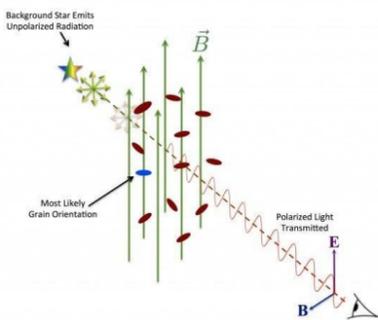
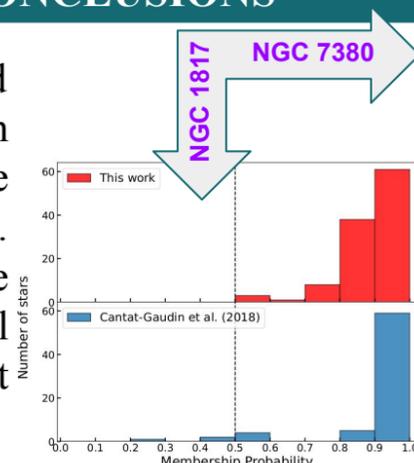Grain alignment in the interstellar medium and the process of polarized light (http://bgandersson.net).

Cluster parameters	NGC 1817	NGC 7380
R.A. (J2000)	$05^h12^m15^s$	$22^h47^m21^s$
Dec. (J2000)	$+16°41'24''$	$+58°07'54''$
Longitude (degree)	186.19	107.13
Latitude (degree)	-13.03	-0.88
Age (Myr)	800-950	4
Distance (kpc)	1.8-2.1	2.5±0.2
Reddening [E(B − V)] (mag)	0.27-0.33	0.50–0.65
References	Harris & Harris (1977); Kharchenko et al. (2005); Wu et al. (2009); Jacobson et al. (2011); Cantat-Gaudin et al. (2020)	Chen et al. (2011); Cantat-Gaudin & Anders (2020) ; Hunt & Reffert (2023); Singh et al. (2024)

2. OBSERVATIONS

❖ Polarimetric observations using the Aries IMaging POLarimeter (AIMPOL), mounted as a bank-end instrument at 104 cm telescope at Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India.

❖ Detailed observations and data reduction methods are described in Rautela et al. (2004), Singh et al. (2020a,b, 2024).

3. METHOD

➢ The mean value of Stokes parameters (Q = P cos2θ, U = P sin2θ) for the cluster ($Q_{cluster}$, $U_{cluster}$) is extracted by fitting the Gaussian curve to their distributions and adopting statistically defined cutoff limits for member selection.
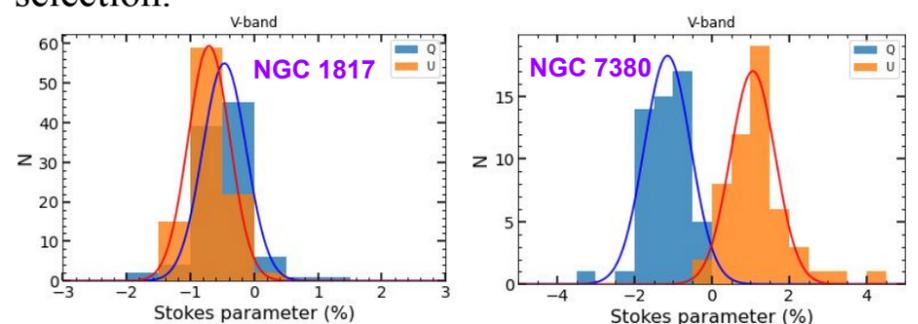
➢ The average deviation of the Stokes vectors Q and U of an individual star from the mean values of $Q_{cluster}$ and $U_{cluster}$ are calculated.

➢ Percentage scaling/calibration is performed using the full ranges of Stokes vectors.

➢ Hence, to estimate any individual star's cluster membership probability we compare the average deviation of the Stokes vectors with these ranges.

4. RESULTS

Using the polarimetric technique, the membership probability of stars of the cluster NGC 1817 and NGC 7380 are calculated:

NGC 1817

NGC 7380

5. CONCLUSIONS

A good correlation is found between this work and previously estimated membership probabilities from proper motion technique. Polarization properties can be effectively utilized to derive membership probabilities. The accuracy and reliability of this method can be further enhanced when combined with additional complementary characteristics, such as independent observational parameters or prior information.
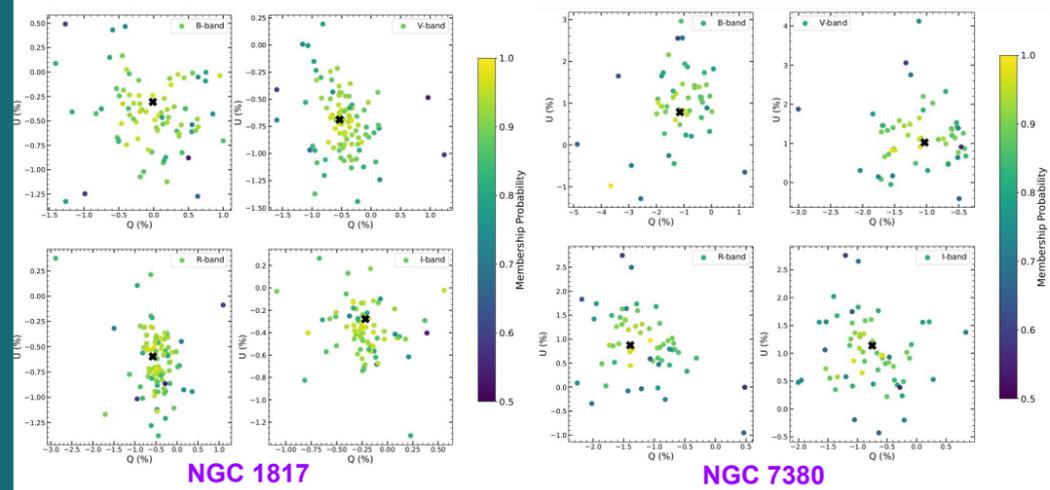
NGC 1817   NGC 7380

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This work
Hunt & Reffert (2023)
Cantat-Gaudin et al. (2018)
Number of stars
Membership Probability