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New Limits on CO Outgassing in Centaurs

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Abstract

We conducted a deep search for gaseous carbon monoxide in three Centaurs. The molecule is not detected, however, the sensitivity of our data to CO outgassing in this population is the highest to date.

1. Introduction

Centaurs are small solar-system bodies, which orbit between Jupiter and Neptune. Their population is in a dynamical transition between the Kuiper Belt in the outer solar system and the Jupiter-family comets orbiting close to the Sun. The sublimation of CO has been proposed as a driver of activity in distant comets, however, no strong detection in a Centaur other than 29P/SW1 (Senay & Jewitt, 1994, Nature 371, 229) has been reported to date (e.g. Bockelée-Morvan et al., 2001, A&A 377, 343; Jewitt et al., 2008, AJ 135, 400).

2. Observations

On 9 nights in late 2011 we used the Caltech Submillimeter Observatory to observe the J(2–1) rotational transition of CO in three Centaurs: 2010 RM64, 2008 QD4, and 2008 YB3. The line is undetected in all three objects (Figure 1), with the following RMS of noise in the main-beam brightness temperature scale in 0.1 km s^{-1} spectral channels: 13 mK for 2010 RM64, 21 mK for 2008 QD4, and 12 mK for 2008 YB3.

3. Discussion

The above limits are converted into CO production rates. We assume steady-state anisotropic outgassing from the day side, proportional to cosine of the zenith angle (cf. Drahus 2009, PhD thesis). The molecules are ejected, and continue to travel, at a constant speed of 0.2 km s^{-1}. The $J=2$ level is populated by 25% of the molecules, which is consistent with thermal equilibrium at 10 K and also with fluorescence equilibrium at the heliocentric distances of our targets ~ 6 AU.

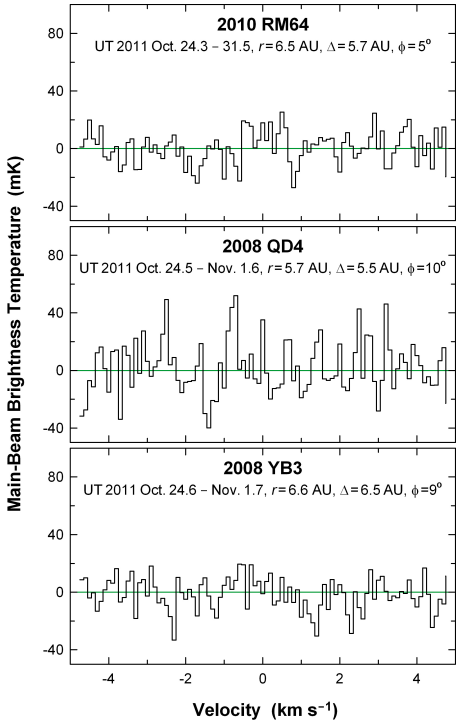

Figure 1: Spectra of CO J(2–1) in three Centaurs.

Under these assumptions, we obtain 3σ upper limits on the CO production rate equal to: 1.2×10^{27} molec s^{-1} for 2010 RM64, 2.0×10^{27} molec s^{-1} for 2008 QD4, and 1.3×10^{27} molec s^{-1} for 2008 YB3. Our limits are more sensitive than those resulting from previous studies of Centaurs, and support an earlier suggestion that the surfaces of these bodies cannot be dominated by exposed CO ice.

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