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COMPACT, The Next Generation Complex Plasma Facility Proposed for Operation Aboard the ISS

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"COMPACT" is the most recent proposed member in a series of "microgravity" (free-fall) experiment facilities dedicated to complex/dusty plasma research. It represents a continuation as well as extension of former bi-national and multinational experiment programs that are based on the facilities "PK-3" (alias "PKE-Nefedov"), "PK-3 plus" and "PK-4" [1] from which the latter is still operated aboard the International Space Station (ISS).

Under ground based conditions microparticles embedded in a plasma (the complex plasma) are subject to sedimentation effects that typically lead to either stressed 3D systems or 2.5 D systems (stacking of just a few layers levitated by the support of the sheath electric field). The research of full three dimensional, homogeneous complex plasma is strongly impaired under gravitational influence. Particle clouds of large vertical extent of more than a couple of centimeters and thus supporting several hundreds of layers in vertical direction can still be realized, even under gravity conditions, however, only for sub-micrometer sized particles or under abandoning the background homogeneity. An example of the latter is shown in figure 1, where we have studied the physics of a complex plasma under active compression utilizing a COMPACT breadboard chamber (seen in figure 2), the "Zyflex" chamber [2].

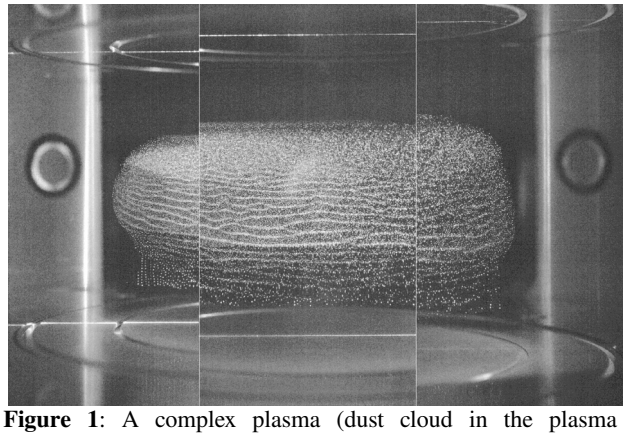

Figure 1: A complex plasma (dust cloud in the plasma background) containing millions of microparticles shows an instability driven wave pattern. Under compression of the dust cloud (images left to right the compression is released) the wave nature (wavelength and other parameters) is changing. This experiment performed under gravity conditions even though supporting a reasonable sized dust cloud, demonstrates the effects of an anisotropic plasma background that is needed to support such a large particle cloud against the gravitational force.

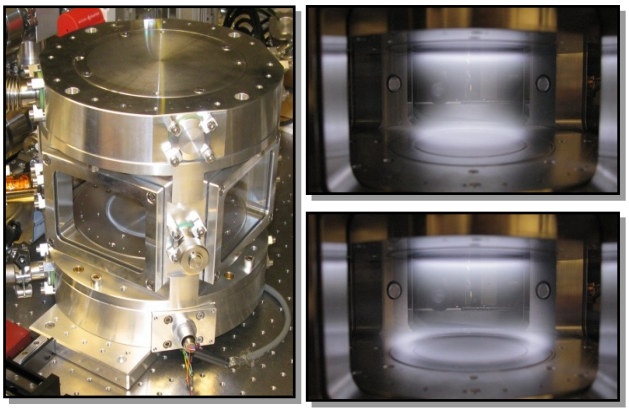

Figure 2: The COMPACT breadboard chamber (left) supported by a four channel, amplitude and phase controlled generator connected to the discharge electrodes can produce a variety of user controlled plasma environments. The right picture show just two examples, a center and mixed center/toroidal discharge.

The mission of the newly proposed experiment facility, COMPACT, include the study of complex/dusty plasma in a homogeneous, isotropic and user controlled plasma environment. It will allow to study the structure and dynamics of "large" microparticle systems, covering multi-millions of particles, down to the position and kinetics of the individual particles in the system. COMPACT therefore is expected to extend the ground based research opportunities to study fundamental question related to multi-particle system significantly. Research topics include phase transitions, crystal properties, (non-linear) waves propagation and flow kinetics (turbulence) all accessible down to their "atomic" nature in fully three dimensional systems.

In this paper we will present the status of the development of COMPACT, give an overview of its capabilities and show results from recent experiments that utilized its breadboard model in the lab and on parabolic flights. We anticipate to trigger a fruitful discussion on potential usage of COMPACT for complex/dusty plasma research and also grazing research fields with the intend to extend the potential users community.

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References

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