Identification of CO-rich comet C/2013 R1 (Lovejoy) — a new member of the CO-rich family

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The significant gas activity and interesting coma features of C/2013 R1 (Lovejoy) triggered our infrared (IR) observations at pre-perihelion distances from 1.35 au to 1.16 au, using NIRSPEC at the Keck Observatory. We detected nine gaseous species (H_2O, OH*, CO, CH_4, HCN, C_2H_6, CH_3OH, NH_3, and NH_2) and obtained upper limits for two others (C_2H_2 and H_2CO). The estimated CO abundance ($\sim$ 10 %, relative to H_2O) in comet C/2013 R1 was enhanced relative to most comets in our and other surveys (typically, $CO/H_2O \sim 5$ % or less), classifying it as a member of the CO-rich group of comets (e.g., [1]).

This result indeed is not trivial. Prior to 2013, only five comets were identified as being enriched in CO within 2.5 au of the Sun (where both H_2O and CO are active) at radio and IR wavelengths: C/1995 O1 (Hale-Bopp) [2,3], C/1996 B2 (Hyakutake) [4,5,6], C/1999 T1 (McNaught-Hartley) [7], C/2008 Q3 (Garradd) [8], and C/2009 P1 (Garradd) [1]. However, how common are these CO-rich comets?

CO is highly volatile (sensitive to temperature), so the chemistry of CO-rich comets could place important constraints on the birthplace and processing history of pre-cometary ices. Are these CO-rich bodies outliers of the typical population of comets? Can the relatively large CO content challenge and inform our current understating of their origin? We will present our recent IR observations and discuss the results found during our observing campaign for comet C/2013 R1 in the context of our IR survey.

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References: [1] Paganini, L., Mumma, M. J., Villanueva, G. L., et al. 2012, ApJL, 748, L13. [2] DiSanti, M. A., Mumma, M. J., Dello Russo, N., et al. 1999, Nature, 399, 662. [3] DiSanti, M. A., Mumma, M. J, Dello Russo, N., & Magee-Sauer, K. 2001, Icarus, 153, 361. [4] Mumma, M. J., DiSanti, M. A., Dello Russo, N., et al. 1996, Science, 272, 1310. [5] Biver, N., Bockeleé-Morvan, D., Crovisier, J., et al. 1999, AJ, 118, 1850. [6] DiSanti, M. A., Mumma, M. J., Dello Russo, N., Magee-Sauer, K., & Griep, D. M. 2003, J. Geophys. Res., 108, 5061. [7] Mumma, M. J., DiSanti, M. A., Dello Russo, N., et al. 2003, Adv. Space Res., 31, 2563. [8] Ootsubo, T., Watanabe, J., Kawakita, H., Honda, M., & Furusho, R. 2007, Planet. Space Sci., 55, 1044.