PROCEEDINGS

RECENT TRENDS IN BASIC SCIENCE RESEARCHES (RTBSR: 2017)

ज्ञान-विज्ञान विमुक्तये

Under the aegis of
University Grants Commission (NERO)

Organized by
Department of Physics and Chemistry
Srikishan Sarda College, Hailakandi,
Assam, 788151

Editors

Dr. Rupam Sen
Debasish Guha Thakurata
Dr. Subha Gaurab Roy

RECENT TRENDS IN BASIC SCIENCE RESEARCHES
(RTBSR: 2017)

Editors

Dr. Rupam Sen
Debasish Guha Thakurata
Dr. Subha Gaurab Roy

ज्ञान-विज्ञान विमुक्तये

Under the aegis of
University Grants Commission (NERO)

Organized by
Department of Physics and Chemistry
Srikishan Sarda College, Hailakandi,
Assam, 788151

Published By
Department of Physics and Chemistry, S. S. College, Hailakandi, Assam

ISBN: **978-81-933690-0-5**

Price: **Rs. 300.00**

Edited By
Dr. Rupam Sen; Debasish Guha Thakurata; Dr. Subha Gaurab Roy; Chitrajit Malakar

Printed at
M's Atelier
Thana Road, Karimganj

CONTENTS

Extinction map of a large globule CB 3

Ajoy Barman*[1] and Himadri Sekhar Das[1]

[1]*Department of Physics, Assam University, Silchar-788011 (India)*

**Email id: ajoy2bar@gmail.com*

Abstract

In this work, we have constructed the visual extinction map of a globule CB 3 for the first time using the Near Infrared Color Excess (NICE) method. This globule is very massive and is a region of intermediate star formation. CB 3 is associated with a sub-millimeter source (SMM1), an IRAS source, two young stellar objects and 22 near-infrared (NIR) sources. The NICE method determines the visual extinction from the NIR color excess measurement and maps the dust column density through a dark cloud. Three extincted cores ($A_V \sim 11$) near the center of the globule are detected in the visual extinction map. The central hydrogen column density is estimated to be ~ 10^{22} cm^{-2}, whereas the density in the low-density regions is given by 1.24×10^{21} cm^{-2}.

Keywords: Molecular cloud, Near Infrared Color Excess (NICE) technique, Visual extinction map.

1. Introduction

In a molecular cloud, H_2 is the most abundant molecules. By mass, H_2 contributes up to 63%; Helium amounts to 36% and about 1% of the mass consist of dust [1]. Measurement of dust extinction of background field stars in a molecular cloud in the near infrared (NIR) wavelengths, where dust obscurity is low, directly show a measure of the dust content of the cloud. Lada et al. [2] developed Near-infrared Color Excess (NICE) method to study the dust distribution and the hydrogen column density. Later, this method was modified by Lombardi& Alves [3] and Rowles & Froebrich [4] Recently, extinction maps of CB 224 [5], CB 130 [6] and CB 34 [7] have been constructed to study the dust distribution in the clouds.

2. The globule: CB 3

CB3 is a very massive globule and is a site for intermediate star formation [8-9]. This is the only globule which is located outside the local arm but at the near side of 'Perseus' arm {10]. The distance of this globule was first estimated by [10], which is 2.5 kpc. This is the most distant object among all 59 globules considered by them in the list. Later, Piehl et al. [11] obtained the distance of this globule to be 969±112 pc, based on *uvbyβ* photometry of 16 stars located in the periphery of CB 3. It is evident that a distance of about 1 kpc would place the cloud within the local arm. This cloud is alternatively known as LBN 594 [12] which have an angular size of 6.7 × 5.6 arcmin [13]. CB3 is associated with two young stellar objects, one of which is a Class 0 source [14] driving an active bipolar molecular outflow [8]. It also contains an IRAS source 00259+5625, having the luminosity of ~ 930 $L_\odot$ [8] and a water maser source [15]. CB 3 has one sub-millimeter core (SMM1) which have a mass of $40M_\odot$ [16]. Huard et al. [16] also estimated the total mass of the cloud to be ~ 150 $M_\odot$ which also includes the mass of SMM1. This estimation of mass is consistent with the previous measurement based on $C^{18}O$ and H_2CO [17] as well as CS molecular line observations by Launhardt et al. [18]. Huard et al. [16] found 22 near-infrared (NIR) sources in the sub mm maps when they included deep NIR

