Quasi-magnetization of rotating dusty plasmas

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We have constructed a new experimental setup to realize and observe rotating dusty plasmas in a co-rotating frame. The “RotoDust” setup is able to create effective magnetizations, mimicked by the Coriolis inertial force, in a strongly coupled dusty plasma that are impossible to approach with superconducting magnets. At the highest rotation speed, we have achieved effective magnetic fields of 3200 T [1]. The effective magnetization $\beta = \omega_c/\omega_p$ (ratio of cyclotron to plasma frequency) reaches 0.76 which is typical for many strongly magnetized and strongly correlated plasmas in compact astrophysical objects [2].

The analysis of the wave spectra as observed in the rotating frame clearly shows the equivalence of the rotating dust cloud and a magnetized plasma. The $k \to 0$ gap frequency is found at twice the rotation frequency, which corresponds to the cyclotron frequency in a magnetized system. The excellent agreement with wave spectra from molecular dynamics simulations supports the applicability of this experimental technique to emulate large magnetic effects. Moreover, the simulations confirm that the setup can be used for quantitative studies of extended, macroscopic strongly coupled magnetized plasmas. While we have focused on the fundamental current fluctuation spectra, several other plasma properties, including diffusion [3] or viscosity, are affected by a strong magnetic field, and are now accessible experimentally. The RotoDust setup opens the way for these investigations in the near future.

References