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1. Introduction

Polarization is an important property for the information of interstellar dust grains. Polarimetric observations of starlight through selective extinction by aligned/partially-aligned and asymmetric dust grains present in the general interstellar medium will provide information on the dust's optical properties (Davis et al. 1951) and interstellar magnetic field in the different directions of galaxy. We are performing a systematic directional mapping of polarization properties of open star clusters along anti-galactic direction. For this, we have made a sample of open star clusters in galactic plane (galactic latitude, $b = \pm 15^\circ$) with galactic longitude (l) between 90° to 270° . Here, we present the linear polarimetric observations towards the open star cluster Alessi 1 ($l = 123.26^\circ$ and $b = -13.30^\circ$) in B ($\lambda_{\text{eff}} = 0.44 \mu\text{m}$), V ($\lambda_{\text{eff}} = 0.55 \mu\text{m}$), R ($\lambda_{\text{eff}} = 0.61 \mu\text{m}$), and I ($\lambda_{\text{eff}} = 0.80 \mu\text{m}$) photometric bands.

3. Preliminary Results

3.1. Distribution of Polarization(P) and Position Angle(θ) and Variation of Polarization with distance:

The observed value of P and θ has a wide range with P ranging from 0.5% to 5% in all pass bands. Distribution of P and θ is shown in Fig.1. This shows that there are several foreground and background stars apart from the cluster stars. To get an idea of the distances to the foreground dust concentration, we have also shown degree of polarization as a function of distance in Fig.2. There are only few foreground stars, which shows relatively low value of polarization. Majority of the stars are located between the distance of 0.7-0.8 kpc, which is similar to the distance of the cluster (Alessi et al. 2003). The constant polarization after distance 0.7 kpc indicates that there is a single layer of the polarized source close to 0.7 kpc towards the direction of Alessi 1.