Extinction measurement of the globule CB34 using the Near-infrared Photometry

Arup Das*[1] and Himadri Sekhar das[1]

[1]*Dept. of Physics, Assam University, Silchar, India*

**Email id: dasarup4@gmail.com; hsdas13@gmail.com*

Abstract

The Near-Infrared (NIR) photometric technique is an excellent tool to determine the visual extinction from measurement of NIR color excess (NICE) and also to map the dust column density of the star forming clouds. In our work, the visual extinction map of a large globule CB34 has been constructed using the NICE method. We have collected the *J, H* and *Ks* magnitudes of all field stars from the 2MASS Point Source Catalog in regions of $25' \times 25'$ centered on the globule CB34. The average extinction in the low density region can be estimated which is given by ≈1.80 mag.

Keywords: Molecular cloud, Near Infrared Color Excess (NICE) technique, Visual extinction map.

Introduction

The dust grains play a vibrant role in dimming the starlight on its way to the observer. This dimming caused due to absorption or scattering of background starlight with the grains and is named as Interstellar extinction. Interstellar extinction depends upon the wavelength of the light. The extinction of background stars depends on the size, composition as well as internal distribution of the dust particles within the molecular cloud. The extinction measurement to the star light gives useful information to the properties of dust particles that play a vibrant role in star formation processes [2].

The study of molecular clouds for the stellar evolution is necessary to understand the star formation process. To determine the structure of a molecular cloud, the variation of column density across the cloud need to be estimated. Measurement of extinction using near-infrared color excess technique is also an important tool to determine the column density distribution of the molecular cloud. The measurement of extinction at NIR wavelengths can be done by using color excess techniques (e.g. NICE, NICER & NICEST) [5-6, 10, 3-4]

Extinction measurement

Measurement of extinction (A_V) is represented by the following extinction law [10]:

$$A_V = \frac{5.689}{2}\left(A_{H,<J-H>} + A_{H\,<H-K_S>}\right)$$

where, $A_{H,<J-H>} = \frac{<J-H>}{\left(\frac{\lambda_H}{\lambda_J}\right)^{\beta} - 1}$ or $A_{H,<H-K_S>} = \frac{<J-H>}{1-\left(\frac{\lambda_H}{\lambda_J}\right)^{-\beta}}$

This is the extinction in the H-band. Here, <J - K> and <H- Ks> are the color excess.

Study of the magnetic field geometry of a globule CB17 using both optical and sub-millimeter polarimetry

Gulafsha B. Choudhury*[1], Ajoy Barman[1], Himadri S. Das[1], B. Indrajit Sharma[1] and Biman J. Medhi[2]

[1]*Department of Physics, Assam University, Silchar-788011 (India)*

[2]*Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital 263129, (India)*

**Email id: gulafsha.97@gmail.com*

Abstract

In this paper, we present the results obtained for a small globule CB17 from both optical polarimetry and sub-millimeter polarimetry. The polarimetric observations of CB17 in the R-band are conducted from 1.04-meter Sampurnanand Telescope, ARIES, Nainital, India on 9th March 2016, whereas the sub-millimeter polarimetry data is taken from data archive which has been reanalyzed. The objective of this study is to map the orientation of the plane-of-sky magnetic field of the globule. In optical range, the offset in the orientation of the local magnetic field of the cloud with that of the galactic magnetic field is found to be 21^0 whereas in sub-millimeter range the same is found to be 69^0. The orientation is different in sub-millimeter range because the dynamics of the core of the cloud is different from that of its periphery. Through optical, we trace the magnetic field structure on large scales of 10^4-10^5 AU, thereby combining with archival sub-millimeter observations to scale the magnetic field structure on small scales of 10^3-10^4 AU.

