High-dispersion spectroscopic observations of comet C/2013 R1 (Lovejoy) with the Subaru Telescope on 2013 November 15

Y. Shinnaka[1], H. Kawakita[1], M. Nagashima[1], H. Kobayashi[1], A. Decock[2], and E. Jehin[2]

[1]Koyama Astronomical Observatory of Kyoto Sangyo Univeristy, Motoyama, Kamigamo, Kita, Kyoto, 603-8555, Japan.

[2]Institut d'Astrophysique, de Géophysique et d'Océanographie, Université de Liège, Allée du 6 août 17, 4000 Liège, Belgium.

Comet C/2013 R1 (Lovejoy) probably originates from the Oort Cloud. Comet Lovejoy provided us with great opportunities to investigate the chemical composition of the comet thanks to its brightness and elongation angle from October 2013 to March 2014. We observed comet C/2013 R1 (Lovejoy) on 2013 November 15 UT using the High Dispersion Spectrograph (HDS) mounted on the Subaru Telescope on Mauna Kea. Its heliocentric and geocentric distances were 1.066 and 0.412 au, respectively. The obtained spectra cover the wavelength region from 360 to 830 nm with the resolving power of $R = \lambda/\Delta\lambda = 72,000$ for the slit size of 0".5 × 9".0 (360–520 nm) and 0".5 × 9".0 (550–830 nm) on the sky. Exposure time was 130 minutes in total (100 minutes for shorter and 30 minutes for longer wavelength regions). We could identify many species such as the radicals (CN, CH, C_3, C_2, NH_2, etc.), ions (CH^+, H_2O^+), and atoms ([OI] and NaI) in the spectra and many unidentified lines were also detected.

Here we discuss the chemical reaction in cometary coma and the origin of icy materials of comet C/2013 R1 (Lovejoy), based on the high-dispersion spectra in the optical wavelength regions. We present (1) the ortho-to-para abundance ratios (OPRs) of water and ammonia inferred from the high-dispersion spectra of H_2O^+ and NH_2, (2) the green-to-red line ratio of forbidden oxygen emissions, (3) the nitrogen and the carbon isotopic ratios of CN, and (4) spatial distributions of radicals, atoms, and dust continuum in the inner coma.