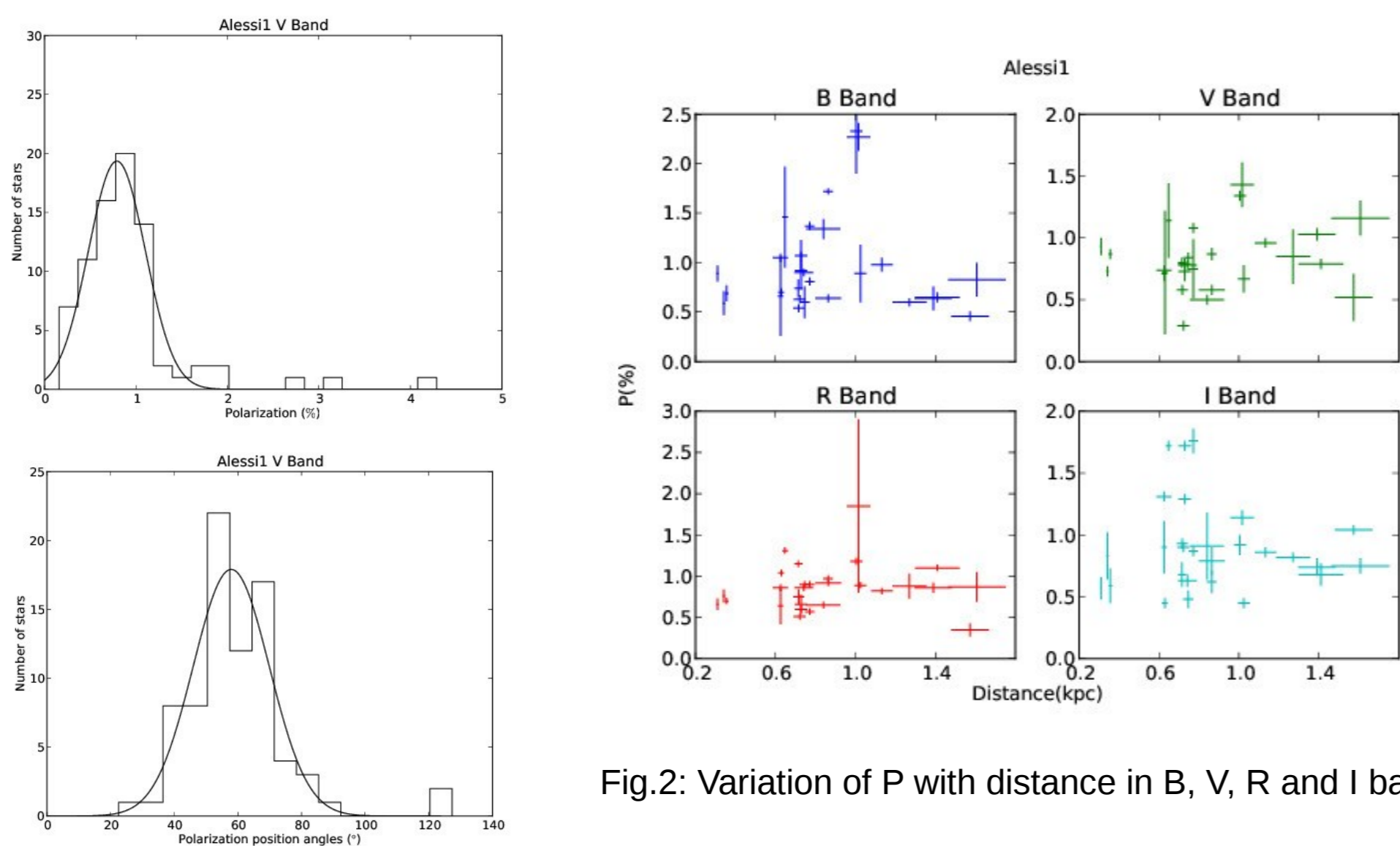


Fig.1: P and θ distribution in V band.

3.2. Q-U plot:

Polarization value of a star depends on the column density of aligned dust grains that lie in front of the stars, hence P value would be similar for cluster member stars. Members of the cluster are showing a grouping in following q-u plots. Around 10 stars in the plot show apparent scattering. Among 10 stars 4 stars are common in each band. This indicates that these stars may not be group members.

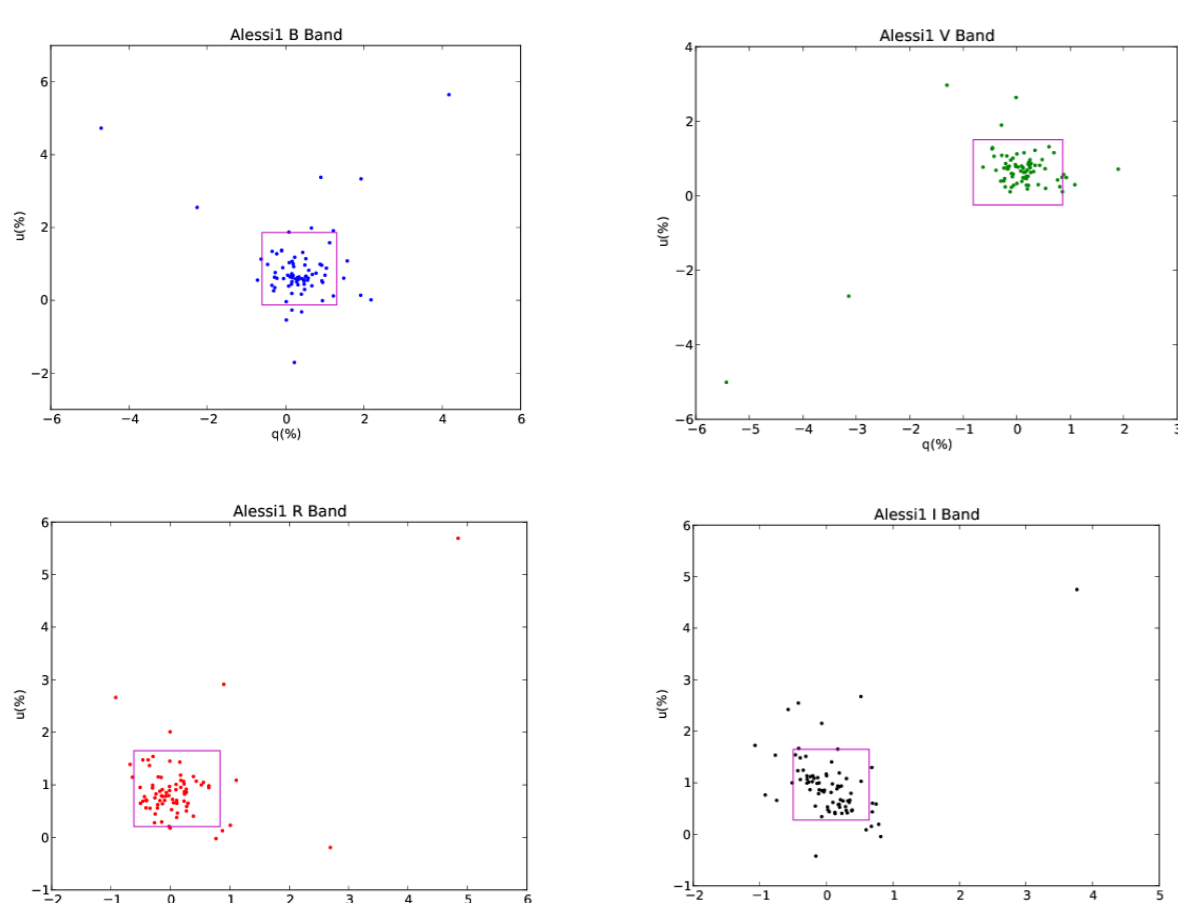


Fig.3: q-u plot for all stars in B,V,R and I bands. In each plot boundary shown by purple lines (1σ line) shows the criteria for members of the cluster.