Keywords: ISM: clouds · Polarization · ISM: magnetic fields

1. Introduction

The formation of stars in our galaxy is as a result of collapse and fragmentation molecular clouds. Bok globules, being the simplest, isolated molecular clouds (dark clouds) in our Milky Way galaxy are the ideal suitable sites for the low mass star formation [1]. Bok Globules are small, opaque and relatively isolated molecular clouds with diameters of about 0.7 pc (0.1-2 pc), temperatures 10-15 K and masses of $\approx 10M_\odot$ (2-$100M_\odot$) [2]. Optical polarimetric observation of these clouds can give the information about the magnetic field orientation in the low-density edge region of the clouds. However the polarimetric observations in IR and sub-millimeter range can range the magnetic field orientation in the higher density central region of clouds [3-9]. Previously, our group performed the optical and sub-mm polarimetric study of CB34 [10] and CB130 [11]. [10]observed two submm cores C1 and C2, and they estimated the magnetic field strength of these two cores to be 34μG and 70μG.

The study of magnetic fields is important as it plays a major role in the evolution of globules and may control the fragmentation of clouds to form stars [12-13]. A better understanding of the star formation process can only be achieved by studying the detailed properties of cores and their surroundings at different evolutionary stages[14]. In this paper, we present the optical and sub-millimeter polarimetric data analysis of the globule CB17. The sub-millimeter continuum maps show mainly the dense cores, which often consist of central condensations and their envelopes. The central condensation can just represent the central dense and warm part of the protostellar core, or an embedded unresolved circumstellar disk [15]. The description of CB17 is presented in Table-1.

Polarimetric study of the dark cloud CB26

Prithish Halder*[1], Ayesha Maryam Mazarbhuiya[1], Himadri Sekhar Das[1] and Biman J. Medhi[2]

[1]*Department of Physics, Assam University, Silchar, 788011*

[2]*Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital 263129, India*

**Email id: prithishh3@gmail.com*

Abstract

In this article, we report the optical polarimetric observations of a Bok globule CB26 which is a small cometary shaped molecular cloud located~10° north of the Taurus/Auriga dark cloud. We study the nature of magnetic field structure in the low-density region of the molecular cloud. The optical polarimetric measurements indicate that the direction of the local magnetic field of the cloud is aligned with the plane of the galactic magnetic field. The mean value of the degree of polarization and the position angle of polarization obtained from the data reduction are p_{avg}=3.013% and θ_{avg}=148.3° respectively.

Keywords: Bok globule, clouds, polarization, magnetic field.

1. Introduction

Bok globules are the most suitable portions in the sky for the study of low mass star formation, and these objects can provide valuable information on the earlier processes of star formation. The structure of a molecular cloud is subdivided into clumps, observed in CO. These clumps have characteristic masses ~10^3-10^4 $M_\odot$, radii ~2-5 parsec, temperature of ~10 K, mean number density of H_2 ~10^2-10^3 cm^{-3} and magnetic field ~3 × 10^5 G. The core of a cloud is the high-density region embedded in clumps, which is observed in NH_3, CS, and other molecules. The core has a typical size of ~0.05-0.1pc, temperature 10K, and density ≈ 10^4-10^5 cm^{-3}. The mass of the core ranges from 1 to a few $M_\odot$, although a few range up to 1000 $M_\odot$. A low density envelope of dimension ≈ 10^4-10^6 AU surrounds the clumps [1].

The magnetic fields play an important role in the collapse dynamics of a cloud by mediating accretion, directing the outflows and collimating jets [2] [3]. The shape of cloud fragments, the contraction timescale and the gas-dust coupling are also influenced by the local magnetic fields of the cloud [4]. The dust grain alignment helps to map the magnetic fields of the molecular clouds [5] [6]. As result of selective extinction, the light from the background stars are linearly polarized by a cloud of dust grains which are aligned with their minor axis parallel to the local magnetic fields. Consequently, the magnetic field can be detected through optical polarimetry in the low-density regions of molecular clouds. Complementary to this, the thermal reemission of aligned grains located in the high-density central region of molecular clouds is linearly polarized perpendicular to the magnetic field direction and can thus be studied through submillimeter polarimetric measurement. Numerous studies have been made on molecular clouds through optical and submillimeter polarimetry [7] [8] [9] [10] [11] [12] [13] [14].

