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It's Raining Diamonds on Neptune and Uranus

Scientists simulate the interior conditions of the icy giant planets, and produce "diamond rain."

MILWAUKEE, Wis.—In an experiment designed to mimic the conditions deep inside the icy giant planets of our solar system, scientists first observed "diamond rain" as it formed in high-pressure conditions. Extremely high pressure squeezes the hydrogen and carbon found in the interior of these planets to form solid diamonds inside a dense hydrogen plasma; the diamonds then sink slowly down further into the planet's interior.

The glittering precipitation has long been hypothesized to arise more than 5,000 miles below the surfaces of Uranus and Neptune, created from commonly found mixtures of just hydrogen and carbon.

Researchers simulated the environment found inside these planets by creating shock waves in plastic with an intense optical laser at the Matter in Extreme Conditions (MEC) instrument at SLAC National Accelerator Laboratory's X-ray free-electron laser, the Linac Coherent Light Source (LCLS). SLAC is one of 10 U.S. Department of Energy Office of Science laboratories; MEC is funded by Fusion Energy Sciences.

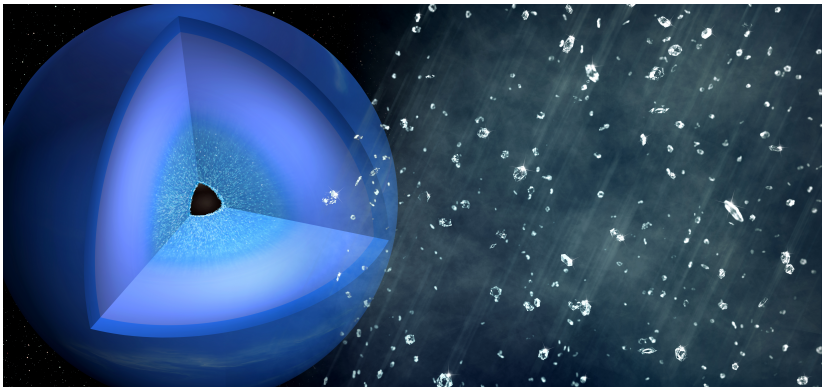

Figure 1: This new study implies that diamonds, of millions of carats in weight, are formed in the icy giant planets of Neptune and Uranus which fall through the dense interior layers as diamond rain.

In the experiment, the scientists saw that nearly every carbon atom of the original plastic was incorporated into small diamond structures up to a few nanometers wide. On Uranus and Neptune, the study authors predict that diamonds would become much larger, maybe millions of carats in weight (Figure 1). Researchers also think it's possible that over thousands of years, the diamonds slowly sink through the planets' interior layers and assemble into a thick layer around the core.

"Previously, researchers could only assume that the diamonds had formed," said Dominik Kraus, scientist at Helmholtz Zentrum Dresden-Rossendorf and lead author on the

publication. “When I saw the results of this latest experiment, it was one of the best moments of my scientific career.”

“For this experiment, we had LCLS, the brightest X-ray source in the world,” said Siegfried Glenzer, professor of photon science at SLAC and a co-author of the paper. “You need these intense, fast pulses of X-rays to unambiguously see the structure of these diamonds, because they are only formed in the laboratory for such a very short time by the pressure of the plasma created by the laser.” The extreme conditions under which tiny diamonds form lasted only for a few femtoseconds, or quadrillionths of a second.

These experimental results are the first unambiguous observation of high-pressure diamond formation from mixtures. The results agree with theoretical predictions about the extreme conditions under which such precipitation can form, and will provide scientists with better information to describe and classify other worlds.

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Abstract

UI3.00004	Dense plasma chemistry of hydrocarbons at conditions relevant to planetary interiors and inertial confinement fusion
Session	UI3: Complex plasmas and reconnection 2:00 PM–5:00 PM, Thursday, October 26, 2017 Room: 103ABC