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PENETRATING PLANETS' SUBSURFACE – LESSONS LEARNT FROM HAMMERING MECHANISMS FOR INSIGHT HP3 AND LUNARDRILL

Abstract

In recent years, there has been a growing interest in research, not only of the surface of planets and other bodies of the Solar System, but also of subsurface properties and geophysical processes taking place inside the planets. However, due to limited tools and instruments to allow for reliable and effective performance, access to direct and in situ measurements of the characteristics of the lower regolith layers is still short. Described in the article research is motivated by the need for better understanding of the structure of the planets, their history and formation, e.g. Moon, Mars, comets. Technical realization of this task requires the use of devices that will be able to independently penetrate the surface to the desired depth and simultaneously measure regolith properties using different sensors, or even to take samples for further analysis.

The paper presents a few types of hammering mechanisms which can be successfully used in penetrators. Depending on the definition of the mission objectives, the type of the celestial body analyzed, its size and soil structure – a different penetration system will be an optimal fit for a given mission. A comparison of various types of penetrators' driving systems (DC motor with cam mechanism, reluctant direct drive, DC motor with crank mechanism) is presented. This analysis is based on the experience gained during the work on Hammering Mechanism for HP3 instrument for NASA InSight mission to Mars and the Lunar Drill project for Luna-Resurs – a Roskosmos and ESA joint mission to the Moon. This experience includes design, integration and testing of fully functional hammering mechanisms: seven models of HP3 instrument (all in flight standard) and breadboard models of Lunar Drill. Penetrators' efficiency and single stroke energy with respect to the size, mass and power consumption is presented,

also in the perspective of potential uses for other bodies of the Solar System.