In this study, we have depicted the polarimetric observation of a small cometary-shaped Bolk globule CB 26, located~10° north of the Taurus/Auriga dark cloud. [15] suggested a distance of 300 pc. From a re-examination of the larger scale velocity structure [16], it is believed to be a part of the Taurus/Auriga complex at 140 pc.

Imaging Polarimetry of the dust coma of some comets at small phase angles

Parizath Deb Roy*[1] and Himadri Sekhar Das[1]

[1]*Department of Physics, Assam University, Silchar - 788011, India*

**Email id: pari.hkd@gmail.com*

Abstract

We present optical polarimetric observation of some recent comets which were performed from the year 2012 – 2014 from IUCAA Girawali Observatory (IGO). Pune and Aryabhatta Research Institute of Observational Sciences (ARIES). Nainital at small phase angles. The observations were carried out with the 2-m telescope of IGO and the 1.04-m ARIES Sampurnanand Telescope using an R-photometric band. The polarization maps by CCD polarimetric technique for the observed four different comets is being obtained to enhance the special structures (like jets or arcs) in the cometary coma. The polarization map derived offers the spatial resolution of the inner coma of the comet and enhance the circumnuclear halo of the comets. The variation in the dust physical properties of the cometary dust are being thoroughly studied for the four observed comets in all possible directions to get a complete physical picture of the asymmetric coma of the comets at small phase angles.

Introduction

Comets are icy bodies of the solar system spend most of their life span at far away from the sun hence their subsurface materials are thought to be primordial. The activity of the comets depends on the heliocentric distance, and its apparent size is a function of the distance to the earth. The physical properties of the dust grains present in the extended coma of the comet varies from one comet to the other and one regions to the other regions of the coma. Linear polarization derives the dust grain characteristics and the physical evolution of dust grains. Comets are known to have a high degree of polarization due to the scattering of sunlight from the cometary dust.

Comet polarization in the continuum is the best technique to understand the physical properties of the dust grains present in the cometary coma. The average polarization on the whole coma infers the dust particles bulk physical properties. The degree of polarization of cometary dust varies with the distance from the photocenter at a particular phase angle and wavelength. Several investigators explore the physical properties of cometary dust through linear polarization measurements and numerical simulation [1-8]

In this paper, we will explain the polarimetric observation and the analysis of the four different comets observed in recent years. We will report the review of the polarization feature of the comets and the physical evolution of the dust grains present in the extended coma of the comet observed at lower phase angle in the different sections of the paper.

Observations and Data Reduction

We have observed four different comets with the help of 2-m telescope of IUCAA Girawali Observatory and 1.04-m ARIES Sampurnanand Telescope at small phase angles. The IUCAA Faint Object Spectrograph and Camera (IFOSC) were used as a focal plane instrument for the polarimetric observation carried out from IUCAA, Pune. The 2K X 2K CCD camera of IUCAA used for the polarimetric observation have an effective field of

A study of the distinctive behaviour of dust grains in a rotating plasma sheath

Jaydeep Paul[1], Apratim Nag*[2] and Himadri Sekhar Das [3]

[1]*Department of Chemistry, Gurucharan College, Silchar, Assam-788004, India*

[2]*Department of Physics, Gurucharan College, Silchar, Assam-788004, India*

[3]*Department of Physics, Assam University, Silchar-788011, India*

**Email id: apratimnag@gmail.com*

Abstract

A study of the sheath characteristics in plasma rotating with a uniform angular velocity about an axis making an angle with the direction of plasma-acoustic wave propagation has been made. Contrary to the earlier observations on sheath in simple plasma, this paper considers the interaction of slowly rotating dusty plasma contaminated with the dust charging effect. The motivation here lies in the fact that the Coriolis force generated from rotation has a tendency to produce an equivalent magnetic field effect as and when the ionized medium rotates. The ubiquitous presence of dust in every plasma environment motivates the study of charged dust grains levitated into the rotating plasma sheath. In the study, calculation of dust grain size, surface potential generation and the net forces acting on it inside the sheath have been carried out for some chosen laboratory parameters.

