Master thesis

修士論文

# Time variations of atomic oxygen UV emission near Io during a volcanic event obtained with Hisaki/EXCEED

# ひさき衛星により観測された火山活動に伴うイオ周辺の酸素原子紫外発光の変動

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# Abstract

The atmosphere of a Jovian satellite Io has been thought to be mainly by volcanism and sublimation of frost. However, it is not understood well which process is dominant to generate the Io's atmosphere, and the characteristics of spatial and time variation is unclear. In this study, we report that atomic oxygen near Io increased during the volcanic active event for the first time. The brightening event of the Io's extended sodium nebula was reported by the ground imaging observation in the spring of 2015. Simultaneously, the increase in $S^{+}, S^{2+}$, and $S^{3+}$ emissions was also observed with EXtrme ultraviolet spectrosCope for ExosphEric Dynamics (EXCEED) on the Hisaki satellite.

We examined the atomic oxygen emission at 130.4 nm obtained with Hisaki/EXCEED for the following two periods: from 19 December 2013 to 24 April 2014 (season 1) and from 27 November 2014 to 14 May 2015 (season 2). In the case of season 1, there was no significant increase of atomic oxygen emission. In the case of season 2, we found the atomic oxygen emission increased by 2.5 during the volcanically active period of DOY 20-110 of 2015. The time variation of atomic oxygen emission was well correlated with that of sodium emission until the brightness maximum on DOY 50 of 2015. In the meanwhile, the declining time scale of atomic oxygen emission (60 days) was longer than that of sodium emission (40 days). We also found the atomic oxygen emission at 130.4 nm in the dawn side were always brighter than that in the dusk side during the observation period with a averaged ratio of 1.13 in the season 1, and 1.17 in the season 2.

In addition, we investigated the Io's System Ⅲ longitude dependence of atomic oxygen emission at 130.4 nm during volcanically quiet period of DOY -30 -1 of 2015. Significant emission peaks appeared in the both dawn and dusk side. There are emission peaks at 130.4 nm at $\lambda = 90 - 135°$ and $\lambda = 275 - 315°$ in the both dawn and dusk side, which implies the System Ⅲ dependence of atomic oxygen emission at 130.4 nm is probably caused by the variation of electron density around Io as well as along the Io torus. Concerning the Io phase angle variation of atomic oxygen emission, we found that weak atomic oxygen emission continuously exists on both sides not depending on the phase angle. This suggests that atomic oxyge1n distributes not only Io but also spreading

all around the Io orbit.

Furthermore, we obtained the relationship between the atomic oxygen 130.4 nm emission and sodium 589 nm emission during the volcanically active period of DOY -35-50 of 2015. Assuming that the sodium emission is proposal to the volcanic activity on Io, we estimated the brightness of atomic oxygen emission as 5.2 R when the sodium emission is zero. This brightness is probably caused by sublimation without any volcanism. Considering the fact that the brightness of atomic oxygen 130.4 nm emission during the volcanically quiet period of DOY $-35-50$ in 2015 was about 12.9 R, 5.2 R out of 12.9 R would be produced by sublimation, assuming that contribution of sublimation was stable, and the remaining was due to volcanism that still exists even in the quiet period.