2. Observations and Data Reduction

The optical polarimetric observations of the cluster Alessi 1 were taken on 22, 23 Nov 2017 from 104-cm telescope of ARIES using AIMPOL (Aries IMaging POLarimeter) as a backend instrument. The telescope is a RC reflector with focal ratio of f/13. The detector used is a TK 1Kx1K CCD camera cooled by liquid-N₂. Observations were done at four positions of HWP ($\alpha = 0^\circ, 22.5^\circ, 45^\circ, 67.5^\circ$). Aperture photometry was performed to extract total counts of ordinary and extraordinary images of the stars. Details about AIMPOL and data reduction are given in Rautela et al. 2004. We have also used data from Gaia Archive for our study.

3.3. Gaia data

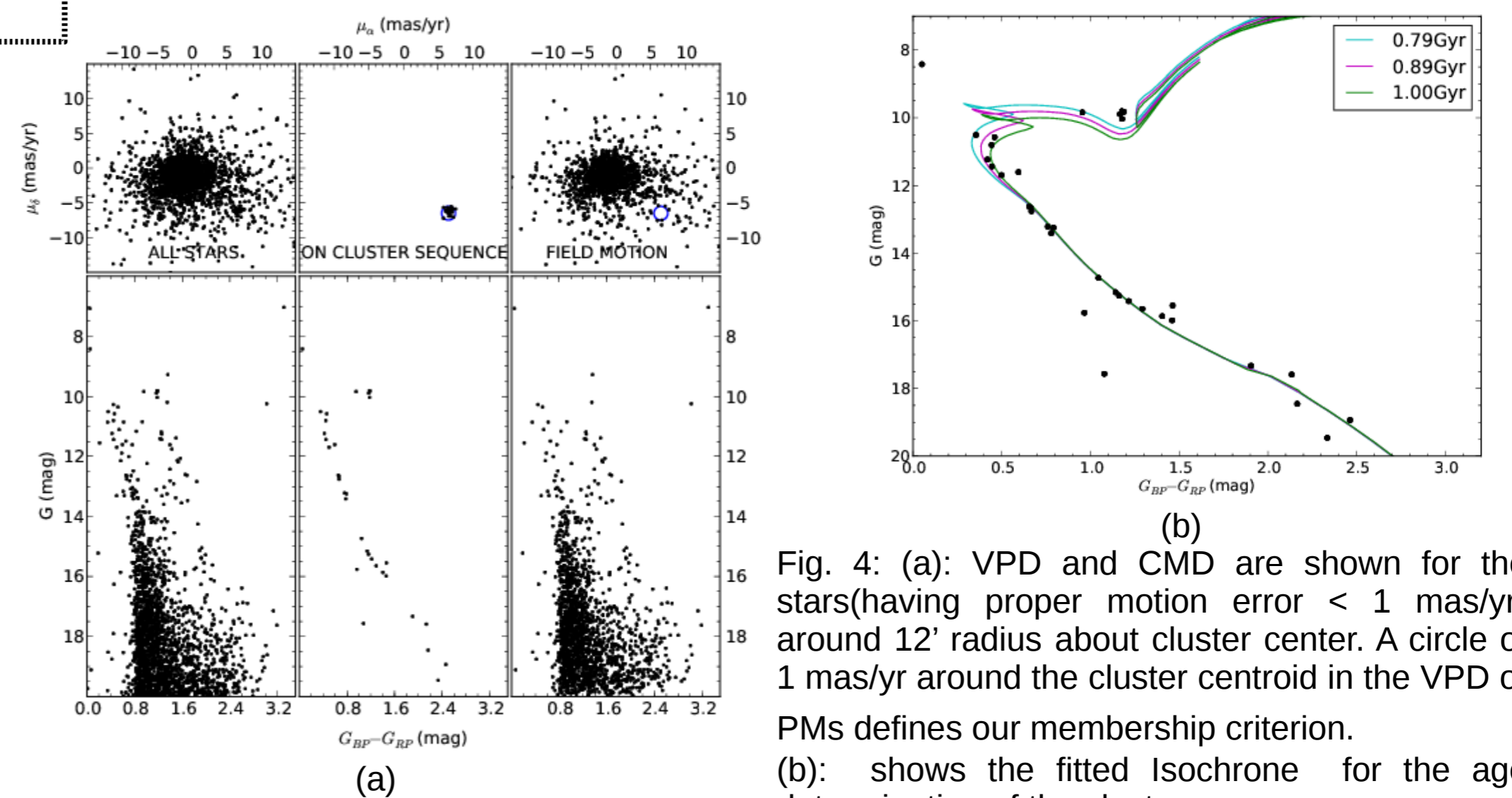


Fig. 4: (a): VPD and CMD are shown for the stars (having proper motion error < 1 mas/yr) around $12'$ radius about cluster center. A circle of 1 mas/yr around the cluster centroid in the VPD of PMs defines our membership criterion. (b): shows the fitted isochrone for the age determination of the cluster.

