Estimation of the drift rate and intensity of Neptune's storm in 2018 with Pirka Telescope

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A storm more than 4,000 km in diameter occasionally occurs in Neptune. In a previous study, Voyager 2 observed Neptune on May 24, 1989, and discovered a storm of 13,000 km in diameter called Great Dark Spot (GDS). GDS was located in the southern hemisphere like the Great Red Spot of Jupiter. But GDS became extinct when the Hubble Space Telescope observed it in 1994 (Hammel et al., 1995). It is unknown whether it is a sudden thing or storms such as GDS always occur in Neptune. In addition, a huge storm of 9,000 km was observed on July 2 and June 26, 2017, by the Keck observatory (Edward et al., 2019). It's considered that Neptune storms occur at a mid-latitude in the north and south that an ascending air occurs. However, this huge storm occurred near the equator. Neptune's rotation axis is 29.6°, and the storm possibly occurred near the equator because of seasonal change. Neptune is observed by large telescopes such as the Keck Observatory and the Hubble Space Telescope, but it isn't easy to always use those telescopes for Neptune observation. Therefore Neptune is not observed for the long term on a short time scale. We developed the technique to estimate the drift rate and intensity of storms by observing Neptune's whole spectrum in this study. When seeing is bad, it's possible to observe and acquire Neptune's observation data for the long term on a short time scale. The purpose is to deepen the understanding of Neptune's atmosphere convection structure by chasing the detailed change of storms.

In this study, we observed Neptune at wavelengths of 890, 855 nm using a 1.6 m Pirka telescope that Hokkaido University owns. The observation time is from October 22, 2018, to November 26, 2018, and from September 3, 2020, to September 8, 2020. Storms look brighter at 890 nm because the altitude of storms is higher than that of other areas. In addition, the apparent size of storms from the observer changes by the rotation of Neptune, so an 890 nm flux changes by the rotation. We took the ratio of an 890 nm flux and an 855 nm flux to correct the atmosphere's effect on the earth and calculated the theoretical values of the relative intensity changed by the rotation. We assumed the storm's diameter is 4,500 km and fit the observed values with the theoretical values in the method of least squares to estimate the drift rate and the 890 nm albedo inside storms. The theoretical values also change with the storm's latitude. Therefore, we calculated the storm's latitude from the HST images and used the latitude as a fixed value for fitting. The 2018 storm latitude was calculated from the HST image as 39°N, and we estimated that the drift rate and the 890 nm albedo are 25.2°/ day and 0.377 in 2018, respectively. In 2018, Simon et al. (2019) discovered a new northern Great Dark Spot (NDS-2018) located at 23°N. NDS2018 drifted westward at 2.46°/hr in November 2018. However, NDS-2018 could not be seen because it was located on the night side during our observation, and it is considered that we observed a different storm. The 2020 storm latitude was calculated from the HST image as 69°S, and we tried to estimate the drift rate and the 890 nm albedo.

However, it's calculated that the storm is always seen beyond a certain latitude in the Southern Hemisphere, and the fitting could not be performed accurately. It is considered that this is because Neptune's atmospheric absorption is not taken into consideration. In the future, we will calculate the theoretical value considering absorption and perform a more detailed fitting, continue Neptune's observation and compare it with other researchers and amateur observations and have a discussion in the future.

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Keywords: Neptune, Ground-based telescope

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