MECHANICAL PROPERTIES OF COMET 67P/CHURYUMOV-GERASIMENKO MEASURED BY CASSE AND DIM ON BOARD ROSETTA'S LANDER PHILAE

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In August 2014 the ESA spacecraft Rosetta encountered the comet 67P/Churyumov-Gerasimenko. Rosetta carried the lander Philae that landed on the comet's nucleus on November 12th 2014. Philae has ten different instruments onboard including the Surface Electric Sounding and Acoustic Monitoring Experiment (SESAME) comprising CASSE, DIM, and PP. The objective of the Rosetta mission is to determine the physical, chemical, and mineralogical properties of comet 67P by the instruments on board of the Rosetta Orbiter and the lander Philae.

The Comet Acoustic Surface Sounding Experiment (CASSE) is housed in the six soles of Philae's landing feet. Its sensors consist of three piezoelectric tri-axial accelerometers, and three transducers. This allows for both passive listening and active sounding of the comet surface. The deceleration signals occurring in the first milliseconds of the touchdown at an impact velocity of approximately 1 m/s were recorded by CASSE. They contain information on the elastic (modulus) and on the crushing strength of the cometary soil. The analysis is based on a recently developed inversion scheme exploiting an extended Hertzian contact mechanics which in turn is based on calibration landing tests on different materials /1/.

The Dust Impact Monitor (DIM) onboard Philae is a cube with three of its sides covered with PZT detectors with the associated detection electronics and data evaluation. DIM is aimed to derive the elastic-plastic properties and the flux of the millimeter-sized

dust-particle population that moves near the surface of the nucleus of the comet. Calibration experiments between -40º C and -20º C were performed to analyze the response of DIM based on Hertzian contact mechanics /2/. DIM was operated during three mission phases of Philae at the comet: (1) before the separation of Philae from Rosetta at three distances larger than 9 km where no dust particles were detected; (2) during Philae's descent to its nominal landing site Agilkia, DIM detected one approximately millimeter-sized particle at an altitude of 2.4 km from the surface; (3) at Philae's final landing site, Abydos, DIM registered no dust impact. The calibration experiments showed that the properties of the detected particle are compatible with a porous particle having a bulk density of ≈ 250 kg/m^3 /3/.

In the oral presentation, an overview is given on the data recorded so far by CASSE at the landing site Agilkia on comet 67P and by DIM during its descent to the comet surface in November 2014, their interpretation and relation to the measurement techniques employed in non-destructive materials characterization based on ultrasonics and in impact testing (Fokker bond test). The data support the concept that the elastic and strength properties of the comet material corresponds to very porous solids with porosities up to ≈ 80% and of agglomerates of regolith particles. The results of other groups in the Rosetta Mission which are related to our data will be discussed as well.

A first account of the results obtained with SESAME instruments have been reported in the references /3/ and /4/. Furthermore, a number of publications appeared in astronomy and astrophysics journals which describe the results obtained by the Rosetta mission until now. There are also three special journal issues dedicated to Rosetta. These are the Science issues of January 23rd 2015: "Catching a Comet" Vol. 347, pages 349-452 and of July 31st 2015: "Philae's First Days on the Comet" Vol. 349, pages 449-556. In the journal Astronomy & Astrophysics, Vol. 583 of November 2015, a number of papers appeared as well (http://www.aanda.org/articles/aa/abs/2015/11/contents/contents.html). There will be a special issue in Acta Astronautica as well.

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