Reproducing core conditions suggests Earth's outer core less dense than liquid iron

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A team of researchers affiliated with several institutions in Japan and France has found evidence that suggests the Earth's outer core is made of more than just liquid iron. In their paper published in the journal *Physical Review Letters*, the group describes simulating conditions in the

outer core and testing its properties and what they found.

Prior research has suggested that Earth's core (which is approximately 3,000 kilometers below the surface) has two major parts—its solid iron-nickel alloy inner core and a liquid iron outer core. Scientists have come to this conclusion by comparing the way seismic waves from earthquakes move through the Earth with similar waves moving through objects in their lab, and by creating and studying computer simulations.

Previous efforts to recreate the conditions in the Earth's outer core involved the use of dynamic compression experiments, but they only allowed microsecond views of the results, making it difficult to draw significant conclusions. In this new effort, the researchers sought to gain a better perspective of the Earth's core by recreating conditions in the outer core that could be held steady for as long as needed, and then testing them to see how they compared to predictions.

The work by the team involved squeezing a 10-micrometer piece of iron using two diamond anvils to 116 GPa (which is slightly less than the pressure calculated for the inner core) and then heating it (using an infrared laser) to 4350 K. At such temperatures and pressure, the iron is a liquid. The team then used X-ray scattering techniques to measure the density of the liquid iron.

The researchers found that when they compared the density of the liquid iron in their experiments with the calculated density of the liquid iron that exists in Earth's outer core, they discovered a difference. The iron in the lab was 7.5 percent denser. This suggests that that the outer core contains some other material—an element that is lighter than iron.

The researchers suggest their results may lead to a better understanding of the Earth's core and may even provide some insights into the inner workings of other planets.

More information: Yasuhiro Kuwayama et al. Equation of State of Liquid Iron under Extreme Conditions, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.165701