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Radiation environment in the interplanetary space and Mars orbit during the declining phase of 24th solar cycle and transition to 25th cycle according measurements aboard ExoMars TGO

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The dosimetric telescope Liulin-MO for measuring the radiation environment is a module of the Fine Resolution Epithermal Neutron Detector (FREND) onboard the ExoMars TGO.

Here we present results from measurements of the charged particle fluxes, dose rates and estimation of radiation quality factors and dose equivalent rates at ExoMars TGO science orbit (circular orbit with 400 km altitude, 74^0 inclination, 2 hours orbit period), provided by Liulin-MO from May 01, 2018 to January 10, 2021.

The obtained data show that: an increase of the dose rates and fluxes is observed from May 2018 to February 2020 which corresponds to the increase of galactic cosmic rays (GCR) intensity during

the declining of the solar activity in 24th solar cycle; From March to August 2020 the measured radiation values are practically equal, corresponding to the minimum of 24th cycle and transition to 25th cycle. The highest values of the dose rate (15.5/16.2 μGy h-1 at two perpendicular directions) and particle flux (3.24/3.33 cm-2s-1 at two perpendicular directions) are registered in this period; Since September 2020 a decrease of the dose rates and fluxes is observed, corresponding to the decrease of GCR intensity during the inclination phase of the 25th cycle.

The cosmic ray fluxes and doses measured in Mars orbit are recalculated into values meaningful for the deep interplanetary space at about 1.5 AU. The flux in the free space is at least 3.68 cm-2s-1 and the dose rate is 18.9 μGy h-1 in August 2020. The results demonstrate that the radiation conditions in the interplanetary space worsen in the minimum of the solar activity in 24th cycle compared to the previous solar minimum.

Liulin-MO charged particles measurements are compared for completeness to similar measurements performed by FREND neutron detectors: the instrument's 3He neutron detectors are also a source of charged particles flux signal that can be used for correlation.

The results are of importance for benchmarking of the space radiation environment models and for assessment of the radiation risk to future manned missions to Mars.

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