

## Mercury Coordinate System Parameters for final MESSENGER PDS products

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Parameter	IAU Value (2011)	Uncertainty	Proposed Value	Uncertainty	Source	Comments
Pole position, Right ascension, Declination (degrees)	281.0097 61.4143	Not specified	281.0103 61.4155	0.0014	Margot et al. (2012)	
Libration amplitude (arc seconds)	35.8	Not specified	38.5	1.6	Margot et al. (2012)	The full libration parameters are in the table below. The new magnitudes are scaled from 2009 values by the ratio of the old to new amplitudes.
Rotation rate (°/Earth day)	6.1385025	Not specified	6.1385108	0.000001	Mazarico et al. (2014)	Equivalent to a rotation period of $58.646146 \pm 0.000011$ days
Prime meridian, $W_0$ (degrees)	329.5469	Not specified	329.5988	0.0037	Stark (2015)	Hun Kal at 340°E. Includes adjustment for rotation rate. Uncertainty limited by knowledge of Hun Kal from images.
Mean radius (km)	2439.7	1.0	2439.4	0.1	Perry et al. (2015)	
Libration parameters	See below	Not specified	See below	Not specified	Margot et al. (2012)	

Libration parameters: IAU (Archinal et al., 2011; Table 1)			Proposed values (Margot et al., 2012)		
Precession angles and rates		Precession amplitude	Precession angles (higher precision)		Precession amplitude
Degrees	Degrees per Julian century	Degrees	Degrees	Degrees per Julian century	Degrees
174.791 086	149,472.535 875	+0.009 938 22	174.791 085 7155	149,472.535 875	+0.010 672 57
349.582 171	298,945.071 750	-0.001 045 81	349.582 171 4311	298,945.071 750	-0.001 123 09
164.373 257	448,417.607 625	-0.000 102 80	164.373 257 1466	448,417.607 625	-0.000 110 40
339.164 343	597,890.143 500	-0.000 023 64	339.164 342 8622	597,890.143 500	-0.000 025 39
153.955 429	747,362.679 375	-0.000 005 32	153.955 428 5777	747,362.679 375	-0.000 005 71

## Sources for proposed parameter values

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## Explanatory note on derivation of quantities

The forced libration amplitude of  $35.8 \pm 2$  arc-seconds was originally published by Margot et al. (2007). This value was used by Margot (2009) to derive the various quantities in the model for  $W$ , which were, in turn, reproduced by Archinal et al. (2011), and the values in question are codified as the accepted International Astronomical Union (IAU) numbers.

Margot et al. (2012) provided an updated libration amplitude (with error) of  $38.5 \pm 1.6$  arc seconds along with the corresponding value of  $(B - A) / C_m = (2.18 \pm 0.09) \times 10^{-4}$ . The model values for  $W$  were not given explicitly by Margot et al. (2012). However, referring back to Margot (2009): "In the proposed model only the coefficients in the trigonometric series depend linearly on  $(B-A)/C$ , so it is straightforward to incorporate improved estimates of the moment differences."

The value used in 2009 was  $(B-A)/C = 2.03 \times 10^{-4}$ , whereas the improved value obtained in 2012 was  $(B-A)/C = 2.18 \times 10^{-4}$ . The ratio of the two is 1.07389162. Multiplying the 2009 coefficients by that ratio provides the proposed coefficients (listed in the table above, e.g.,  $1.07389162 \times 0.00993822 = 0.01067257$ ).

Hence, even though the actual values of the coefficients were not provided in the 2012 paper, the 2009 and 2012 papers do contain all the information required to construct the proposed coefficients, which are provided explicitly in the table herein.