THE VOLATILE COMPOSITION OF CO-DOMINATED COMET C/2016 R2 (PANSTARRS)

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Introduction: Comets consist of a primitive volatile composition that is reflective of the physics and chemistry operating in the protosolar disk during planet formation. The volatile carbon content of comets is thought to be mostly CO_2, followed by CO, CH_4, and CH_3OH, with C_2H_6, H_2CO, and HCN also being present. However, this general rule of thumb is not always applicable, especially for CO, for which abundances compared to H_2O vary by several orders of magnitude.

We present observations of comet C/2016 R2 (PanSTARRS) obtained with the IRAC instrument on the Spitzer Space Telescope, iSHELL on the NASA IRTF, ARCES at Apache Point Observatory, the Tull Coude Spectrograph at McDonald Observatory, and ARO SMT during January-February 2018 aimed at characterizing the carbon chemistry in this comet. The Spitzer observations targeted CO_2, while the iSHELL observations targeted CO, CH_4, C_2H_6, CH_3OH, and H_2CO. The ARCES and Tull Coude observations targeted CN, which can be used as a proxy for HCN, and the SMT observations targeted CO and HCN.

Results: We obtained secure detections of CO and CH_4 (Fig. 1) with iSHELL, while sensitive upper limits are derived for CH_3OH, C_2H_6, and H_2CO. The CH_4/CO ratio is ~2%, much lower than typically observed in comets. The upper limits on CH_3OH/CO, C_2H_6/CO, and H_2CO/CO are < 0.95%, < 0.19%, and < 0.43% respectively. These upper limits are much lower than typically observed values as well. CN was not detected with ARCES or Tull Coude, nor HCN with SMT, providing a sensitive upper limit on HCN. However, the optical spectra show emissions from CO^+ and N_2^+, further illustrating the peculiar composition of this comet. The Spitzer observations show evidence for strong gas emission (Fig. 2), though due to the broadband nature of the Spitzer imaging there is a degeneracy between CO and CO_2 emission. We will use the iSHELL and SMT observations of CO (Fig. 3) to evaluate the contribution of CO to the Spitzer imaging and derive the CO_2 abundance. We will discuss our derived abundances of key carbon-bearing species, including CO/CO_2, and discuss implications for the carbon chemistry in the early Solar System.

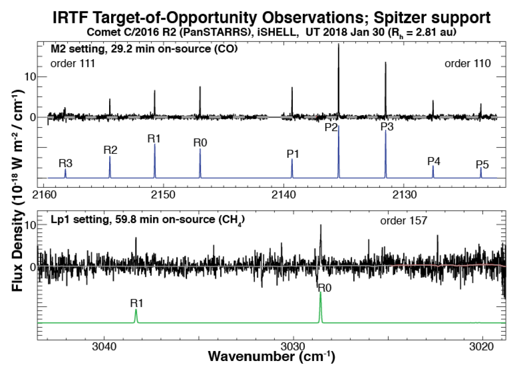

Fig.1: Spectra showing CO (top) and CH_4 (bottom) emission from C/2016 R2 (PanSTARRS).

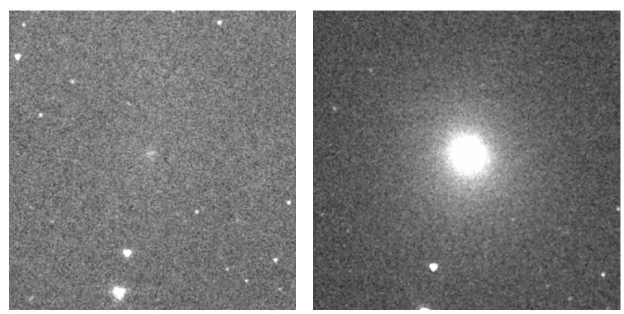

Fig. 2: Spitzer IRAC images of C/2016 R2 (PanSTARRS) at 3.6 microns (left) and 4.5 microns (right). The 3.6 micron image is dominated by dust, while the 4.5 micron image is dominated by CO+CO_2 emission.

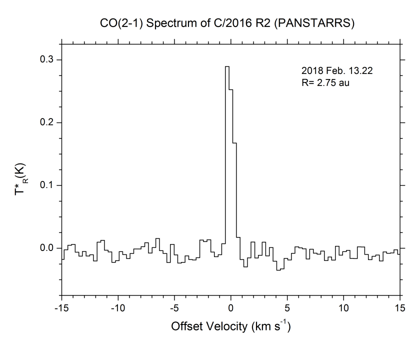

Fig. 3: CO emission detected using the ARO SMT.