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Space experiments with dusty plasmas

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Dusty (complex) plasmas are plasmas containing small solid particles, typically in the micrometer range, the so-called microparticles. Dusty plasmas are specially prepared to study fundamental processes in the strong coupling regime on the most fundamental (kinetic) level, through the observation of individual microparticles and their interactions. Many interesting phenomena can be studied starting from small two-dimensional (2D) and three-dimensional (3D) clusters, to larger 2D and 3D systems where collective effects play a dominant role. In laboratory conditions, the microparticles are heavily affected by the force of gravity. Under microgravity conditions, e.g. on the International Space Station (ISS), gravity is negligible. It is possible to form dusty plasmas in the bulk region of plasmas in homogeneous large 3D systems and to investigate other phenomena than those accessible on Earth in detail. Since 2001, complex plasma research under microgravity conditions is continuously performed in Russian-German cooperation onboard the ISS with the long-term laboratories PKE-Nefedov and PK-3 Plus. The laboratory PK-3 Plus was perfectly suited for the formation of large stable liquid and crystalline systems and provided interesting insights into processes like crystallization and melting, laning and phase separation in binary mixtures, electrorheological effects due to AC electric fields and projectile interaction with a strongly coupled complex plasma cloud. Although the operation of the PK-3 Plus laboratory stopped in 2013, the promising research of large three-dimensional dusty plasmas will be continued with the next microgravity laboratory, PK-4. This was launched in October 2014 and is operational now and available for the next generation of experiments with dusty plasmas under microgravity conditions onboard the ISS.

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Non-rocket launch from Mars

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Return missions to Mars (especially pilot ones) will need delivering to Mars rockets and fuel that is very expensive. We propose an elevator system for safety landing to and launch from Mars. This elevator may be based on both Martian satellites, because they are synchronized. The lifting theater being connected to a satellite will not wind it around. The far end of the elevator rope will fly over Martian surface with velocity 2 km/s or 1 km/s for Phobos and Deimos respectively. If the far end of the rope will have a hook, it can capture a loop connected to space vehicle, - just like aircraft carriers do decelerate of landing airplanes. After catching, elevator can lift spacecraft from Martian surface. To decrease hook velocity it may be installed onboard of controllable kite at far elevator's end. This will make possible to evacuate a vehicle from any point of Martian surface, not only from sub-satellite trajectory. Phobos' elevator needs 9500 km tether. It is 4 times less than it believed to be for so called "geostationary" elevator and 40 times less the length of Moon-Earth elevator. If the Martian space elevator will be constructed similarly to proposed lunar one, it will lift its cargo with acceleration, so launched spacecraft would be provided with enough velocity for returning flight to the Earth.

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