**FEASIBILITY OF IN SITU $^{40}$AR-$^{39}$AR DATING BY A LUNAR LANDER MISSION.**

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$^{40}$Ar-$^{39}$Ar dating of neutron-activated samples is one of the most reliable radioisotopic methods to determine the absolute age of impact metamorphosed rocks and to decipher lunar, asteroidal or terrestrial impact cratering histories [e.g., 1-6]. Hence, in-situ $^{40}$Ar-$^{39}$Ar dating at landing sites of a lunar mission is of utmost scientific importance, as the highest-priority science goals for lunar exploration are related to chronology: testing the cataclysm hypothesis, determining the age of the South Pole Aitken basin, establishing a precise absolute chronology, or dating very young basalts (~1.2 Ga) south of the Aristarchus Plateau, which likely mark the end of active volcanism on the Moon [7,8]. Though of vital scientific interest, in situ dating of planetary surfaces has not been performed up to now.

Based on a feasibility study with DLR co-funding in the frame of the "LUROP" project [9], we discuss the development of a compact self-standing in-situ dating instrument. It includes a small neutron source ($^{252}$Cf, half live 2.6 yr) and sophisticated radiation shielding. As an alternative, fusion sources may be candidates for neutron sources in the future. Due to radiation mitigation the neutron source should be deployed from the lander spacecraft. A rover or a robotic arm is required to collect the samples and for transport between neutron irradiation unit and analysis unit. After irradiation, collected samples and reference samples are heated in a furnace to achieve noble gas extraction, and are analyzed by mass spectrometry. The mass spectrometric analyses of argon and other noble gases will allow dating impact metamorphism and crystallization ($^{40}$Ar from in situ decay of $^{40}$K), as well as cosmic ray exposure ages using cosmogenic nuclides (e.g., $^{38}$Ar from Ca) and solar wind implanted noble gases, yielding information on small cratering events or regolith reworking. The mass has been estimated to be 9-15 kg (depending on the neutron source type and shielding measures, and miniaturization potential). Advantages of this concept are the superior interpretation when compared to conventional K-Ar ages and dating of both high temperature events and (low temperature) surface exposure events on the same samples, when compared, for example, to in-situ Rb-Sr dating. The proposed instrument could be part of the payload to any planetary mission.

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