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Supplementary information

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An upper limit on late accretion and water delivery in the Trappist-1 exoplanet system

Sean N. Raymond[1], Andre Izidoro[2], Emeline Bolmont[3], Caroline Dorn[4], Franck Selsis[1], Martin Turbet[3], Eric Agol[5], Patrick Barth[6,7,8], Ludmila Carone[9], Rajdeep Dasgupta[2], Michael Gillon[10], Simon L. Grimm[11]

Supplementary Information

Exact orbital configurations of the Trappist-1 system that were used in our analysis

As explained in the Methods, we tested four different best-fit orbital configurations of the system, each drawn from Agol et al.[1] They are listed in Table 1.

Interior structure modeling to estimate the water contents of the Trappist-1 planets

In Tables 2-6 we include the full results of our interior structure modeling described in the Methods. Each of the five tables contains the derived water contents (including the means, 1-σ and $2-\sigma$ errors) for each planet.

1. Agol, E. et al. Refining the Transit-timing and Photometric Analysis of TRAPPIST-1: Masses, Radii, Densities, Dynamics, and Ephemerides. The Planetary Science Journal **2**, 1 (2021). 2010.01074.

Planet	Mass ($M_\oplus$)	Radius ($R_\oplus$)	Semimajor Axis a (AU)	Eccentricity e	Longitude of periastron ϖ (°)	Mean Anomaly M (°)
Fiducial (Set 1)						
b	1.3925	1.1174	0.011551	0.002344	253.61247	105.78489
c	1.2943	1.0967	0.015820	0.001224	132.62793	54.89836
d	0.3958	0.7880	0.02229	0.005045	202.45580	171.39157
e	0.6824	0.9200	0.02930	0.007013	52.42997	30.97582
f	1.0634	1.0448	0.038551	0.008298	170.04247	247.44087
g	1.3464	1.1294	0.046896	0.003760	355.97714	87.27858
h	0.3198	0.7552	0.061963	0.003571	172.18673	118.58431
Set 2						
b	1.3925	1.1174	0.011551	0.004677	181.37652	178.45848
c	1.2896	1.0979	0.015821	0.002755	276.77544	270.77957
d	0.3909	0.7889	0.022289	0.007069	217.02820	156.90568
e	0.7068	0.9210	0.029296	0.005359	44.52192	38.91996
f	1.0477	1.0460	0.038551	0.009050	179.50878	238.00290
g	1.3232	1.1307	0.046896	0.003686	335.57244	107.74799
h	0.3309	0.7561	0.061965	0.003714	188.97120	101.87152
Set 3						
b	1.3405	1.1174	0.011550	0.003402	194.66082	165.01640
c	1.3062	1.0979	0.015818	0.000802	196.57200	351.02606
d	0.3987	0.7889	0.022290	0.006354	210.05726	163.88358
e	0.7003	0.9210	0.029295	0.005947	51.87353	31.58265
f	1.0777	1.0460	0.038549	0.008950	175.24378	242.26801
g	1.3652	1.1307	0.046897	0.003526	347.44533	95.88219
h	0.3404	0.7561	0.061966	0.003855	172.27644	118.53050
Set 4						
b	1.3370	1.1174	0.011551	0.000611	167.48106	191.83734
c	1.2811	1.0979	0.015818	0.004240	330.78097	216.35048
d	0.3803	0.7889	0.022288	0.005124	210.85020	162.86095
e	0.7112	0.9210	0.029294	0.007072	45.29093	38.04304
f	1.0464	1.0460	0.038551	0.007802	173.00821	244.39623
g	1.3231	1.1307	0.046892	0.004384	352.07474	91.11644
h	0.3050	0.7561	0.061960	0.003833	182.31057	108.43892

Table 1: Starting orbital configurations of the Trappist-1 system that were used in our simulations. The fiducial system is at the top (and referred to as Set 1 in our tests). In all systems the planets' orbits have zero inclinations, but in our simulations rogue planets and planetesimals were given non-zero inclinations to ensure that the systems were not 2-dimensional. Each system was taken from the best-fit posteriors of Agol et al.[1]

Planet	Mean water content by mass	Uncertainties (1σ)	Uncertainties (2σ)
b	–	–	–
c	–	–	–
d	–	–	–
e	6.88×10^{-3}	$^{+1.58\times10^{-2}}_{-6.88\times10^{-3}}$	$^{+4.31\times10^{-2}}_{-6.88\times10^{-3}}$
f	2.05×10^{-2}	$^{+1.69\times10^{-2}}_{-1.20\times10^{-2}}$	$^{+4.40\times10^{-2}}_{-2.05\times10^{-2}}$
g	3.64×10^{-2}	$^{+1.84\times10^{-2}}_{-1.42\times10^{-2}}$	$^{+4.82\times10^{-2}}_{-2.66\times10^{-2}}$
h	3.53×10^{-2}	$^{+4.37\times10^{-2}}_{-3.02\times10^{-2}}$	$^{+9.57\times10^{-2}}_{-3.53\times10^{-2}}$

Table 2: Water contents from interior model i.

