

Nuclear Spin Temperature of Methane in Comet C/2001 Q4

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Comets are primordial icy bodies in the Solar System. Formation or condensation conditions of cometary molecules remain in various properties of the molecules, e.g., chemical compositions. Here we concentrate on abundance ratio of nuclear spin isomers of cometary molecules. Cold nuclear spin temperatures of cometary water and ammonia have been reported so far. However, there are no reliable reports on a nuclear spin temperature of methane in comets.

Methane has four identical hydrogen nuclei and its rotational energy levels are classified into three nuclear spin states; *A*, *E*, and *F*. We observed comet C/2001 Q4 (NEAT) by the 10-meter Subaru telescope with the IRCS (Infrared Camera and Spectrograph) to determine the nuclear spin temperature of methane on 2004 May 28 UT. High-dispersion spectroscopic observations ($R=10000$) were performed by using the cross-dispersed echelle mode of the IRCS. R-branch emission lines ($R_0 - R_6$) of the ν_3 vibrational band of methane were clearly detected. Cold nuclear spin temperature of methane has been derived to be 33 K at the first time in the comet.

Keywords: Comets; Nuclear spin temperature; Methane.

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