

INVESTIGATION OF WATER FEATURES IN THE NEAR IR SPECTRUM OF COMET 8P/TUTTLE USING THE BT2 LINE LIST. R. J. Barber¹, S. Miller¹, N. Dello Russo², J. Tennyson¹

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Background: Water is the dominant ice in comets and within ~ 3 AU of the sun its rate of sublimation controls the release of other volatiles. Consequently a determination of cometary water production rates is of fundamental importance in understanding the physical properties of the inner coma and in interpreting the spectral lines due to other species.

Because of the low temperatures that characterize cometary coma, photons from the strongest (fundamental) water transitions are absorbed by the Earth's atmosphere. However, away from the inner coma, number densities are sufficiently low that higher energy states that have been populated by solar pumping have time to decay radiatively to levels above the ground vibrational state. These hot band, or so-called 'solar-pumped fluorescent' (SPF) transitions are present in high resolution spectra obtained using ground-based instruments. Their relative intensities are frequently sufficiently temperature-dependent to enable the lines to be used to derive the temperature of the inner coma. However, this is not a straight-forward process. Because the radiating molecules are in regions of the coma that are not in local thermodynamic equilibrium, Boltzmann statistics do not apply, and upper state populations have to be computed using fluorescence models that have been developed to determine g -factors as a function of temperature for each rovibrational transition [1]. These calculations are complex as each upper energy state is able to be pumped from several different ground states as well as being populated by downward transitions from higher energy states. Also, the branching ratio is the ratio of the Einstein A coefficient for the transition in question to the total for all possible downward transitions. The energy levels and Einstein A coefficients are obtained from the BT2 line list [2]. In addition BT2 is used to identify many previously unrecorded weak water lines in the spectrum.

Observations and Data Analysis: Using CGS4 on UKIRT, we obtained high resolution, near-IR spectra of Comet 8P/Tuttle on the nights of 3, 4, 5 January 2008. Data from the second and third nights will be published at a later date. Here we present our observations in the $3440\text{--}3463\text{ cm}^{-1}$ region obtained on 3 January. The intensities of the observed solar pumped fluorescent (SPF) water lines are used to derive the rotational temperature of the inner coma. In addition

we compute the water production rate. Our spectra include a large number of weaker water features, most of which have not previously been recorded in cometary spectra. We have assigned many of these features, and we discuss the possibility that some of the lines are produced by an alternative mechanism.

References:

- [1] Dello Russo N., et al., (2004) *Icarus*, 168, 186
- [2] Barber R.J., et al., (2006), *MNRAS*, 368, 1087