The Scattering of Hα Emission Associated with the Rosette Nebula in the Monoceros Region Studied Using Polarimetry

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ABSTRACT

Polarimetric CCD images of HII regions were obtained using a rotating polarizer device designed, built, and used in conjunction with the Spectral Line Imaging Camera (SLIC) at Virginia Tech's Martin Observatory in Giles County, Virginia. The SLIC uses a narrow bandpass interference filter coupled with a 58 mm camera lens and cryogenically cooled CCD camera to image diffuse, extended Hα emission over a 10° angular extent. A rotating polarizer device was placed in front of the Hα filter with images recorded at every 45° with respect to a fiducial setting. Stoke's parameters I, Q, and U were obtained and polarization maps of selected HII regions were created. Maps of the Monoceros supernova remnant and the Rosette Nebula (NGC 2237-9) were made in an attempt to detect polarization by selective extinction in Hα light. While this was not detected, polarization by scattering in a dust shell around the Rosette Nebula (NGC 2237-9) was observed.

Scattered continuum light from the central star cluster NGC 2244 in the Hα bandpass was ruled out. Using Celnik's (1985) map of extinction across the Rosette Nebula at the Hα wavelength, coupled with Serkowski's empirical relationship between maximum polarization and color excess, it was shown that the maximum degree of polarization seen in the Rosette Nebula should be no more than 3% to 4%. The polarization observed in this project reaches values as high as 10%. It was found that a correlation exists between the Hα intensity and infrared emission by dust grains in all four IRAS waveband images in the suspected scattering region of the Rosette Nebula. A radial comparison between [SII] images and Hα images in the region of high polarization showed that the Hα intensity in that region is dominated by scattered Hα light from the Rosette Nebula.

A single scattering model was constructed in an effort to predict the observed polarization. The model used parameters based on 21 cm observations by Kuchar and Bania (1993) of the HI shell which surrounds the HII region of the Rosette Nebula. The single scattering model can not accurately predict the degree of polarization. It was concluded that a multiple scattering model is required. A spatial comparison of the 12μm emission with the degree of polarization strongly suggested that multiple scattering is important in describing the observed radial behavior of polarization.

Polarization images of regions in Cygnus were obtained. A polarization map of the North America Nebula (NGC 7000) and surroundings reveals a large amount of polarization. The map reveals that scattering of Hα light from the North America Nebula is the most likely cause of polarization in these images.

From the analysis in this thesis, I conclude that in the northwest quadrant, at radial distances greater than $\sim 40'$ from the center of the Rosette Nebula, the observed Hα intensity is due to scattered Hα light from the nebula itself. This implies that, in Hα, the Rosette Nebula appears slightly larger than it actually is. With evidence of polarization by scattered Hα supported by the polarization map of the North America Nebula (NGC 7000), it is concluded that other HII regions may very well appear larger in Hα than they actually are. Thus, scattered Hα light may account for a small part of the more extended warm ionized medium as well.

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This dissertation is dedicated to my father who did not live to see its completion.

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