






































LETTER TO THE EDITOR

## The two rings of (50000) Quaoar (Corrigendum)

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We identified an error in our opacity calculations for Quaoar’s rings in the original paper.

We used the Cuzzi (1985) calculations to obtain the ring opacity, accounting for both the Fresnel diffraction caused by the ring and the Airy diffraction caused by individual particles. These calculations show that the actual ring optical depth is half the apparent optical depth observed during Earth-based stellar occultations, as detailed in the correct equations of our Appendix E. However, this correction was applied twice in our fitting code, resulting in optical depths underestimated by a factor of two in the text and Table E.1.

The corrected values of optical depths are listed in Table 1 below, with the associated corrections on equivalent widths and equivalent depths. This does not change the main conclusion of the original paper, but using the incorrect normal optical depths

presented previously would result in underestimated values of the particle filling factor and thus collision rate. Also, when ring photometry becomes available, it would underestimate the particle albedo.

Moreover, we mentioned an optical depth peaking at  $\tau_N \sim 0.4$  for the dense part of ring Q1R. Previously, this value was obtained from the equivalent optical depth and the full width at half maximum (FWHM) of the fitted Lorentzian. Here we used the exact peak value to calculate the normal opacities,  $p_N$ , and optical depths,  $\tau_N$ , for the Q1R dense region.

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**Table 1.** Revised physical parameters of rings Q1R and Q2R.

Ring	Detection	Mid-time August 9th, 2022	$r$ (km)	$W_r$ (km)	$p_N$	$\tau_N$	$E_p$ (km)	$A_r$ (km)
Q1R- ing	CFHT	06:31:15.8 (0.1)	3,994.5 (2.0)	105.6 (4.4)	0.0059 (0.0004)	0.0060 (0.0004)	0.6 (0.2)	0.6 (0.2)
	Gemini (z')	06:31:15.72 (0.02)	3,995.5 (0.4)	76.5 (0.9)	0.0051 (0.0002)	0.0052 (0.0002)	0.4 (0.1)	0.4 (0.1)
	Gemini (r')	06:31:15.69 (0.04)	3,995.9 (0.6)	85.5 (1.4)	0.0066 (0.0006)	0.0066 (0.0006)	0.6 (0.2)	0.6 (0.2)
Q1R- egr	CFHT <sup>(a)</sup>	06:38:32.58 (0.07)	4,123.69 (0.05)	6.09 (0.11)	0.17 (0.02)	0.2 (0.1)	2.01 (0.03)	2.41 (0.03)
	Gemini (z') <sup>(a)</sup>	06:38:32.44 (0.04)	4,122.88 (0.02)	5.29 (0.06)	0.18 (0.02)	0.26 (0.06)	1.87 (0.02)	2.21 (0.02)
	Gemini (r') <sup>(a)</sup>	06:38:32.43 (0.04)	4,122.62 (0.04)	5.1 (0.1)	0.17 (0.03)	0.2 (0.1)	1.74 (0.03)	2.03 (0.03)
	TUHO	06:38:37.4 (0.4)	4,113.6 (7.7)	78 (18)	0.06 (0.02)	0.07 (0.03)	4.6 (3.5)	5.2 (4.0)
	TAOS II	06:34:55.7 (0.3)	4,131.4 (4.5)	35 (16)	0.09 (0.04)	0.12 (0.06)	3.3 (3.1)	4.0 (3.9)
Q2R- ing	CFHT	06:32:43.86 (0.09)	2,490.6 (1.5)	16.1 (3.3)	0.0045 (0.0008)	0.0045 (0.0008)	0.07 (0.04)	0.07 (0.04)
	Gemini (z')	06:32:43.60 (0.04)	2,493.9 (0.6)	11.3 (1.1)	0.0065 (0.0009)	0.0065 (0.0009)	0.07 (0.04)	0.07 (0.04)
	Gemini (r')	n.d. <sup>(b)</sup>	n.d. <sup>(b)</sup>	n.d. <sup>(b)</sup>	n.d. <sup>(b)</sup>	n.d. <sup>(b)</sup>	n.d. <sup>(b)</sup>	n.d. <sup>(b)</sup>
Q2R- egr	CFHT	06:37:00.21 (0.02)	2,540.8 (0.3)	11.2 (0.4)	0.0090 (0.0009)	0.0092 (0.0009)	0.10 (0.04)	0.10 (0.04)
	Gemini (z')	06:37:00.08 (0.02)	2,540.4 (0.3)	6.8 (0.8)	0.009 (0.001)	0.010 (0.001)	0.06 (0.03)	0.06 (0.03)
	Gemini (r')	06:36:59.91 (0.08)	2,537.7 (1.3)	9.4 (2.9)	0.006 (0.002)	0.007 (0.002)	0.06 (0.05)	0.06 (0.05)

**Notes.** The normal opacity,  $p_N$ , and normal optical depth,  $\tau_N$ , were calculated from the ring opening angle,  $B$ , and position angle,  $P$ , on August 9, 2022, derived from the orientation of the body obtained from the 2018–2022 data. The other parameters are: mid-time in UT and the error bars in parentheses given in seconds;  $r$ , the radial distance from Quaoar’s center in kilometers;  $W_r$ , the radial width in kilometers;  $E_p$  and  $A_r$ , the equivalent width and equivalent depth in kilometers, respectively. The terms “ing” and “egr” stand for ingress and egress, respectively, and refer to the fact that the detection occurred before and after the occultation by Quaoar’s main body, respectively. The error bars in parentheses are at the  $1\sigma$  level. <sup>(a)</sup>From Lorentzian fit. The width  $W_r$  is defined as the FWHM of the  $\tau_N$  profile. The  $E_p$  and  $A_r$  values were obtained from respective integrals in the ring profile (see Sect. 3 of original file); <sup>(b)</sup>Not detected.