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# Relevance of PHILAE and MASCOT in-situ Investigations for Planetary Defense

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## ABSTRACT

On November 12th, 2014, PHILAE successfully achieved the first ever landing on the surface of a comet, as part of the ROSETTA mission launched in 2004 towards comet 67P/Churyumov-Gerasimenko. This event was preceded during the summer of 2014 by an intense phase of remote investigation of the comet nucleus also including landing site selection. PHILAE has a mass of about 98 kg including a 26.7 kg science payload, and a deployed size of almost 1 m³. Separated at an altitude of 22.5 km, it descended to the surface in 7 hours, as expected. On landing, it however failed to anchor and rebounded unexpectedly. After surviving two more touchdowns in good health it successfully executed a scientific sequence of 55 hours which was adapted live to the unexpected conditions of the final landing site. Each of the ten instruments aboard was operated at least once. Caught in a shadowed crevice, PHILAE is expected to wake up during the summer of 2015 and then may operate longer than originally expected through the comet's perihelion.
MASCOT, the small asteroid lander launched on December 3rd, 2014, aboard the Japanese HAYABUSA-2 asteroid sample-return mission, evolved in a series of Concurrent Engineering Facility sessions at DLR Bremen from a PHILAE-like design towards the shoebox-sized 10 kg spacecraft it has become. Like PHILAE, it is also integrated aboard its mothership at science instrument level. Developed two decades after PHILAE and being an order of magnitude smaller, MASCOT has no deployable landing gear or active anchoring devices, but it has a fully contained internal uprighting and relocation device for the future in-situ investigation of different sites on the asteroid surface. It carries four full-scale asteroid science instruments.

Both landers‘ science instruments are designed to operate in conjunction with those aboard their motherships in orbit. They also send their housekeeping and scientific data to the respective mothership which then store-forwards them to Earth, with only a subset transmitted live for lander operations.
The overall picture of the small body will benefit from the combined investigation of located in-situ and global remote measurements. The recent operational experiences and first evaluation of the scientific data provided by PHILAE and ROSETTA now enable a first comparison of the results of remote and in-situ investigations, leading towards an improved understanding of the benefits and operation of landers in planetary defence applications. Results from the simultaneous operation of PHILAE and ROSETTA also provide a basis for optimized planning for MASCOT surface operations and the coordination of its science instrument activities with the orbiter, HAYABUSA-2. Combined, these will support and improve the development of the joint U.S.-ESA mission AIDA to binary near-Earth asteroid (65803) Didymos.

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