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Broad-band Optical Polarimetric Studies toward the Galactic young star cluster Be59

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ABSTRACT

We present multiwavelength linear polarimetric observations for 69 stars around young open cluster Be 59 region. The observations reveal the presence of three dust layers located at the distances of ∼300, ∼500 and ∼700 pc. The dust layers produce a total polarization $P_V \sim 5.5$ per cent. The mean values of polarization and polarization angles due to dust layers found to increase systematically with the distance. We have further shown that the polarimetry in combination with the $(U-B)-(B-V)$ colour-colour diagram can yield a better identification of cluster members. The polarization measurements of the identified cluster members indicate that the polarization due the intracluster medium is ∼ 2.2 per cent. The two-color-diagrams for the cluster members as well as the mean value of the λ_{max} for the cluster members and foreground stars suggest anomalous reddening law for the cluster region indicating a relatively larger grain size in the cluster region in comparison to those in the diffuse ISM. The spatial variation of the polarization and $E(B-V)$ is found to increase with radial distance from the cluster center, whereas the θ_V and λ_{max} are found to decrease with increasing radial distance from the cluster center. About 40 per cent of cluster members show the signatures of either intrinsic polarization or rotation in their polarization angles. There is an indication that the star light of the cluster members might have been depolarized because of non-uniform alignment of dust grains in the foreground dust layers and in the intra-cluster medium.

Key words: Polarization- dust, extinction - open clusters and associations: individual: Berkeley 59.

1 INTRODUCTION

Interstellar grains are aspherical in nature and, given proper conditions, are aligned in space by the magnetic field (Davis & Greenstein 1951). The effective extinction cross sections of the dust particles are the greatest when the electric vector of the incident light is parallel to the long axes of the dust particles as projected on the plane of the sky, and the least when parallel to the short axes. This differential extinction introduces a small degree of linear polarization in the transmitted light.

Studies of polarization due to the interstellar matter (ISM) are important as these provide information about the properties of the dust associated with the ISM and intra-cluster matter as well as help to trace the Galactic magnetic field. As the grains are thought to align due to the local magnetic field, the observed polarization vectors map the general geometry of the magnetic field. The observed maximum upper limit relation between the degree of the polarization and the color excess $E(B-V)$ is found to be $P_{max} = 9 \times E(B-V)$ (Aannestad & Purcell 1973). The relation between P_{max} and colour excess, and the variation of P with wavelength are interpreted in terms of the grain properties and the efficiency of the grain alignment. Therefore, polarimetry is a useful technique to investigate the properties like maximum polarization $P_{\lambda_{max}}$, the wavelength λ_{max} corresponding to $P_{\lambda_{max}}$ and the orientation of the magnetic field in various Galactic locations.

Polarimetric studies of star-forming regions/young star clusters are specially important because physical parameters such as distance, age, membership and color excess $E(B-V)$ of these regions are known accurately, which consequently helps in analyzing the polarimetric data in a meaningful way. Strong ultraviolet radiation from O/B type stars in these regions have strong impact on the surrounding medium. Dust grains can undergo destruction processes due to direct radiative pressure, grain-grain collisions, sputtering or shattering etc. As a result, it is likely that the mean size of the dust grains could be smaller. The stars associated with the star-forming regions can help to understand the nature of dust as well as the magnetic field of the intra-cluster medium.

Young star clusters (age < 10 Myr), still embedded in the parent molecular cloud, are unique laboratories to understand the dust properties as well as the nature of interaction between young star(s) and the surrounding medium. Berkeley 59 (α = 00h 02m 13s, δ= +67° 25′ 11″; l = 118°.22, b = 5°.00) is such a young star cluster associated with a heavily obscured gas-dust complex of the Cepheus OB4 association. The cluster Be 59, located at