Dust properties and the magnetic field geometry towards Barnard 227

**Abstract:** We present the results based on single and multi-band polarimetric and photometric observations towards a star-less molecular cloud core LDN 1578 (Barnard 227). Using NIR-photometric method by Maheswar et al. (2010), the distance of the cloud B227 is determined as 394±70 pc. Forground dust contribution up-to the cloud minimum distance (≈ 324 pc) is estimated and removed from the observed polarimetric measurements of the stars towards B227, using the polarimetric and distance information of the foreground stars determined in a radius of 10 degree around B227. The obtained magnetic field using the polarimetric informations of 127 stars distributed all over the cloud suggests that the cloud is still under the stage of formation, during which magnetic field could act as a mediator in such a way that the cloud material channelled along the field lines and hence cloud formation would be a very likely event. Observed bend in the magnetic field structure would indicate that the material could be accumulated and condensed towards the core of the cloud. The observed linear polarization structures (evident in Hα and Spitzer images) of B227 along with the magnetic field lines are closely in line with the inferred magnetic field map. Moreover, the high resolution CO observations reveal that the core consists of three sub-structures with slightly different radial velocities and these sub-structures are colliding with each other. Hence the magnetic field orientation is suggested to be closely link with the cloud kinematics, cloud formation and its evolution such as mass accumulation and contraction processes. Multi-wavelength polarimetric observations of nearly 44 stars have been used to study the dust grain properties. The obtained mean value of $\lambda_{max}$ (0.58±0.01 μm), the $R_v$ is found to be 3.3±0.2. Which indicates that the extinction law could be anomalous towards B227, thereby indicating the presence of slightly bigger dust grains. Nearly 140 stars with optical wavelengths have been used to study the dust grain properties. The weighted mean value of $\lambda_{max}$ is found to be 0.58±0.01 μm which is slightly higher than that for the general diffuse ISM. Using the relation $R_v = (5.6 \pm 0.3)\lambda_{max}$ (Whittet & van Breda 1978) and the obtained mean value of $\lambda_{max}$, the size of the dust grains towards B227 can be estimated. The biggest dust grain sizes could be because of the dust grain growth due to accretion and coagulation processes. Hence the magnetic field orientation is suggested to be closely link with the cloud kinematics, cloud formation, and finally the star-formation. And observations are indeed essential to compare, support and re-develop more accurate and refined models of cloud formation and star-formation. The authors also suggest that the magnetic field orientation is determined as 394±70 pc to B227.

**Motivation:**

Now it has been recognized that the magnetic fields plays an important and perhaps crucial role in the formation, evolution, content and kinematics of molecular clouds and in the star formation processes (e.g., Gaitskell & Spitzer, 1976; Lada, 2003; Brauweiler & Feinman, 2000; Kandeb et al. 2008).

A study of magnetic field geometry of the molecular cloud in relation with other properties like star distribution, kinematics, and alignment of bipolar outflows that may be present in the cloud, can give great insight into the role played by the magnetic field in shaping the molecular cloud and its properties (Kandeb et al. 2008).

Below one of core collapse, core growth should be achieved. In the MHD, a turbulent cloud forms multiple cores that are linked together by elongated structures known as filaments (Whitworth & King 2004). Because the cloud is instant and contains magnetic field, the core trajectories will be affected by the magnetic field of magnetic filaments as well as filaments of matter. The filaments serve to funnel matter down into the cores. In this way, the cores grow.

Balbus, Whitworth & Cruikshank (2010) state that material accreting on to the cloud is channelled along the filamentary structure. They proposed that this mechanism of accretion along filaments may provide a means for molecular cloud cores to give rise to the protostars by the gravitational collapse and core formation. This is in conflict with recent observations of T Tauri stars and their close relationships with protostellar filaments (McKee, Tielens & Goldsmith 2007).

It is argued by many researchers that, unlike the magnetic fields, the protostars are very strong, so that flows are channelled completely along the field lines, cloud evolution can be described as a regime of mass condensation/accretion onto the cores and finally the first generation of stars will form under the influence of gravity and turbulence.

In the presence of gas flow by construction, it is not possible to understand the formation, evolution of molecular clouds and finally the star-formation. And observations are indeed essential to compare, support and re-develop more accurate and refined models of cloud formation and star-formation. Hence the magnetic field orientation is suggested to be closely link with the cloud kinematics, cloud formation, and finally the star-formation. And observations are indeed essential to compare, support and re-develop more accurate and refined models of cloud formation and star-formation.

The observed magnetic field vectors of the stars lying in the background of the B227 and high dust density regions of our line-less cores will be unique targets (a) to study the dust grain properties as well as (b) to map the orientation of magnetic field within these objects in much the same way played by the magnetic field in controlling the velocity, mass accumulation and its contractors, formation of clouds, core and the star-formation.

**Theme:** We present a study by a photographic data (B227) in the star-less molecular cloud core LDN 1578 (Barnard 227) to investigate the properties of the dust grains within the cloud and to map the magnetic field by observing the back ground stars distributed all over the cloud. For this purpose, we have carried out optical polarimetric (using SIMBAD, and HIP PARALLAX) and photometric observations using SIMBAD. We have also performed linear polarimetric and photometric observations at B227. The presence of magnetic field has been confirmed by using linear polarimetric and photometric data. From the observations of the B227, we have determined a distance of 394 ± 70 pc to B227. The effect of foreground dust polarization was determined using the two-color-diagram of the form (V−I)/(B−V) where V is one of the broadband-filter (1, H, or J). The observed lengths of DC and magnetic field lines were weighted mean value of λ_{max} at 3.3±0.2. With the error, the value is quoted 0.58±0.01 μm.

**References:**

5. Dobashi et al. (2005) 2.5 ×1.5 degree2 extinction map produced by Dobashi et al. (2005) containing B227 is shown with the fields F1-F3, each covering 1.5 degree2. The solid curve connecting the points on the extinction map is the best fit of the observations. The distance of the cloud B227 is determined as 394±70 pc. Forground dust contribution up to the cloud minimum distance (≈ 324 pc) is estimated and removed from the observed polarimetric measurements of the stars towards B227, using the polarimetric and distance information of the foreground stars determined in a radius of 10 degree around B227. The effect of foreground dust polarization was determined using the two-color-diagram of the form (V−I)/(B−V) where V is one of the broadband-filter (1, H, or J).

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**Figure Legends:**

- Fig 1: The J vs. (H-K) GC diagram shows data for stars (with A = 0). The solid line is the fit to the data using the method of Maheswar et al. (2010) to determine the distance. The solid curve represents the data for B227 using the method of Maheswar et al. (2010) to determine the distance.
- Fig 2: Polarization vectors of the stars lying in the background of the B227 and high dust density regions of our line-less cores will be unique targets (a) to study the dust grain properties as well as (b) to map the orientation of magnetic field within these objects.
- Fig 3: The radial variation of the observed stars {u, v} from the field-star (B227) to investigate the properties of the dust grains within the cloud and to map the magnetic field by observing the back ground stars distributed all over the cloud. From the above procedure, we determined a distance of 394 ± 70 pc to B227.