EPSC Abstracts
Vol. 13, EPSC-DPS2019-1046-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

A 7-Year Stretch: NEOWISE CO+CO_2 Production Rates

James Bauer (1), Amy Mainzer (2), Emily Kramer (2), Tommy Grav (3), Joseph Masiero(2), Yan Fernandez(4), Justin Van Winkle (1), Michael S. P. Kelley(1), Silvia Protopapa(5), Tim Spahr(6), Karen Meech(7), Casey Lisse(8), Roc Cutri(9), Dave Milewski(10), Ned Wright (11) and the NEOWISE Team. (1) Dept. Of Astronomy, University of Maryland, (2) Jet Propulsion Laboratory, California Institute of Technology, (3) Planetary Science Institute, (4)Dept. of Physics and Florida Space Inst., University of Central Florida, (5) Southwest Research Institute, (6) NEO Sciences, (7) Univ. of Hawaii, Institute for Astronomy, (8) Applied Physics Laboratory, John Hopkins University, (9) IPAC, California Institute of Technology (10) Dept. of Earth, Planetary, and Space Sciences, University of California, Los Angeles (UCLA), (11) Dept. of Physics and Astronomy, UCLA.

Abstract

We will present 7 years of CO and CO_2 production rates in comets observed by the NEOWISE mission [7]. Using the emission from CO_2, a species that can only be directly measured from spacecraft, in combination with emission from CO, we will assay the production of these species as a function of heliocentric distance and comet dynamical class. Understanding the role of such constituents in driving activity at varying heliocentric distances can provide observational constraints for icy-planetesimal formation and evolution.

1. Introduction

Carbon-bearing volatile ices (C-ices) have begun recently to be inventoried in statistically significant numbers amongst cometary populations in our solar system. One reason for the more recent increase in measurements is the prevalence of space-based platforms capable of detecting CO and CO_2 emission at IR wavelengths, specifically the Akari spacecraft [8], Spitzer Space Telescope (SST; [9]), and NEOWISE [7]. These species are difficult, or in the case of CO_2 impossible, to detect through Earth's atmospheric absorption and so production rate measurements were previously limited. Attempts to use cometary C-ice abundances to clarify icy-planetesimal formation and transport models in star-forming regions and in disks are complicated by the fact that the cometary CO_2 abundances do not match [6], and also more fundamentally by (a) the lack of measurements across enough cometary sub-classes [1] and (b) the lack of contemporaneous water measurements. Furthermore, comet diversity is inferred through the comparison among major comet dynamical sub-classes such as long period and short-period comets (LPCs and SPCs; [1]). Real-time relative abundances of CO and CO_2 compared to other species were provided by the Akari spectroscopic data set of 17 comets, but limited to single or a few observations per comet and a handful per LPC and SPC classification. These observations found that CO_2 dominated the abundances at heliocentric distances less than 2.5 AU.

2. NEOWISE Observations

NEOWISE's 4.6μm band contains two strong gas emission lines, CO at 4.67μm, and the CO_2 line at 4.23μm. By using the signal at 3.4 μm to constrain the quantity of dust, we extrapolate the dust signal contribution. For cometary dust, the reflected-light signal at 3-5 microns is generally flat, and [2] demonstrated that the dust thermal signal on average follows a black body to within +/- 20K. Hence both the reflected light signal and thermal signal at 4.6 μm can be extrapolated from the 3.4 μm signal and removed to extract the CO+CO_2 emission signal, in the 4.6 μm band. The excess flux can then be attributed to CO or CO_2 emission lines. Since the CO_2 fluorescence efficiency is more than a factor of 10 stronger, and since CO/CO_2 is at most a factor of a few, and usually less when the comet is within 2.5 AU, we expect that most of the NEOWISE excess above continuum (dust) is due to CO_2 production. This technique has provided measures of CO_2 production rates that match those of spacecraft observations in 103P [3,4] and 67P [5].

We will present preliminary results from the full set of moving-object pipeline-detected comets and their CO+CO_2 production rates (Fig. 1), for all phases of the NEOWISE mission [7]. Analysis of the first two years of the reactivated mission indicate continuing trends from the cryogenic-mission data results presented in [2], where the distribution of LPCs show larger CO+CO2 production out to greater distances (Fig. 2).

We will determine if this trend continues across the entire data set and for individual comets observed at multiple epochs.

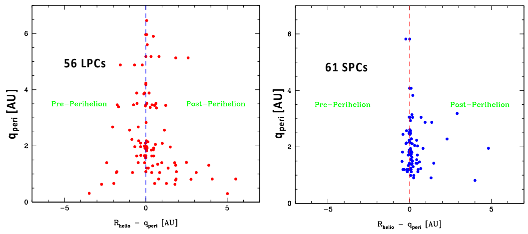

Figure 1: *The distribution of detections of comets for the first two years of the re-activated NEOWISE mission. Detections are shown as a function of their perihelion distance with pre-perihelion detections on the left of each panel. The left panel is the LPC detections and the right the SPC detections; 117 comets were detected.*

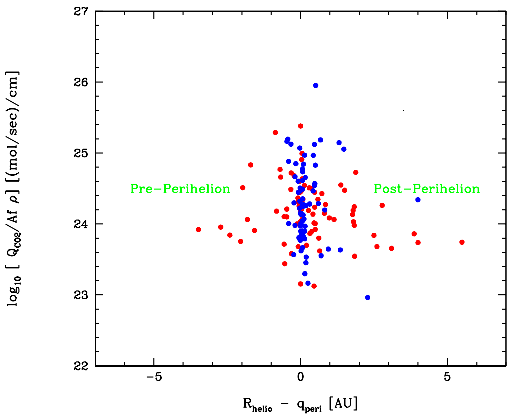

Figure 2: *CO+CO2 production for the first 2 years of the mission shown as a function of their perihelion distance with pre-perihelion detections on the left of each panel. Emission-line flux excesses are converted into CO2 production rates and ratio-ed against 3.4μm-band Afρ measurements, used as a proxy for dust production. Blue and red dots represent SPCs and LPCs, respectively.*

References

[1] A'Hearn, M. F., et al. 2012, ApJ, 758, 29

[2] Bauer et al. 2015, ApJ, 814, 85.

[3] Bauer et al. 2011, ApJ, 738, 171.

[4] Bauer et al. 2012a, ApJ, 758, 18.

[5] Bauer et al. 2012b, ApJ, 747, 49.

[6] Boogert, A. C., Gerakines, P.A., & Whittet, D.C.B. 2015, ARAA, 53, 541.

[7] Mainzer et al. 2014. ApJ 792, 30.

[8] Ootsubo, T., et al. 2012, ApJ, 752, 15.

[9] Reach, W. T., Kelley, M. S., & Vaubaillon, J. 2013, Icarus, 226, 777.