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The Alpha Particle X-Ray Spectrometer APXS on the Rosetta lander Philae to explore the surface of comet 67P/Churyumov-Gerasimenko

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Introduction

The Rosetta Mission was launched in 2004 with the main objectives to gain a better understanding of the origin and formation of comets and the solar system. After 10 years of cruise Rosetta will rendezvous with the comet 67P/Churyumov-Gerasimenko in 2014. It will study the nucleus of the comet and its environment. Rosetta consists of an orbiter and a lander (Philae) with 11 and 9 scientific experiments respectively. It is supposed to do what has never been attempted before, orbiting and landing on a comet. After orbit insertion in 2014, the main spacecraft will follow the comet for several months to investigate its surface and subsequently, Philae will be deployed for a safe landing. As a part of the lander payload the APXS will measure in situ the chemical composition of the comet's surface and it's changes during the journey of the comet around the sun. Most theories assume that comets are pristine objects that have been formed from primordial material of the early solar nebular preserving chemical evidence for the fractionations that occurred in the solar nebula [5-6]. The data obtained with the APXS will be used to characterize the surface of the comet, to determine the chemical composition of the dust component, and to compare the dust with known meteorite types.

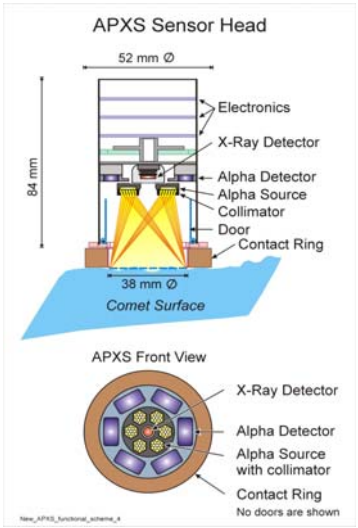

Figure 1: Functional scheme of the APXS sensor head in measurement position.

1. Experimental - APXS Sensor head

APXS combines an alpha mode for alpha backscattering spectroscopy and an x-ray mode for alpha particle/x-ray induced x-ray spectroscopy (XRF) in one single instrument, being low in mass (640g) and power consumption (1.5 W in operating mode) [5]. The comet surface will be irradiated by a Curium 244 source exciting characteristic x-rays of the elements present in the surface material. The alpha mode will allow detection of elements like C and O and groups of elements with a higher Z. The x-ray-SD-detector will allow the detection of most of the elements from Na up to Ni and above. The design of the Rosetta APX spectrometer is based on the experience gained with the APXS built for Russian and American Mars missions: Mars 96 spacecraft and Mars Pathfinder, MPF [1]. Two APXS were also built for the Mars Exploration Rovers mission of the NASA, MER [2-4].
During the long travel to the comet checkouts and software updates of the Rosetta probe and its payload are performed at regular intervals. These are used to optimise and improve the quality of the x-ray and alpha-spectra of the APXS.
Soon the Rosetta probe will go into a 3 year long hibernation mode. It will awake when approaching it's target, providing us with new exiting data that will shed light on state, evolution and origin of comets and the solar system.

2. Results

The X-ray and α-spectra measured during the first tests after launch of the mission, using the inner side of the cooper doors as calibration target,

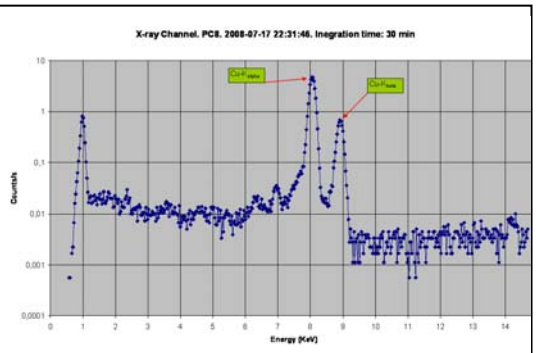

Figure 2: X-ray spectrum of the inner side of the copper doors of the APXS instrument. Lower threshold at about 1.0 keV; upper threshold at about 14.8 keV.

indicated good functionality and energy resolution of the instrument. Only the selectable settings of the lower thresholds for both the X-ray and α-channels were much to high. They had to be changed in order to be able to detect energies down to ~1 KeV for the X-ray channel and down to ~0.4 MeV for the alpha channel. These changes and optimisation of the thresholds and subsequent 7 hours long measurements of the inner cooper doors have been performed during several in-flight checkouts (PC) of the mission.

Figure 2 shows the X-ray spectrum of the copper doors obtained during PC8 in 2008 with optimised threshold values. The characteristic Cu-X-ray lines are visible with good energy resolution.

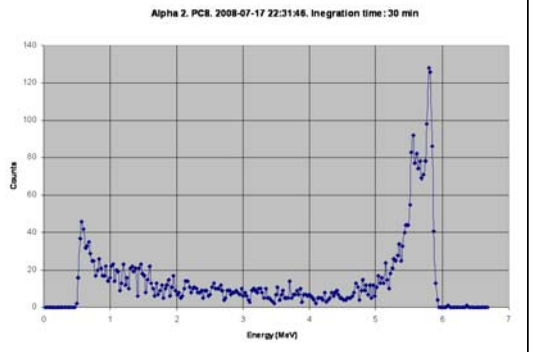

Figure 3: α - spectrum of the inner side of the copper doors of the APXS instrument. Lower threshold at about 0.4 MeV; upper threshold at about 5.8 MeV.

Figure 3 shows the α-spectrum of the copper doors obtained during PC8 in 2008 with optimised threshold values. The energy range will allow to look for low Z elements and groups of high Z elements. The Cm-lines at high energies are due to sputtered particles from the Cm source covering the inner side of the doors. They will disappear when the doors will be opened for in-situ measurements on the comet surface.

The Rosetta probe will go into a 3 year long hibernation mode by mid 2011 for its coldest part of the journey to the target comet, with an APXS instrument well prepared and ready for the On-Comet-surface mission phase of the Rosetta mission.

Acknowledgements

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