Interplay between eclipses and soft cosmic rays

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Solar and lunar eclipses are very important astronomical events that provide the opportunity for studying the disturbances produced in the atmosphere due to them and their effect on cosmic ray intensity. The variation of secondary cosmic ray (SCR) flux during solar and lunar eclipses have been studied and reported earlier by several groups of researchers. Most of them observed a decrease in secondary cosmic gamma ray (SCGR) flux during the solar eclipse and enhancement of the same during lunar eclipse. Rapid reduction in solar irradiation during the eclipse causes many secondary effects on the Earth's atmosphere. The explanation for the decrease in SCGR during solar eclipse given by some groups is that a quasi-periodic pressure wave is set up in the ionosphere by the shadow band in the ozone layer which may, considerably, affect the production of SCGR. Another explanation is that π - μ component production layer of the atmosphere is lowered due to atmospheric cooling during the eclipse which shortens the path (or the time available) for decay of π^0 meson to γ-rays and μ meson to $e^{\pm}$ and induces the changes in relative cosmic ray counts. The drop of SCGR intensity during solar eclipse cannot be explained by atmospheric cooling alone because geophysical disturbances are present at all levels of the atmosphere. The interaction of the cosmic rays in the atmosphere is affected by the weather parameters and solar activities. SCGR is also affected by interplanetary parameters and tidal effects. However, there is no verified explanation for the increase of SCGR during lunar eclipse. During lunar eclipse, there is a particular geometrical alignment of the Sun, the Earth, and the Moon, which makes the tidal forces very effective, which may be the reason for the observed phenomena. We have measured the SCGR flux during an annular solar eclipse on 26 December 2019 passing over South India, and two lunar eclipses, on 31 January and 27 July in 2018 that took place in India. We have systematically measured the SCGR flux using a NaI(Tl) scintillator detector. During the annular solar eclipse, we have observed a SCGR flux decrement of 2.6 % in the energy range 150-500 keV and 3.3% in the energy range 0.5-1 MeV and 3.8% in the energy range 1-1.5 MeV. Such a kind of experiment has been carried out at high altitude (2240 m above sea level) for the first time. Weather parameters are also observed. SCGR flux is influenced by various factors such as geomagnetic field, interplanetary parameters, ionospheric parameters and space weather. Checking the correlation of these factors with the observed variation in SCGR during the eclipse is in future plan. An enhancement of 3.8% is observed in the SCGR flux of energies above 25 keV during the lunar eclipse on 31 January 2018. No changes in SCGR is observed during the lunar eclipse on July which contradicts earlier reports. Although these observations need explanation which cannot be given based only on the present measurements and need to be confirmed in future eclipses.