Keywords: Sheaths, Coriolis force, Sagdeev potential equation.

Introduction

The formation of sheath in plasma has been one of the most fascinating phenomena involving nonlinear plasma dynamics. When plasma is in contact with a negative wall, as a consequence of the different mobility of electrons and ions, the negative wall repels the electrons while the ions are attracted towards the wall. This results in the formation of a thin layer of positive space charge at the wall. This non-neutral layer, with thickness of few Debye lengths, is called plasma sheath [1-3]. In spite of the fact that unraveling the sheath is one of the oldest problems in plasma physics, yet this field still continues to draw the interests of the plasma physics community because of its practical importance in plasma dynamics[4-11].

Over the last few decades, electronegative plasma sheaths have found extensive use in many areas such as material surface treatment, etching and thin-film deposition processing, and plasma chemistry. As a result, the investigation of electronegative plasma sheaths is considerably significant [12,13].

Quite a number of studies [8-11] have been conducted to analyse the importance of the plasma sheath in the presence of magnetic field. However, the physics of the magnetized plasma sheath is still not flawlessly understood. Chodura [14] is credited with the introduction of a hydrodynamic model for semi-infinite plasma, which is valid for an oblique magnetic field to the wall, without taking into account the effect of ionization and collisions. Khoramabadi *et al.*[15] have conducted a study of the ion temperature effect on magnetized dc plasma sheath. Their study has revealed that the ion temperature strongly affects the sheath properties, i.e., an increase of the ion

Imaging Polarimetry of Comet C/2015 V2 (Johnson)

Ayesha Maryam Mazarbhuiya*[1], Prithish Halder[1], Himadri Sekhar Das[1] and Biman J. Medhi[2]

[1] *Department of Physics, Assam University, Silchar 788011, India*

[2] *Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital, 263129, India*

**Email id: ayesha.hkd@gmail.com*

Abstract:

In this paper, we present the optical imaging polarimetric observation of comet C/2015 V2 (Johnson) at low phase angle 21.6°. The observation of this comet was performed with the 1.04-metre Sampurnanand telescope of ARIES near Nainital in India on 30th December, 2016 using R photometric band (λ= 630 nm, $\Delta\lambda$=120 nm). We have observed the variation of polarization value with the increase of aperture radius. The variation of degree of polarization with photocentric distance indicates that the physical properties of cometary dust of this comet differ in both inner and outer region. We have observed that on increasing aperture radius, negative polarization decreases gradually. The average polarization is estimated to be -0.686%. Also the decrease in intensity with a gradual increase in distance from the photocenter is being observed in both the solar and antisolar directions. The intensity is higher in the solar direction as compared to the antisolar direction and a diffuse coma is observed in the antisolar direction due to the sublimation of ice, rocks by solar radiation pressure.

Key words: negative polarization - cometary dust - diffuse coma.

1. Introduction:

The polarization in comets is mainly caused by scattering of solar radiation by cometary dust grains and by the fluorescence emission of cometary gas molecules. The polarization mainly depends on the phase angle, the wavelength of the incident solar light, the size, shape and the composition of dust particles present in the extended coma of the comet.

Imaging polarimetry is an important tool to study the physical properties of cometary dust grains. The optical polarimetric observation of comets at different phase angles and wavelengths visualize the actual nature of the dust particles present in the coma of the comet. Imaging polarimetry reveals the realistic characteristics of the dust population of any comet. The intensity and polarization profile drew from the imaging polarimetry also plays a significant role in understanding the various physical evolutions going in the cometary coma [1-4]. The jet feature of the comet which is the signature of the active comets can also be derived from the imaging polarimetry. It possess a high degree of polarization as compared to the other specified regions of the cometary coma.

Polarimetric study of comets at large phase angles are numerous but there is a lack of observations made at small phase angles. Observation of comet at lower phase angle is a typical task comet is expected to be far off in the sky and appears as a faint object at such phase angle. Observations at small phase angles characterize the size, external and internal structure of the particles [5]. One of the important features observed in comet is the negative polarization feature. The origin of negative polarization and its phase angle