Planet	Mean water content by mass	Uncertainties (1σ)	Uncertainties (2σ)
b	–	–	$^{+3.11\times10^{-5}}$
c	–	–	–
d	–	–	–
e	1.60×10^{-2}	$^{+1.88\times10^{-2}}_{-1.21\times10^{-2}}$	$^{+4.66\times10^{-2}}_{-1.60\times10^{-2}}$
f	3.25×10^{-2}	$^{+1.74\times10^{-2}}_{-1.36\times10^{-2}}$	$^{+4.50\times10^{-2}}_{-2.43\times10^{-2}}$
g	4.90×10^{-2}	$^{+1.89\times10^{-2}}_{-1.47\times10^{-2}}$	$^{+4.94\times10^{-2}}_{-2.78\times10^{-2}}$
h	4.70×10^{-2}	$^{+4.46\times10^{-2}}_{-3.37\times10^{-2}}$	$^{+9.65\times10^{-2}}_{-4.70\times10^{-2}}$

Table 3: Water contents from interior model ii.

Planet	Mean water content by mass	Uncertainties (1σ)	Uncertainties (2σ)
b	–	$^{+1.05\times10^{-5}}$	$^{+6.89\times10^{-5}}$
c	–	–	$^{+2.69\times10^{-5}}$
d	–	–	–
e	2.75×10^{-2}	$^{+2.06\times10^{-2}}_{-1.57\times10^{-2}}$	$^{+5.03\times10^{-2}}_{-2.59\times10^{-2}}$
f	4.59×10^{-2}	$^{+1.88\times10^{-2}}_{-1.46\times10^{-2}}$	$^{+4.84\times10^{-2}}_{-2.76\times10^{-2}}$
g	6.40×10^{-2}	$^{+2.03\times10^{-2}}_{-1.60\times10^{-2}}$	$^{+5.31\times10^{-2}}_{-3.03\times10^{-2}}$
h	6.11×10^{-2}	$^{+4.68\times10^{-2}}_{-3.79\times10^{-2}}$	$^{+1.01\times10^{-1}}_{-6.11\times10^{-2}}$

Table 4: Water contents from interior model iii.

Planet	Mean water content by mass	Uncertainties (1σ)	Uncertainties (2σ)
b	–	$+1.65\times10^{-5}$	$+1.25\times10^{-4}$
c	–	–	$+5.11\times10^{-5}$
d	–	–	–
e	3.69×10^{-2}	$+2.14\times10^{-2}$ -1.76×10^{-2}	$+5.17\times10^{-2}$ -2.96×10^{-2}
f	5.61×10^{-2}	$+1.95\times10^{-2}$ -1.54×10^{-2}	$+5.00\times10^{-2}$ -2.87×10^{-2}
g	7.49×10^{-2}	$+2.12\times10^{-2}$ -1.64×10^{-2}	$+5.56\times10^{-2}$ -3.14×10^{-2}
h	7.16×10^{-2}	$+4.77\times10^{-2}$ -4.02×10^{-2}	$+1.03\times10^{-1}$ -6.91×10^{-2}

Table 5: Water contents from interior model iv.

Planet	Mean water content by mass	Uncertainties (1σ)	Uncertainties (2σ)
b	–	–	
c	–	–	–
d	–	–	–
e	–	$+2.55\times10^{-2}$	$+4.92\times10^{-2}$
f	7.01×10^{-3}	$+1.39\times10^{-2}$ -7.01×10^{-3}	$+3.91\times10^{-2}$ -7.01×10^{-3}
g	2.01×10^{-2}	$+1.70\times10^{-2}$ -1.20×10^{-2}	$+4.50\times10^{-2}$ -2.01×10^{-2}
h	2.13×10^{-2}	$+3.98\times10^{-2}$ -2.13×10^{-2}	$+9.04\times10^{-2}$ -2.13×10^{-2}

Table 6: Water contents from interior model v.