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Venusian upper hazes observed by Imaging-Polarimetry system HOPS

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Physical properties of the aerosols in the Venusian upper atmosphere can be derived by measuring the polarization of light scattered by them. Kawabata et al. [1980] obtained polarization maps of Venus from the data of Orbiter Cloud Photopolarimeter (OCPP) onboard the Pioneer Venus Orbiter, and found that numerous haze particles distributed mainly on polar region. Kawabata [1987] and C. J. Braak et al. [2002] analyzed years of data observations and reported that optical depth of the hazes had rapidly declined. The variability of hazes and clouds can change longitudinal balance of solar absorption and atmospheric dynamics.

Two dimensional polarization maps are in general advantageous as they allow us to selectively pick up the local characteristics. We developed a planetary imaging-polarimetry system HOPS (Hida Optical Polarimetry System), which can take polarization maps as OCPP, and do observations for the purpose of monitoring of Venusian upper hazes.

The optical system of HOPS is composed of combination of a Wollaston prism and a half wave retarder, and the observation channels are 930, 647(650), 548(546), 438nm. One observation includes a total of four shots with the retarder position angle is incremented by 22.5 degrees. By arithmetic operations of the data, the degrees of linear polarization are obtained accurately after removing the effects of 'unevenness of the CCD sensitivities' and 'transparency of the atmosphere'. However, the uncertainties of registration and resulting polarization errors caused by the effect of the time-variable atmospheric turbulence are problems for planetary observations, which need to be taken care of.

The observations were performed in Hida observatory of Kyoto Univ. on May, Aug., and Oct. 2012. The phase angles of Venus at that time were 128, 85 and 58 deg., and apparent diameters are 42, 21, 14 arc second, respectively. The scale of one CCD pixel on the 65cm refractor is about 0.3 arc second, so the diameter of images of Venus on Aug., whose apparent diameter was about 21 arc second, was about 70pix. Polarization maps of this resolution are enough to pick up the local characteristics as PVO.

As a quick-look of the observations, we compared the data of 548nm and 930nm, whose channels are close to those of Kawabata et al. [1980], with them. The disk-integrated polarization degrees of 548nm matched with the past data. In contrast, the 930nm data were -3% ~ -2% while those of PVO were -2 ~ -1%. By comparison of equatorial and polar region, it was found that polarization degree of polar region is more negative than PVO data, this relatively lowered the disk-integrated polarization degree. These values are, however, less negative than those of ground-based observations in 1960s, this may indicate that the distribution of haze particles at the time of HOPS observation is somewhat similar to the situation of PVO arrival at Venus.

We are planning to observe at other phase angles and developing the calculation code of radiative transfer including polarization for the purpose of quantitative evaluations.

Keywords: Venus, Haze, Imaging-Polarimetry, Ground-based observation