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Magnetic Field Structure in Molecular Clouds by Polarization Measurements

W. P. Chen[1], B. H. Su[1], C. Eswaraiah[2], A. K. Pandey[2], C. W. Wang[3], S. P. Lai[3], M. Tamura[4] and S. Sato[5]

[1]Graduate Institute of Astronomy, National Central University, Taiwan
[2]Aryabhatta Research Institute of Observational Sciences, India
[3]Graduate Institute of Astronomy, National Tsing Hua University, Taiwan
[4]National Astronomical Observatory of Japan, Japan
[5]Department of Astrophysics, Nagoya University, Japan

Abstract. We report on a program to delineate magnetic field structure inside molecular clouds by optical and infrared polarization observations. An ordered magnetic field inside a dense cloud may efficiently align the spinning dust grains to cause a detectable level of optical and near-infrared polarization of otherwise unpolarized background starlight due to dichroic extinction. The near-infrared polarization data were taken by SIRPOL mounted on IRSF in SAAO. Here we present the SIRPOL results in RCW 57, for which the magnetic field is oriented along the cloud filaments, and in Carina Nebula, for which no intrinsic polarization is detected in the turbulent environment. We further describe TRIPOL, a compact and efficient polarimer to acquire polarized images simultaneously at g', r', and i' bands, which is recently developed at Nagoya University for adaption to small-aperture telescopes. We show how optical observations probe the translucent outer parts of a cloud, and when combining with infrared observations probing the dense parts, and with millimeter and submillimeter observations to sutdy the central embedded protostar, if there is one, would yield the magnetic field structure on different length scales in the star-formation process.

We present near-infrared JHKs imaging polarimetry of RCW 57A (NGC 3576) and the Carina Nebula (NGC 3372), both among the the brightest Galactic H II nebulae, with a wealth of massive stars and infrared excess stars, suggestive of recent and ongoing star formation. By measuring the polarization of background stars seen through the molecular clouds, the magnetic field structure in the clouds can be diagnosed. In the central part of the Carina Nebula, around Eta Carina where a cavity has been created, only a moderate level of polarization is measured, mainly by the general Galactic magnetic field. In contrast, in RCW 57A, which is associated with copious molecular clouds, we infer an hour-glass shaped field that governs the cloud morphology.

An optical imaging polarimeter has been recently acquired at Lulin Observatory. The Triple-Range Imaging Polarimeter (TRIPOL) uses dichroic mirrors to split the beam into three SBIG ST-9XE camera detectors and a wire-grid polarizer, providing an efficient, flexible, compact, and economic solution for polarization measurements with small telescopes. The ST-9XE camera uses has 512 20-micron pixels on a side, rendering a field-of-view of 4.4 arcmin when adapting to the 1-m telescope. We show a variety of TRIPOL measurements of T Tauri stars, classical Be stars, AGNs, and solar system bodies, along with polarized and unpolarized standard stars. A few Bok globules have been observed to delineate the magnetic field geometry in the periphery of a cloud, which will be corroborated with infrared results to probe the inner part of the cloud, and with submillimeter data to study the field structure close in to the embedded protostar.