FOR IMMEDIATE RELEASE
November 16, 2015
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Made to order: Researchers discover a new form of crystalline matter

Experiments reveal a new type of imposed ordering of particles in dusty plasma.

SAVANNAH, Ga.—Dust is everywhere: under the bed, on the stairs and even inside of plasmas. A team of researchers from Auburn University, the University of Iowa and the University of California, San Diego, using the new Magnetized Dusty Plasma Experiment (MDPX), the first U.S. experiment of its kind, recently discovered a new form of crystalline-like matter in strongly magnetized dusty plasma.

A feature of dusty plasmas is that under the proper conditions, usually at higher gas pressures, the dust particles can form self-organized, hexagonal structures—a configuration known as a "plasma crystal."

The striking aspect of the newly discovered crystal structures is that the lattice (spacing between crystal particles) properties can be imposed arbitrarily by an external grid/mesh structure (Figure 1). These new made-to-order crystals can have any geometric pattern, making them distinct from the crystal lattices of ordinary solids and traditional plasma crystals, which are self-organized structures not imposed by external boundary conditions.

In space, scientists observe large dust structures in star-forming regions such as planetary nebula. Small dust grains—the thickness of human hair or smaller—form amazing

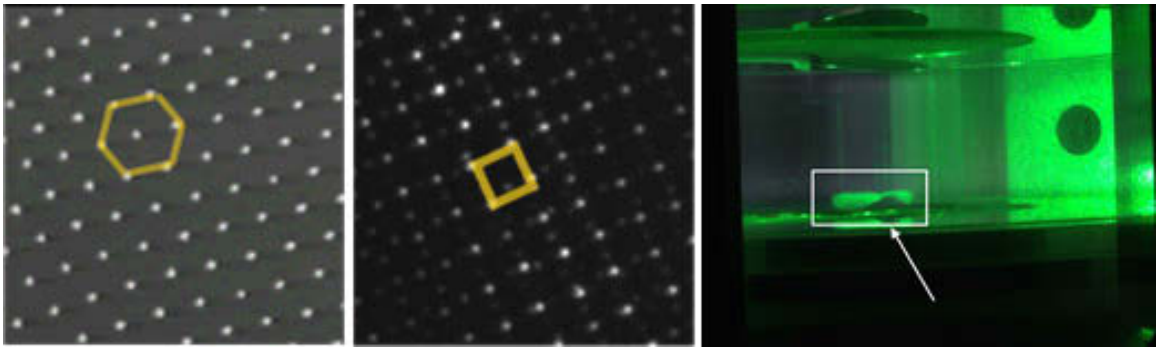

Figure 1: [Left] Typical plasma crystal with a self-ordered, hexagonal arrangement of dust particles indicated by the bright white spots (Courtesy, Max Planck Institute). [Middle] Made to order square pattern formed in an imposed dust crystalline-like structure. [Right] A typical dusty plasma illuminated by a green laser in the MDPX experiment at Auburn University.

structures such as Saturn's rings and the long tails of comets. Most of these naturally-occurring dusty plasma systems have a very complex interaction between plasma, magnetic fields and these tiny, charged grains of dust.

On the Earth, this same mixture of plasma, magnetic fields and charged dust grains, is often present in many industrial and research plasmas from semiconductor manufacturing to fusion experiments. In some cases, the dust is considered to be a source of contamination that needs to be controlled and safely removed from the plasma. But, if the properties of smaller (nanometer-scale) particles can be controlled and manipulated, they could prove to be an important tool in the future of plasma manufacturing.

Ongoing studies on the MDPX show the ability to control the shape of these ordered structures and where they are suspended in the plasma (Figure 2). In the future, this discovery could lead to new approaches to trapping and controlling micro-particles in plasma and further efforts in designing their properties for both fundamental physics investigations and possible processing and industrial applications.

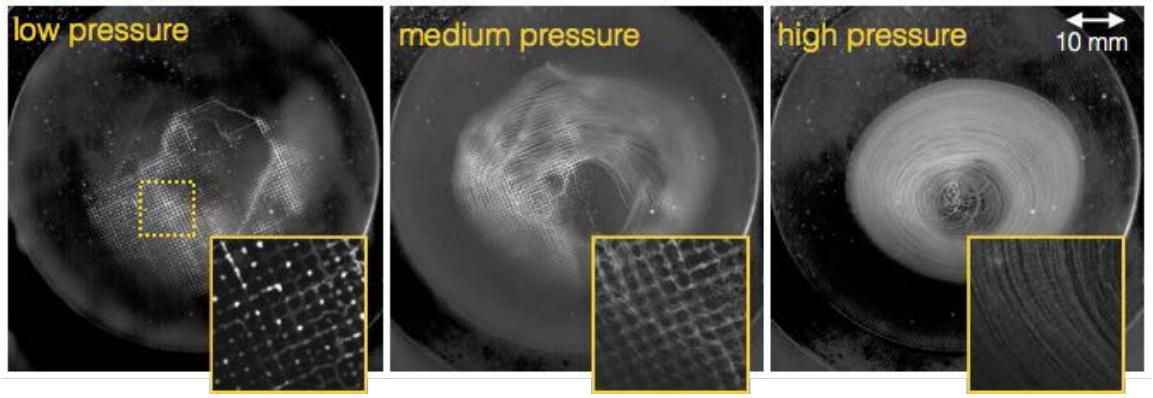

Figure 2: Breakup of the dust grid structure is observed as the background neutral pressure is increased from low to high pressure. Each image is a sum of over 100 individual picture frames to reveal the motion of the dust particle trajectories. With increasing pressure the particles "unlock" from the grid generated crystal and begin to flow, first from lattice site to lattice site, and then forming a swirling pattern at high pressure. The yellow boxes show close-ups of the observed particle pattern at different pressures for the area highlighted in the left figure.

This work was supported by the U.S. Department of Energy under grant number DE - SC0010485 and by the National Science Foundation under grant numbers PHY-1301881 and PHY-1301856.

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Abstracts:

JP12.00034 Analysis of particle trajectories in a simulated, magnetized dusty plasma in a radially-increasing electric field

NI2.00001 Summary of initial results from the Magnetized Dusty Plasma Experiment (MDPX) device

UP12.00057 A Single Particle Deflection Experiment for MDPX

UP12.00059 Probe induced voids at high magnetic field

UP12.00060 Imposed, ordered dust structures and other plasma features in a strongly magnetized plasma

Sessions

Session JP12: Poster Session IV (Education and Outreach; Undergraduate/High School Research; DIII-D I, Diagnostics and Simulation Methods; Low Temperature Plasmas, Breakdown, Thrusters, and Sheaths)
2:00 PM–5:00 PM, Tuesday, November 17, 2015
Room: Exhibit Hall A

Session NI2: Waves and Instabilities
9:30 AM–12:30 AM, Wednesday, November 18, 2015
Room: Chatham Ballroom C

Session UP12: Poster Session VIII (Pinches, Diagnostics, Codes and Modeling, One Component, Laser-Plasma Ions, Strongly Coupled and Dusty Plasmas)
2:00 PM–5:00 PM, Thursday, November 19, 2015
Room: Exhibit Hall A