Imaging Observations of Entire Hydrogen Coma of Comet 67P/Churyumov-Gerasimenko in 2015 September

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The water production rate, Q_{H_2O} of a comet is one of the fundamental parameters to understand cometary activity when a comet approaches the Sun within 2.5 au because water is the most abundant icy material in the cometary nucleus (~70 % of icy materials). For instance, the slopes of the water production rate with respect to heliocentric distance, r_H, of comets seem to depend on dynamical ages of the comets [1].

Comet 67P/Churyumov-Gerasimenko (hereafter 67P) is a Jupiter-family comet with an orbital period of ~6.5 years. During the 2015 apparition of the comet, the comet was the target of ESA's Rosetta mission. Q_{H_2O} of the comet have been derived by various instruments on board the *Rosetta* spacecraft throughout the 2015 apparition. However, measurement of an absolute Q_{H_2O} is difficult because the *Rosetta* spacecraft was located in the cometary coma. Note that an obtained Q_{H_2O} strongly depends on the coma models [2,3].

To derive gas production rates based on in situ measurements by the *Rosetta* instruments at the close distances from the comet 67P, entire coma observations from the ground-based and space observatories can realize the critical calibration for the gas production rates. We performed wide-field imaging observations of Lyα emission in comet 67P by the LAICA telescope on board the micro spacecraft for deep space exploration, the *PROCYON*, on UT 2015 September 7, 12, and 13 [4].

To estimate a Q_{H_2O} from a single Lyα image, we use the two-dimensional axi-symmetric Direct Simulation Monte-Carlo (DSMC) model of atomic hydrogen coma using the Adaptive Mesh Particle Simulator code [5] (Fig. 1). Because there were bad observing conditions during the time the comet could be observed from Earth, our observations were important to test the coma models for the comet. Combined with Rosetta's results, such as water production rates at different r_H and chemical composition, we could accurately estimate the total ejected mass of the comet in the 2015 apparition. Moreover, 67P shows that the activity in the 2015 apparition was comparable to those in the past fourth apparitions at least, and has much icy materials in the nucleus.

This result is the first scientific achievement by a micro spacecraft for deep space exploration. Moreover, this provides an ideal example where observations by a low-cost mission support precise observations by a large mission. We hope this will become one of model cases for micro spacecraft missions.

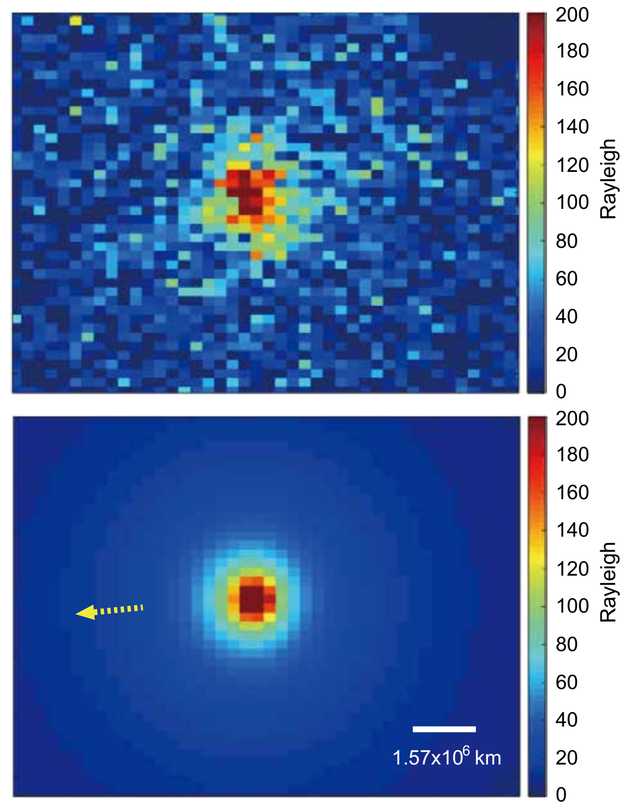

Figure 1: Trimmed reduce Lyα (upper) and reproduced (lower) images of hydrogen coma of comet 67P by 2D axi-symmetric model in Rayleigh units on UT 2015 Sept 13. Yellow allow is solar direction.

References

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