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IUE Observations of Periodic Comets Tempel-2, Kopff and Tempel-1

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ABSTRACT

We summarize the results of observations made between 10 June and 18 December 1988 with the *International Ultraviolet Explorer* of comet P/Tempel-2 during its 1988 apparition. The derived water production rate and relative gas/dust ratio are compared with those of P/Halley, observed with *IUE* in 1985–86, and other potential CRAF target comets, P/Kopff and P/Tempel-1, both observed with *IUE* in 1983.

I. INTRODUCTION

Periodic comet Tempel-2 (1988 XIV) is the current primary target comet for the Comet Rendezvous/Asteroid Flyby (CRAF) mission. It was also the target comet in 1987 so that extensive observations were planned for its apparition to provide information about the gas and dust environment to be expected for the spacecraft and the scientific instruments. Although the CRAF project schedule led to a subsequent change in target to periodic comet Kopff (1983 XIII), observations of Tempel-2 by the *International Ultraviolet Explorer* (*IUE*) satellite were carried out as planned over the period 10 July to 18 December 1988 and produced ultraviolet spectra on ten separate dates during this period. The observation parameters are listed in Table 1, together with the measured brightness (in a nominal $10''.3 \times 15''.1$ aperture) of the OH(0,0) and CS(0,0) bands at 3085 Å and 2575 Å, respectively. Also given is the continuum flux in a 100 Å wide band centered at 2950 Å, reduced to the parameter $Af\rho$ defined by A'Hearn *et al.* (1984). Here, A is the mean grain albedo, f is the filling factor of the grains in the aperture and ρ is the radius of the aperture.

II. COMET P/TEMPEL-2

The derived water production rates have already been presented by Roettger *et al.* (1990). They are summarized in Table 1 and shown in Figure 1 as a function of heliocentric distance, r. To facilitate a comparison with previously published production rates derived from *IUE* data, the

Table 1: Observational data

Comet/Date	r(AU)	Δ(AU)	B_{OH}(R)	B_{CS}(R)	$Af\rho$(cm)	Q_{H_2O}(s^{-1})	Q_{CS}(s^{-1})
P/Tempel-2							
1988 June 10	1.72	0.79	45	–	< 40	1.1×10^{27}	–
1988 July 28	1.48	0.80	640	20	60	1.2×10^{28}	5.6×10^{24}
1988 August 20	1.42	0.86	1500	60	110	2.4×10^{28}	1.7×10^{25}
1988 September 6	1.39	0.92	2130	–	120	3.5×10^{28}	–
1988 September 14	1.38	0.94	2100	65	100	3.6×10^{28}	1.8×10^{25}
1988 September 29	1.39	1.02	2510	70	130	3.8×10^{28}	2.2×10^{25}
1988 October 4	1.40	1.04	2570	75	110	3.6×10^{28}	2.4×10^{25}
1988 October 28	1.45	1.21	2620	60	120	3.2×10^{28}	2.4×10^{25}
1988 November 15	1.52	1.36	1700	–	150	2.4×10^{28}	–
1988 December 18	1.69	1.74	510	–	140	1.0×10^{28}	–
P/Kopff							
1983 July 18	1.59	0.81	1960	50	430	5.1×10^{28}	3.5×10^{25}
P/Tempel-1							
1983 July 18	1.50	1.00	450	20	160	1.0×10^{28}	5.4×10^{24}

model used in the derivation assumed a parent molecule velocity of 1.0 km s^{-1} independent of r. The CS production rates are also given in Table 1, assuming a short-lived parent (presumably CS_2), and the ratio Q_{CS}/Q_{H_2O} derived from the data is in the range of $5-8\times10^{-4}$, typical of all comets observed by *IUE* at this range of heliocentric distances. The H_2O production rate follows the same pre-/post-perihelion asymmetry as exhibited by the visual light curve, as has been demonstrated by Roettger *et al.* (1990).

