A search for emission lines Na, K and Ca in the atmosphere of Europa

*Seiko Takagi[1], Tatsuhiro Tsurumi[2], Jun Kimura[2], Hideo Sagawa[3], Ryu Hasegawa[3], Hikaru Kubota[3], Taro Matsuo[4], Kazuo Yoshioka[5]

1. Hokkaido University, Graduate School of Science, 2. The University of Osaka, 3. Kyoto Sangyo University, 4. Nagoya University, 5. the University of Tokyo

For the Jovian icy moon Europa, telescopic observations have confirmed the existence of atomic sodium and potassium in its tenuous atmosphere [Brown and Chaffee, 1974; Brown, 2001]. Such components are considered to be originated from the surface materials. Spectrographic evidence on the surface acquired from the Galileo spacecraft suggests that hydrated salt minerals, such as sodium, potassium, magnesium and calcium sulfates, carbonate and their mixtures, are concentrated at the linear features and in the chaotic terrains [e.g., McCord et al., 1999]. Furthermore, recent visible spectroscopic observations by the Hubble Space Telescope suggests the presence of sodium chloride on the surface [e.g., Trumbo et al., 2019]. The following mechanisms have been proposed as the origin of Europa’s tenuous atmosphere: (1) sputtering of materials from the surface by energetic particles in the Jupiter’s magnetosphere, (2) the impact supply from meteorites and dusts, (3) contamination due to volcanism from nearby Io. However, sodium-to-potassium for the Europa’s atmosphere does not simply agree with chemical model of the Europa’s ocean and with meteoritic origin. In addition, no positive signal from magnesium and calcium atoms has been reported despite their expected presence [Horst and Brown, 2013]. The search for such materials is crucial not only to understand the chemical information in the present Galilean moons and the transport processes among moons, but also to evaluate the primordial environment, formation process and evolution of the moon.
In this study, we searched for emission lines (500-720 nm) in the atmospheres of Europa from 2021 to 2023 using the Multi Spectral Imager (MSI) [Watanabe et al., 2012] on board the Pirka telescope (the primary mirror is 1.6 m in diameter) of Hokkaido University. Furthermore, several nights of spectroscopic observations (400-850 nm) were made from 2023 to 2024 using an echelle spectrograph, named VESPolA [Arasaki et al., 2015] on the Araki telescope (the primary mirror is 1.3 m in diameter) at Koyama Observatory of Kyoto Sangyo University. Here we will report the investigation using those ground-based telescopes.

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