Opacity of the lowermost mantle

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Optical properties of the lower mantle determine its radiative thermal conductivity. Of particular importance is the opacity of lower mantle minerals in the proximity of the core-mantle boundary (CMB) as it may contribute significantly to the total thermal conductivity, which in turn governs the heat flux out of the core, enabling mantle convection and core geodynamo. Unfortunately, optical properties of lower mantle minerals at CMB P-T have never been reported due to severe experimental challenges associated with spectroscopic measurements at temperatures of several thousand Kelvin. In this work we employed statically and dynamically laser-heated diamond anvil cells combined with an ultra-bright light probe synchronized with fast time-resolved detectors to determine the opacity of the lowermost mantle. We measured the absorption coefficient of bridgmanite and ferropericlase single crystals as well as their polycrystalline aggregate (pyrolite) up to 135 GPa and 4000 K, the P-T conditions at the base of the mantle. We find that bridgmanite opacity in the visible range is doubled upon heating to 4000 K, while the opacity of ferropericlase is increased by a factor of five across the same T range. Pyrolite opacity appears consistent with the expected volume fractions of bridgmanite and ferropericlase in this potential lower mantle rock. Our spectroscopic data allowed to determine the radiative conductivity (k_{rad}) of the lowermost mantle with implication to the CMB heat flux, geodynamo mechanisms, and the age of the inner core.