RADIO-WAVELENGTH INVESTIGATIONS OF THE GREAT COMET C/2006 P1 (McNAUGHT) NEAR PERIHELION. Nicolas Biver[1], Helmut Wiesemeyer[2], Gabriel Paubert[2], Jacques Crovisier[1], Dominique Bockelée-Morvan[1], Jérémie Boissier[1,3], Pierre Colom[1], [1]LESIA, Observatoire de Paris, 5 place J. Janssen, F-92190 Meudon, France (Nicolas.biver@obspm.fr), [2]IRAM, Granada, Spain, [3]IRAM, Grenoble, France.

Surprising us by its rapid brightening near perihelion which made it visible in broad daylight, the "Great Comet of 2007", C/2006 P1 (McNaught), was observed with the Nançay and Institut de Radioastronomie Millimétrique (IRAM–30m) radiotelescopes on short notice. This dynamically new Oort cloud comet reached perihelion at 0.17 AU from the Sun on 12.7 January 2007 with a total visual magnitude around -5.

The OH radical lines at 18-cm were observed at Nançay between 10 and 20 January [1]. They were marginally detected on 13.5 and 19.5 Jan. 2007. An evaluation of the OH production rate is difficult because of the particular excitation of the OH radical so close to the Sun. A tentative value of Q_{OH} is 5×10^{30} molec./s on 19.5 Jan.

The comet was observed with the IRAM-30m between 15 and 17 January around 0.23 AU from the Sun. We report on the detection of HCN, HNC, CS, CH_3OH, H_2CO and HCO^+ and marginally CH_3CN and HDO in this comet. The HCN production rate was estimated to $Q_{HCN} = 4.3\times10^{28}$ molec./s on 16.5 January, larger than that of comet Hale-Bopp at its perihelion. It varied as $r_h^{-5.3}$ during the period of observation.

Due to the close proximity to the Sun and large outgassing rate ($Q_{H2O} = 10^{31}$ molec./s or larger), screening of solar UV flux by water molecules, especially at the Lyman-α wavelength, plays an important role in lengthening the molecular lifetimes. This effect can become important for comets close to the Sun and we modelled it for observations of comets C/2006 P1 and also C/2002 X5 (Kudo-Fujikawa) and C/2002 V1 (NEAT) which were observed at less than 0.2 AU from the Sun in 2003. The optically thick Lyman-α region around the nucleus has been estimated to be 3000 km in diameter for C/2006 P1 on average (given that it varies with the phase angle). This nearly doubles the effective lifetime of HCN, but the effect was smaller for the two other comets due to their lower outgassing.

The measured rotational temperatures are between 80 K (CH_3OH) and ~150 K (HCN). The mean gas expansion velocity estimated from the line widths varies between 1.2 km/s (H_2CO, CS) and 1.5 km/s (CH_3OH, HCN) in comet C/2006 P1 (figure). We expect an increase of the coma expansion velocity with distance to the nucleus [2] and this should affect the line widths. Indeed molecules with shorter lifetimes will sample a region closer to the nucleus where the velocity is lower. The observations of Sun approaching comets provide constraints on the lifetime of the molecules as the scalelengths become smaller than the field of view. We use these observations to constrain the poorly known lifetime of CS. A value of the photodissociation rate $\beta_{CS}(1\ AU) = 2\text{-}3\ 10^{-5}\ s^{-1}$ is compatible with observations of CS in the 3 comets. This rate is comparable to the range of values derived from interferometric mapping of CS in comet Hale-Bopp [3].

The relative molecular abundances at 0.23 AU from the Sun are estimated to be:

(HCN:HNC:CS:CH_3OH:H_2CO:CH_3CN:HDO:CO) = (1 : 0.1 : 1.5 : 5.0 : 2.3 : 0.1 : 0.25 : <15).

The CH_3OH/HCN and CO/HCN (upper limit) ratios are relatively low in comparison to other comets [4,5].

References:

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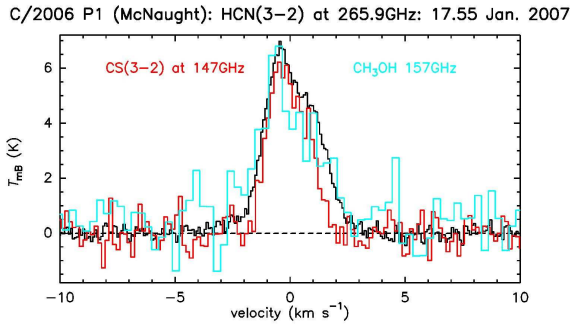

Figure: Profiles of the HCN, CS and CH_3OH lines observed simultaneously in comet C/2006 P1 (McNaught) on 17.6 Jan. 2007 UT.