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On the Seismological Estimation of Planetary Core Radii

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One seismological property of a liquid planetary core is the shadowing effect: If the propagation speed of seismic waves inside the core is smaller than in the overlying mantle, it acts like a collecting lens: incoming seismic waves are focused to a region antipodal to their source, and a shadow zone is created in which no direct waves arrive.

The distance at which a seismic ray arrives is an integral over the velocity structure through which it propagates. It is thus subject to trade off between velocity variations along the ray path. This trade off is used to separate the problem of core radius determination from the problem of determining the mantle structure.

A parameterization of a simplified mantle structure is presented in which the structure/distance trade off is controlled by a single dimensionless parameter, such that all mantle structures with the same controlling parameter produce the same core shadow. Although approximate in nature, this parameterization allows estimating the core radius from the extent of the core shadow for a wide variety of planetary mantles, including Mercury, Venus, Earth, Moon, and Mars, without knowing seismic wave velocities or velocity gradients within the mantle.