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Neutrons and gamma-rays spectroscopy of Mercury surface: global mapping from ESA MPO-BepiColombo spacecraft by MGNS instrument.

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For analyse chemistry composition of Mercury subsurface we will apply method of as-called remote sensing of neutrons. This method can be use for study celestial body of Solar system without thick atmospheres, like Moon, Mars, Phobos, Mercury etc. by the analysis of induced nuclear gamma-rays and neutron emission. These gamma-rays and neutrons are produced by energetic galactic cosmic rays colliding with nuclei of regolith within a 1-2 meter layer of subsurface.

Mercury Planetary Orbiter of BepiColombo mission includes the nuclear instrument MGNS (Mercury Gamma-rays and Neutrons Spectrometers), which consists of gamma-rays spectrometer for detection of gamma-ray lines and neutron spectrometer for measurement of the neutron leakage flux. To test know theoretical models of Mercury composition, MGNS will provide the data for the set of gamma-ray lines, which are necessary and sufficient to discriminate between the models. Neutron data are known to be very sensitive for the presence of hydrogen within heavy soil-constituting elements. Mapping measurements of epithermal neutrons and 2.2 MeV line will allow us to study the content of hydrogen over the surface of Mercury and to test the presence of water ice deposits in the cold traps of permanently shadowed polar craters of this planet. There are also three natural radioactive elements, K, Th and U, which contents in the soil of a celestial body characterizes the physical condition of its formation in the proto-planetary cloud. The data from gamma-spectrometer will allow to compare the origin of Mercury with evolution of Earth, Moon and Mars.

Three sensors for thermal and epithermal neutrons are made with similar ^{3}He proportional counters, but have different polyethylene enclosures and cadmium shielding for different sensitivity of thermal and epithermal neutrons at different energy ranges. The fourth neutron sensor for high energy neutrons 1-10 MeV contains the scintillation crystal of stylbene with cylindrical shape of size Ø30×40 cm. The gamma-rays spectrometer contains scintillation crystal of $LaBr_3$ for detection of gamma-ray photons with very high spectral resolution of 3 % at 662 keV. The total mass of MGNS instrument is 5.2 kg; it consumes 4.0 W of power and provides about 9.0 Mb of telemetry data per day.

At present, the nuclear instrument MGNS is under development for implementation on the MPO of BepiColombo mission, as the contribution of Federal Space Agency of Russia to this ESA project. In comparison of gamma-rays spectrometer onboard NASA's Messenger interplanetary probe, whitch will provide mapping data for northern hemisphere of the planet only because of elliptical orbit, the MGNS onboard MPO will provide global mapping of the planet with similar coverage of southern and northern hemispheres of the Mercury.