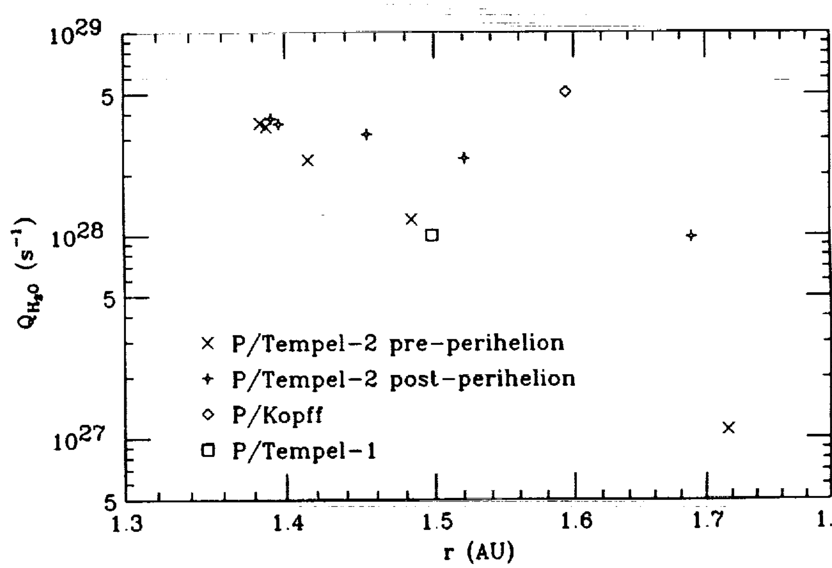

Figure 1: Water production rate as a function of heliocentric distance.

Figure 2 shows the values of $Q_{H_2O}/Af\rho$ as a function of heliocentric distance. This quantity is a measure of the gas-to-dust ratio in the coma, although it is model dependent in that the assumptions of a constant ratio of dust velocity to gas velocity and a constant dust size distribution

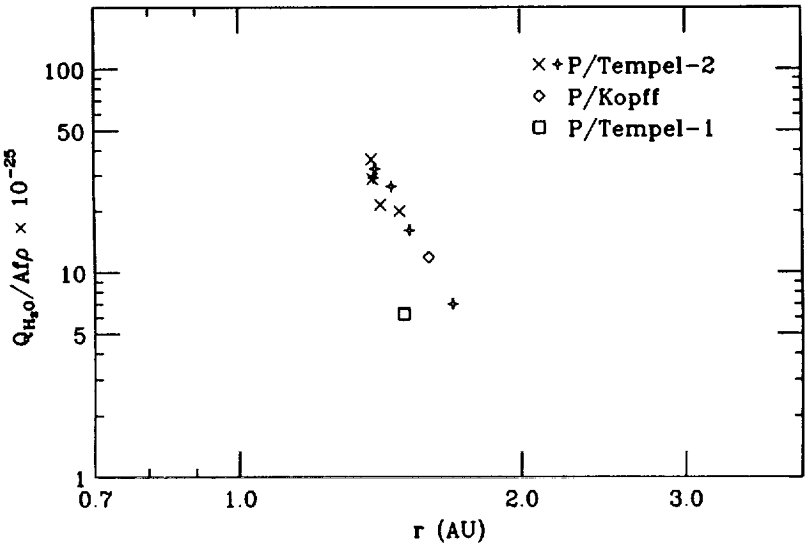

Figure 2: The ratio of water production rate to $Af\rho$ as a function of heliocentric distance.

as a function of heliocentric distance are required for this quantity to be proportional to Q_{gas}/Q_{dust}. A comparison with other comets is given in Figures 3 and 4. The first of these is an updated version of a similar figure from Feldman and A'Hearn (1985), and with the caveat noted above, indicates that at larger heliocentric distances, the ultraviolet continuum appears to dominate the gas emission. Even so, there is a clear indication of varying gas/dust ratios in this sample of comets. Figure 4 shows $Q_{H_2O}/Af\rho$ for comets P/Halley (1986 III), Wilson (1987 VII) and Bradfield (1987 XXIX), three "dusty" comets observed over a wide range of heliocentric distances by *IUE*. These data indicate a variation in gas/dust with heliocentric distance, as is also indicated for P/Tempel-2, although over a much more limited range of r, in Figure 2. For P/Tempel-2, all of the continuum measurements were made at phase angles between 40 and 46°, so a change in observational geometry cannot be responsible for the range of $Q_{H_2O}/Af\rho$ values.

