EPSC Abstracts
Vol. 8, EPSC2013-76, 2013
European Planetary Science Congress 2013

Gamma-ray spectroscopy of Mercury subsurface by the Mercury Gamma-ray and Neutron Spectrometer (MGNS) from MPO/BepiColombo mission

A.S. Kozyrev (1), I.G. Mitrofanov (1), M.L. Litvak (1), F. Fedosov (1), D. Golovin (1), D.I. Lisov(1), A. Malakhov (1), M. Mokrousov (1), S. Nikiforov (1), A.B. Sanin (1), V.N. Shvetsov (2), V.I. Tret'yakov (1), A. Varenikov (1), A. Vostrukhin (1), O. Demenko (3) and the MGNS Team
(1) Space Research Institute, RAS, Moscow, 117997, Russia, kozyrev@rssi.ru, (2) Joint Institute for Nuclear Research, Dubna, Russia, (3) Lavochkin Research and Production Association, Moscow region, Russia

Abstract

The nuclear instrument Mercury Gamma-ray and Neutron Spectrometer (MGNS) is under development, manufacturing and tested for implementation on the Mercury Planetary Orbiter (MPO) of BepiColombo mission, as the contribution of Federal Space Agency of Russia to ESA BepiColombo/MPO project. The science objectives and tasks are presented of MGNS. The concept of the instrument design is discussed. The calibration results of gamma-ray spectrometer of MGNS instrument are presented.

1. MGNS science

MPO of BepiColombo mission includes the nuclear instrument MGNS, 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.

2. MGNS instrument

Three sensors for thermal and epithermal neutrons are made with similar 3He 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 mm. The gamma-rays spectrometer contains scintillation crystal of LaBr3 for detection of gamma-ray photons with very high spectral resolution of 3 % at 662 keV. The total mass of MGNS instrument is 5.5 kg; it consumes 5.0 W of power and provides about 9.0 Mb of telemetry data per day.

2. Summary

At present, the flight model of the nuclear instrument MGNS is under manufactured and tested for delivery to MPO of BepiColombo project. The first data of calibration for gamma-rays spectrometer will be presented. The numerical simulation of temperature dependence of gamma-ray flux from nuclear line and neutron flux from Mercury surface will be described. The comparisons of MGNS expected data and first data from neutron and gamma-ray instrument from MESENGER will be discussed.

References

[1] Mitrofanov, I. G.; Kozyrev, A. S.; Konovalov, A.; Litvak, M. L.; Malakhov, A. A.; Mokrousov, M. I.; Sanin, A. B.; Tret'Ykov, V. I.; Vostrukhin, A. V.; Bobrovnitskij, Yu. I.; Tomilina, T. M.; Gurvits, L.; Owens, The Mercury Gamma and Neutron

Spectrometer (MGNS) on board the Planetary Orbiter of the BepiColombo mission, Planetary and Space Science, Volume 58, Issue 1-2, p. 116-124, 2010.

[2] Gun'ko, N. A.; Kozyrev, A. S.; Mitrofanov, I. G.; Tsygan, A. I., Dependence of the neutron and gamma-ray emission of Mercury on its surface composition and temperature, Astronomy Reports, Volume 56, Issue 4, pp.315-327, 2012.