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Table 1 Measured gravity harmonic coefficients of Saturn (un-normalized; reference radius 60330 km) and total ring mass (in units of Mimas' mass).

The J_2 value includes a constant tidal term owing to the average tidal perturbation from the satellites. The associated uncertainties are recommended values to be used for analysis and interpretation. For the zonal harmonics they correspond to 3 times the formal uncertainties. The solution for the total ring mass (A+B+C) is stable independently of the adopted dynamical model (table S2) and the uncertainty reported is the 1σ formal uncertainty. See table S2 for our total ring mass estimates for several models of the unknown accelerations.

	Value	**Uncertainty**
J_2 (x10^6)	16290.573	0.028
J_3 (x10^6)	0.059	0.023
J_4 (x10^6)	-935.314	0.037
J_5 (x10^6)	-0.224	0.054
J_6 (x10^6)	86.340	0.087
J_7 (x10^6)	0.108	0.122
J_8 (x10^6)	-14.624	0.205
J_9 (x10^6)	0.369	0.260
J_{10} (x10^6)	4.672	0.420
J_{11} (x10^6)	-0.317	0.458
J_{12} (x10^6)	-0.997	0.672
Ring mass (M_M)	0.41	0.13

Table 2 Comparison of observed and calculated gravitational harmonics (un-normalized; reference radius 60330 km).

Where two values are given they denote the minimum and maximum values from the suite of models. The physical models in column 3 match the observed J_2 and J_4 in Table 1, over a parameter space considering ranges of S_{met}, Y_{mol}, Z_{mol}, r_c and rotation periods from 10h32m44s to 10h47m06s. For the same span of rotation periods, column 4 reports a wider range from models that match only J_2 and allow for density modifications assuming r_c = 0.2. For J_6-J_{10}, the discrepancy between measurements and uniform rotation models is large for all models that assume uniform rotation. Column 5 shows a representative model with DR on cylinders and a deep rotation period of 10h39m22s that matches measurements from J_2 to J_{10}.

	Measurements	Physical models with uniform rotation		Uniform rotation model with modified density profiles		Physical model with differential rotation
J_2	16290.573 ± 0.028	16290.57		16290.57		16290.573
J_4	-935.314 ± 0.037	-935.31		-990.12	-902.93	-935.312
J_6	86.340 ± 0.087	80.74	81.76	75.69	90.42	86.343
J_8	-14.624 ± 0.205	-8.96	-8.70	-10.26	-7.97	-14.616
J_{10}	4.672 ± 0.420	1.08	1.13	0.97	1.33	4.677

Table 3 Contribution to the higher gravity harmonics ΔJ_8 and ΔJ_{10} resulting from differential rotation and thermal-wind optimization.

The deviation (Column 1) is the difference between the measured J_8 and J_{10} (Table 1) and the average of the computed values from the 11 CMS models with uniform rotation (Table 2). Two optimizations are shown: one without latitudinal truncation of the zonal flow, resulting in the reconstructed zonal wind profile shown in Fig. 4A and with a flow depth of 9363 km (Column 2), and the second with the flows truncated at latitude 60° (Fig. 4B) and a flow depth of 8832 km (Column 3). Columns 4 and 5 show the deviations calculated with the thermal-gravity equation (*48*) for similar wind profiles. The solutions from thermal wind are closer to the measurement because the optimization was done using the thermal wind method, but the thermal-gravity solutions also match the observations within 10%.

	Deviation	Thermal-wind solution	Thermal-wind solution truncated at latitude 60°	Thermal-gravity solution	Thermal-gravity solution truncated at latitude 60°
ΔJ_8	-5.600 ± 0.205	-5.624	-5.533	-5.758	-5.759
ΔJ_{10}	3.528 ± 0.659	3.570	3.660	3.974	4.037