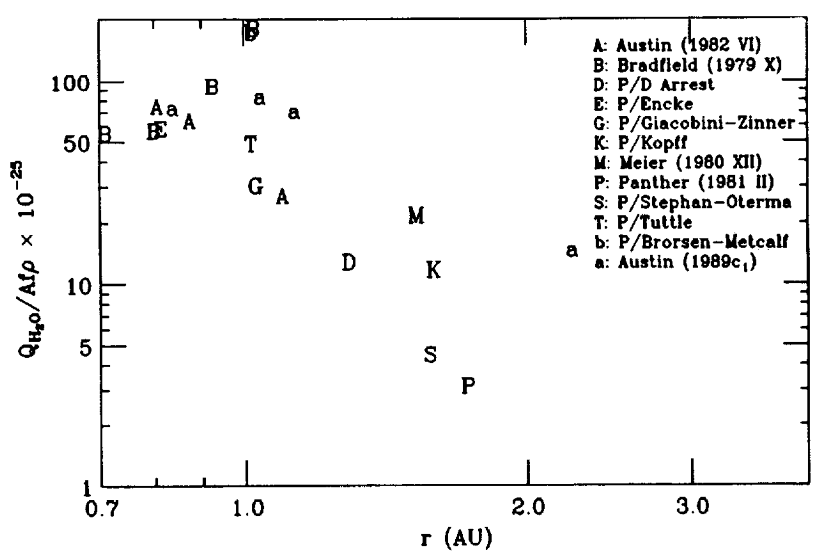

Figure 3: Same as Figure 2 for several comets observed by *IUE*.

III. OTHER CANDIDATE COMETS

Figures 1 and 2 and Table 1 also include similar data for comets P/Kopff (1983 XIII) and P/Tempel-1 (1983 XI), two other potential CRAF mission targets. These data were obtained on a single date, 18 July 1983, so that no information is available about the evolution of these comets with time from *IUE*. Nevertheless, it is possible to infer that near their perihelia P/Kopff is somewhat more active and "dustier" than P/Tempel-2, while P/Tempel-1 is less active and also fairly "dusty".

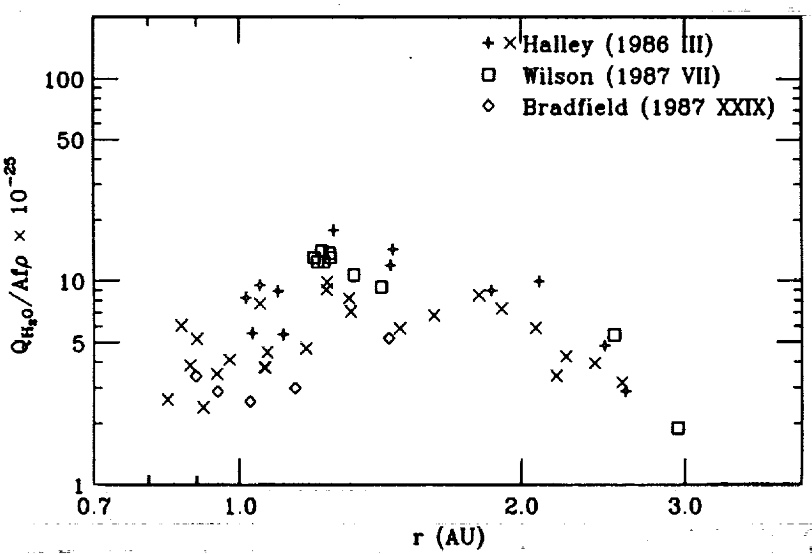

Figure 4: Same as Figure 2 for three "dusty" comets.

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