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Polarization is one of the useful information sources on the study of circumstellar envelope. By observing polarization from the star, we can obtain information on scattering process such as the geometry and density distribution. A history of polarimetry in stellar astronomy is at most fifty years and shorter than other observational methods. Although polarization had been discovered in many types of stars, most of applications were still quantitative, except for the field of interstellar matter guided by Serkowski and his collaborators. In addition, new scattering processes such as Raman scattering and Hanle effect causing polarization also have been detected or predicted in recent. Thus, the situation surrounding the field of astronomical polarimetry is still chaotic and immature at present, although polarimetry is excepted to become valuable because of improvement of all kinds of resolutions in 10 m telescope age. The aim of this thesis is to control these chaotic situation from theoretical, observational, and technical faces, and to produce the base for the coming generation of polarimetric astronomy.

We had been carried out spectropolarimetery of R CrB stars in attention to the time variations, using our home instrument, HBS (Kawabata et al., 1999). The spectropolarimetric monitoring to R CrB amounted to about three years from Jan.1998 to Mar.2001. Of 36 nights data, we discovered *the transient polarization* in near light maximum phase when any intrinsic polarization had not been detected until now. This phenomenon can be quantitatively explained by dusty puff off the line of sight, which is considered to be the first direct evidence of *a randomly puffing-off model* currently accepted by an explanation as observational behaviors of R CrB stars. In order to investigate the transient polarization more deeply, I carried out numerical calculations with the Monte-Carlo method. Simulations suggest that the transient polarization can be produced by a dusty cloud formed near the star from $\sim 2\ R_*$ where is known as a hostile environment for condensation into dust. An estimation of total dust mass in the cloud also supports this suggestion. The importance of rapid construction of a dust formation theory in a hostile environment is carved in relief.

The photosphere of nova is considered to deviate from an ideal spherical shape, which is confirmed by deep imaging of post novae (Slavin et al., 1995; Gill & O'Brien,

1998). It is an attracting problem when the deformation starts in the brightness evolution. In order to resolve the spatial shape to solve such a problem, we carried out spectropolarimetry of some novae in early phases and discovered clear intrinsic polarization. This may be the first detection of deformation of the photosphere. In addition, the sudden jump of a polarization vector was also detected in the decline of the brightness. The results by the Monte-Carlo simulations indicate that electron scattering in the ellipsoidal photosphere can produce the observed polarization even if multiple scattering is dominated. However, polarization shows the different tendency from the expected one by the attenuation of the single scattering approximation. It is also found that a jump of the P.A could occur when a nova is observed with the inclination angle of a certain range.

The velocity field in circumstellar envelope is one of the most important information. These can be extracted from the polarization line profiles of the emission or absorption lines. However, there is few spectropolarimeter with high spectral resolution for such a observation. Then, we have been developing a high resolution echelle spectropolarimeter, LIPS, since 1998. LIPS has the resolving power of $R = 10000$ and accuracy in polarimetry of $\Delta < 0.1$ %. In this project, I am in charge of design of optics and instrumental box. For keeping an accuracy of $\Delta P < 0.1$ %, LIPS must be compact and light as it can be mounted on the Cassegrain focus. I designed a compact optical system and strong instrumental box with help of FEM analysis. A constructed instrument satisfies our specification. Moreover, I designed and manufactured diffraction limited lens units whose aberrations are adequately removed. Then, I investigated the characteristics of *ripple*, which is seen in spectra through after a super-achromatic waveplate of Pancharatnam type and seriously degenerates the data quality. I proved the physical origin by some examinations and simulations. Based on those studies, I succeeded reducing ripples of a super-achromatic waveplate. LIPS is in the phase of engineering observations. It will provide unexcepted and fruitful results in near future.

Finally, I simulated a polarization line profile of Hα in AB Aur, which is one of a few polarization spectra actually observed until the present. This trial is not only the case study on an analysis of polarization line profile but also a demonstration for success brought by data obtained with LIPS. I include the resonance scattering into a model in addition to electron scattering, which sometimes can be dominant near atomic lines. I can well reproduce polarization line profiles of polarization degree and P.A with a velocity component of rotation of about 50 km s^{-1} at the inner edge of the disk containing turbulence in addition to an expanding component. This result supports *the equatorial disk model* of two wind models for Herbig Ae star proposed by Catala et al.(1999). Moreover, it is found that the separation and ratio between peaks of double-peak profile seen in polarization is promising for a diagnostics of the inclination angle and expanding velocity of the disk, and comparison of polarization profiles between different lines could bring information on optical thickness in the circumstellar envelope.