3.3.1. Cluster membership and Age determination:

By using VPD and CMD, we have separated cluster member stars from field stars. From Fig. 4(a), we have identified 34 stars to be cluster members. Among these member stars, 17 stars were polarimetrically observed and have same value of polarizations. Age of Alessi 1 cluster estimated to be 0.9 ± 0.1 Gyr. Reddening $E(G_{BP} - G_{RP})$ and distance modulus are found to be 0.18 ± 0.04 and 9.5 ± 0.2 mag, respectively. Distance of the cluster thus calculated to be 692 ± 16 pc, which is close to the distance of individual stars in the cluster using Gaia parallax.

3.4. Polarization Vector Plot:

The position angles are measured from the north, increasing eastward. The length of the polarization vectors is proportional to the percentage of polarization. The dashed line in the fig represents the Galactic parallel at $b = -13.30^\circ$. From the Fig. 5, it can be concluded that dust grains are mostly aligned by galactic magnetic field.

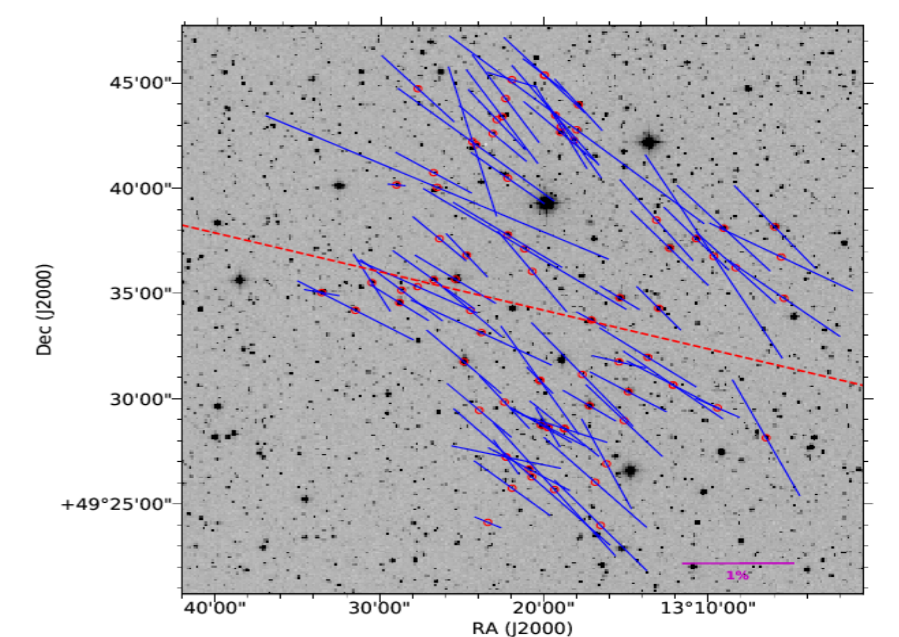


Fig.5: The stellar polarization in V band superimposed on 27×27 arcmin² DSS image of the field containing Alessi 1.

4. Summary

The average values of the polarization for the cluster Alessi 1 are found to be $0.85 \pm 0.39\%$, $0.79 \pm 0.31\%$, $0.89 \pm 0.30\%$, $0.86 \pm 0.30\%$, in B, V, R, and I bands, respectively, whereas the average values of position angles are found to be $53.5 \pm 8.2^\circ$, $57.9 \pm 11.9^\circ$, $60.1 \pm 12.5^\circ$, $54.7 \pm 8.9^\circ$ in B, V, R, and I bands, respectively (including field stars). Polarization towards Alessi 1 cluster is dominated by foreground dust grains. A single layer of polarized source exist at ~ 0.7 kpc close to Alessi 1 cluster. Members of the cluster are extracted by using the Gaia data. Non members stars can also be identified by polarization data (i.e. Q-U plots). Age and distance of the cluster is determined as 0.9 ± 0.1 Gyr and 692 ± 16 pc, respectively. Dust grains are mostly aligned by galactic magnetic field towards the direction of Alessi 1 cluster.

5. References

1. Davis L., Jr, Greenstein J. L., 1951, ApJ, 114, 206
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3. Alessi, B.S., Moitinho, A., Dias, W.S.: 2003, A&A 410, 565