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High resolution interferometry of astrophysical objects

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The thesis comprises the studies on two distinctly diverse astrophysical situations; one on the outer envelope of a late-type star at its main sequence stage (solar corona) while the other on the ionized cloud surrounding an early-type star at its formation stage (the HII region—Orion Nebula). The following problems are addressed in the work; the nature of velocity fields in the solar corona and its relations to local magnetic fields and the phase of the solar cycle, the excitation mechanism of the coronal green line and its variations in different coronal regions and the kinematics of an HII region in the farthest regions from the ionizing star. The observations on the solar corona were carried out by the PRL group during the total solar eclipses of 1980 and 1983, using Fabry-Pérot interferometric techniques and coronal photography in the emission lines [Fe XIV] 5303 Å and [Fe X] 6374 Å (Chandrasekhar 1982; Desai & Chandrasekhar 1983). The velocity fields in the corona were studied by a detailed analyses of the line profiles obtained from the eclipse interferograms. The excitation mechanism of the coronal green line was found out from the line to continuum intensity ratios derived from filter and white light photographs of the solar corona obtained during the 1980 total solar eclipse. The spatial variations of the excitation mechanism in the magnetic and non-magnetic regions were calculated from a model of solar corona and were compared with the observed values. An observational study on the kinematics of Orion Nebula was carried out in the emission line [SII] 6731 Å, which is predominant in the ionization front in the Nebula.

The important results are briefly described below.

(1) The study indicated that the corona can be viewed, as made up of, an ambient plasma medium with embedded discrete moving components associated with the coronal structures such as coronal loops. A detailed analyses of the emission line profiles showed the presence of strong velocity fields in the 1980 solar maximum corona. The 1983 epoch, which was at a declining solar activity phase, showed the presence of only weak velocity fields. It was also found that velocity fields are strongly correlated with the magnetic structure of the solar corona. The velocity associated with the coronal structures is mainly the velocity of plasma motions inside the coronal loops which were found to show a considerable range (0-100 km s^{-1}). The line of sight velocities associated with the interferogram fringes in the 1980 corona were found to increase with the coronal height which was mainly observed in the coronal active regions. The result was found to be consistent with the model of subsonic siphon flow of plasma along the coronal flux tubes (Cargil & Priest 1980). A large excess of blue shifted components were seen in the 1980 coronal line profiles which implies that the direction of motion of the plasma in coronal flux tubes is mostly directed towards the

observer, at the solar maximum phase of 1980. In active regions many coronal loops were found whose kinetic temperature is much below (less than 10^6 K) than that of the ambient coronal plasma (2×10^6 K). This result agrees with the finding of Foukal (1975) who reported the existence of low temperature plasma at coronal heights.

(2) The excitation mechanism of the coronal green line was found to be mainly due to collisional processes in the inner coronal regions (up to about 1.4 $R_{\odot}$). Radiative processes become progressively important outwards. The line-to-continuum intensity ratio of the coronal green line was found out at a large number of points in corona and a contour map of the same was prepared.

(3) The relative line-of-sight velocities were calculated at about 1500 points on the face of the Orion Nebula in a $6' \times 6'$ field around the trapezium stars. Large velocities of ~ -30 km s^{-1} which are probably due to jets associated with the protostars, were found to lie at in the nebular boundaries. These results generally agree with the flow model of Balick *et al.* (1980).

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