



The Topography and Gravity of Mercury from the MESSENGER Flybys of 2008

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In January and October 2008, the MESSENGER spacecraft passed within 200 km of the surface of Mercury en route to Mercury orbit insertion in March 2011. Data acquired by the laser altimeter and Doppler signals from tracking the spacecraft have provided new information on the planet's equatorial shape, near-surface structure, and gravity field. During both flybys the laser altimeter made range measurements to the surface for approximately 10 minutes along ground tracks 3000 to 4000 km long just south of the planet's equator. The two ground tracks, on opposite sides of the planet, both revealed a crater-studded surface with a long-wavelength slope that we believe to be a global feature of the planet and not inconsistent with earlier radar measurements. In addition to craters, the altimeter sampled scarps and ridges – dominantly products of planet-wide contraction that accompanied cooling of the interior – whose topographic profiles provide fresh constraints on mechanical models for lithospheric deformation on Mercury. The tracking of MESSENGER provided new information about Mercury's mass and gravity field. For periods of approximately 30 minutes on both flybys the spacecraft was sensitive to the non-sphericity of the planet's gravity field. On both occasions the perturbations were larger than anticipated on the basis of the gravity field inferred from observations made during the Mariner 10 flybys of 1974-75 and could not be modeled fully by adjustments only to the planet's mass, gravitational flattening, and equatorial ellipticity. Changes in the position of Mercury and errors in the Doppler tracking data can be ruled out. The possibility that Mercury has uncompensated lunar-like mascon anomalies centered on major impact basins appears consistent with the observations.