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SPACEDRIVE – DEVELOPMENT OF A SUPERCONDUCTING LEVITATION THRUST BALANCE FOR PROPELLANTLESS PROPULSION

Abstract

Space travel at an interstellar scale within our lifetime is a challenge primarily relying on the propulsion system of the spacecraft. Despite the continuous advancements in electrical propulsion systems, a sufficient system for this task remains to be developed. Propellantless propulsion however is believed to be the best approach towards interstellar travel. Compared to solar sails and photon rockets, the EMDrive and Mach-effect thruster are believed to excel these systems in terms of thrust. These breakthrough propulsion concepts are not yet confirmed to be functional, thus requiring the need for advanced testing facilities. To investigate these concepts amongst others at the Institute of Aerospace Engineering at TU Dresden, a new kind of rotational thrust balance was designed. By measuring the change in angular velocity of a magnetically levitated system inside a vacuum chamber onto which the thrusters apply a torque, thrusts in the range of 1 N will be detected. Goal of the thrust balance is to reduce the probability of false measurements due to interactions between the thrusters and the environment, such as earth's magnetic field or vibrations through the balance components. Therefore, the balance is based on a magnetic levitation bearing utilizing high-temperature superconductors and permanent magnets to provide a frictionless rotational degree of freedom. Measurements of the levitation force resulted in a maximum axial load capability of 22 kg for the magnetic bearing, which is an order of magnitude above electromagnetically levitated thrust balances. Preliminary experimental setups of superconducting bearings on a smaller scale have been analyzed at atmospheric pressure towards frictional torque at angular velocities below 0.5 rad/s. The measured torque of 10e-6 Nm contains a decreasing tendency for a vacuum environment. The facility will feature a high precision optical sensor to track its angular position in order to derive the actual thrust force along its trajectory. Liquid-metal contacts will provide on-board power as well as data acquisition. A levelling mechanism will be able to adjust the centre of mass of the levitating system in order to enable full rotations for the thrusters. The facility will provide a space-like friction-free environment to test propellanteless propulsion concepts as well as complete Nanosatellites.