Experimental observation of large 2D plasma crystals

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Two-dimensional (2D) complex plasma crystals are popular model systems where various generic as well as plasma-specific phenomena can be studied in real time at the level of individual particles. System-size dependence of the plasma crystal properties is an important issue which is not fully understood due to the limited size (and particle number) of the crystals obtained so far. To achieve larger plasma crystals, a new experimental setup was built at the DLR Institute of Materials Physics in Space [1]. It is based on a relatively large (90 cm in diameter) vacuum chamber where a capacitively coupled radio-frequency (rf) discharge is used to suspend a 2D cloud of micrometer-size polymer particles. The discharge is created between the lower rf electrode and the grounded chamber walls, the particles levitate in the plasma (pre)sheath above the electrode.

	Present work	Literature (see [1])
Crystal diameter (cm)	27	5–6
Number of particles	34000	5000–15000
Interparticle spacing (mm)	1.4	0.6–0.8
1^{st} peak of $g(r)$, magnitude	16	6–8

The main parameters of the 2D plasma crystal obtained in an experiment with argon pressure of 0.4 Pa and discharge power of 150 W are shown in the Table. The particles were arranged in a triangular lattice with hexagonal symmetry. The pair correlation function for particles g(r) has a sharp first peak and fully split second peak. This plasma crystal is much larger and contains more particles than the crystals produced in previous experiments using the GEC rf reference cell. In preliminary tests, plasma crystals with a diameter of up to 50 cm were achieved.

Further tests showed that stable 2D plasma crystals can be suspended in argon plasma at the pressure as low as 0.1 Pa. In these experimental conditions, the Epstein neutral gas damping rate is a small fraction (around 0.5%) of the complex plasma's Einstein frequency. Therefore, virtually undamped dynamics can be studied in detail in this system.

1. V. Nosenko, J. K. Meyer, S. K. Zhdanov, and H. M. Thomas, AIP Advances **8**, 125303 (2018).