Radio investigations of 19P/Borrelly in support to the Deep Space 1 flyby

Dominique Bockelée-Morvan[1], Nicolas Biver[2], Pierre Colom[1], Jacques Crovisier[1], Michel C. Festou[3], Florence Henry[1], Alain Lecacheux[1], Harold A. Weaver[4]

[1] *ARPEGES/LESIA, Observatoire de Paris, 5 place Jules Janssen, F-92195 Meudon, France*

[2] *ESA, ESTEC SCI-SB, Keplerlaan 1, NL-2200 AG Noordwijk ZH, The Netherlands*

[3] *Observatoire Midi-Pyrénées, 14 avenue Edouard Belin, F-31400 Toulouse, France*

[4] *Department of Physics and Astronomy, The Johns Hopkins University, Baltimore, Maryland 21218, USA*

April 28, 2002

Abstract. NASA's Deep Space 1 mission flew by comet 19P/Borrelly on September 22, 2001. We present observations of molecular species obtained with the 30-m telescope of the Institut de Radioastronomie Millimétrique (IRAM) and the Nançay radio telescope at and near the time of this flyby. OH, HCN, and CS production rates were measured, while upper limits were deduced for CO, H_2CO and H_2S.

Keywords: 19P/Borrelly, molecules, radio lines

Our observations at IRAM 30-m were obtained on September 19–21 and 24, 2001, when 19P/Borrelly was at ~ 1.36 AU and ~ 1.48 AU from the Sun and the Earth, respectively. Bad weather prevented us to collect data on September 22 and 23, at the time of the Deep Space 1 encounter with the comet. HCN was detected on all dates by its J(1–0) (88.6 GHz) and/or J(3–2) (265.9 GHz) lines. The HCN J(3-2) line is significantly blueshifted (Δv = -0.18 ± 0.04 km s^{-1}), which is indicative of molecules mostly expanding in the earthward portion of the coma. The CS radical was marginally detected on September 21 and 24 by its J(3–2) (147 GHz) and J(5–4) (245 GHz) lines. The H_2S (168 GHz), H_2CO (225 GHz) and CO (230 GHz) lines were not detected but useful upper limits of these species production rates were obtained. As part of the Nançay comet monitoring programme (Crovisier et al., 2002, in press and this colloquium), observations of the OH 18-cm lines were successfully obtained from July 19 until September 3, 2001. This monitoring was resumed in November, but the comet was then no longer detectable.

A summary of inferred production rates and abundances relative to water is given in Table I. These rates were calculated as explained in, e.g., Biver et al. (1999) and Crovisier et al. (2002, in press). Molecular abundances inferred at the previous passage in 1994 (Bockelée-Morvan

© 2002 *Kluwer Academic Publishers. Printed in the Netherlands.*

Table I. Molecular production rates and abundances relative to water in 19P/Borrelly (Q(OH) ~ 0.9 $Q(H_2O)$; upper limits are 3σ values).

Date 2001	Species	Line	Production rate [mol s^{-1}]	Abundance 2001[a]	Abundance 1994[b]
19/07–01/08	OH	18 cm	$(1.2\pm0.3)\times10^{28}$		
02–15/08	OH	18 cm	$(1.6\pm0.4)\times10^{28}$		
16–22/08	OH	18 cm	$(2.6\pm0.5)\times10^{28}$		
22/08–03/09	OH	18 cm	$(2.5\pm0.5)\times10^{28}$		
19–24/09	HCN	J(1-0)	$(2.13\pm0.40)\times10^{25}$	0.082%	0.11%
	HCN	J(3-2)	$(2.11\pm0.13)\times10^{25}$		
19–24/09	CS	J(3-2)	$(2.1\pm0.6)\times10^{25}$ [c]	0.10%	
24.3/09	CS	J(5-4)	$(3.3\pm0.8)\times10^{25}$ [c]		
20.3/09	H_2S	1_{10}-1_{01}	$<1.5\times10^{26}$	<0.55%	
21.3/09	CO	J(2-1)	$<4.9\times10^{27}$	<19%	
19–20/09	H_2CO	3_{12}-2_{11}	$<1.4\times10^{26}$ [c]	<0.5%	0.46%
	CH_3OH				1.5%

[a] assuming a water production rate of 2.6×10^{28} mol s^{-1} (Schleicher, 2001);
[b] from Bockelée-Morvan et al. (1995);
[c] assuming distributed sources with parent scalelengths of 500 km (CS) and 11000 km (H_2CO).

et al., 1995) are also given. The CS abundance in comet Borrelly fall in the middle of values measured in comets, while the HCN and CH_3OH abundances are rather low, compared to the mean cometary values (Biver et al., 2002). CO and H_2S are underabundant compared to values measured in comets Hale-Bopp and Hyakutake.

The detailed report and analysis of these observations are to be published in Astronomy and Astrophysics.

References

Biver, N., Bockelée-Morvan, D., Crovisier, J., Colom, P., Henry, F., Moreno, R., Paubert, G., Despois, D. and Lis D.C.: 2002, 'Chemical diversity among 24 comets observed at radio wavelengths', these proceedings.

Biver, N., Bockelée-Morvan, D., Crovisier, J., Davies, J.K., Matthews, H.E., Wink, J.E., Rauer, H., Colom, P., Dent, W.R.F., Despois, D., Moreno, R., Paubert, G., Jewitt, D. and Senay, M.: 1999, *Astron. J.* 118, 1850–1872.

Bockelée-Morvan, D., Biver, N., Colom, P. Crovisier, J., Gérard, E., Jorda, L., Davies, J.K., Dent, W.R.F., Colas, F., Despois, D., Paubert, G. and Lamy, P.: 1995, *BAAS* 27, 1144.

Schleicher, D.: 2001, *IAU Circ.* 7722.