Interplay between eclipses and soft cosmic rays

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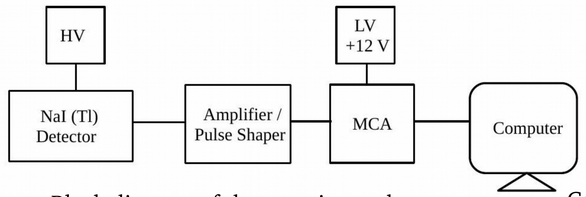
Introduction

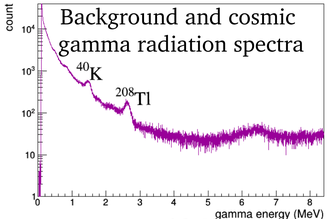
Solar and Lunar eclipses provide the opportunity for studying the disturbance produced in the earth's atmosphere by these events and its effect on cosmic ray intensity. There are earlier reports on decrease in secondary cosmic gamma ray (SCGR) flux during solar eclipse and enhancement of the same during lunar eclipse. We have measured the variation of SCGR using NaI(Tl) scintillator detector during the solar eclipse on December 26, 2019 at Cosmic Ray Laboratory, Ooty and also during two lunar eclipses that took place on 31 January, 2018 and 27 July, 2018 at the laboratory of Bose Institute, Kolkata.

Experimental Setup

- NaI(Tl) scintillator detector used to measure SCGR
- Gamma energy calibration done with ^{137}Cs, ^{60}Co and ^{22}Na radioactive sources

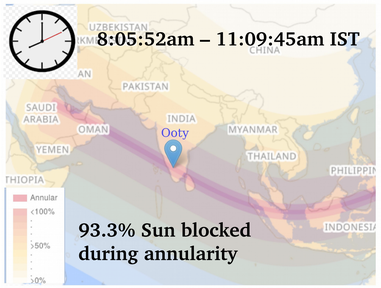


Block diagram of the experimental arrangement

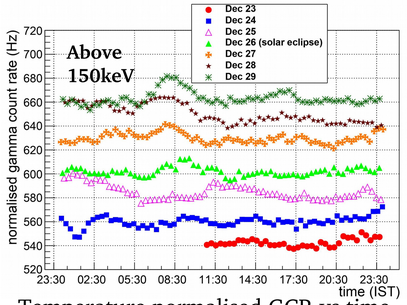


Gamma ray spectra with NaI(Tl) detector

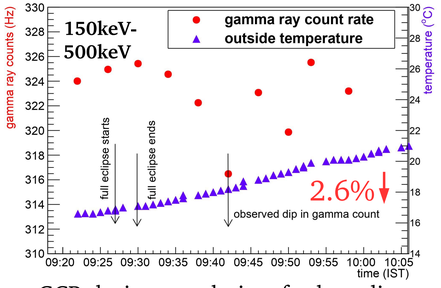
Annular solar eclipse on 26 December 2019



The eclipse map

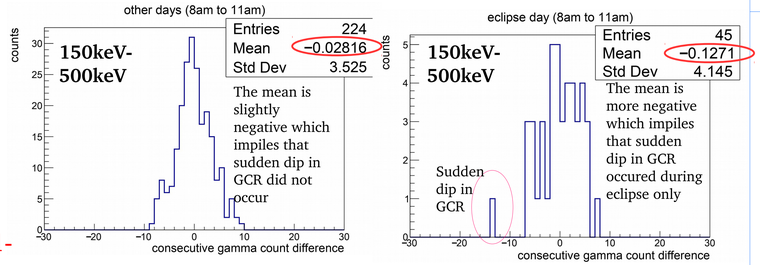


Temperature normalised GCR vs time.
Green points ⟶ the solar eclipse day



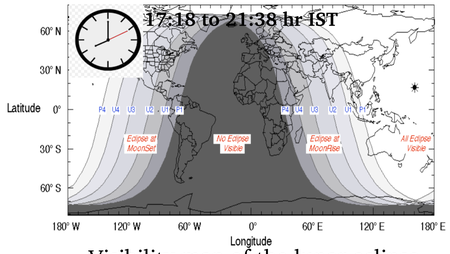
GCR during annularity of solar eclipse

- Gamma count rate(GCR) above energy 150keV was observed
- GCR has inverse temperature correlation which is properly normalised
- GCR has a decreasing trend during 8am-11am for all the days (23 Dec to 29 Dec 2019)
- A sudden dip in GCR of 2.6%(150keV-500keV), 3.3%(500keV-1MeV), and 3.8%(1-1.5MeV) was seen during the eclipse
- Such dips are not seen on other days of the week so maybe it was due to the solar eclipse

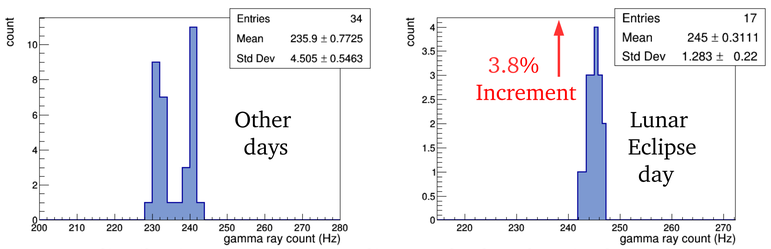


All the difference between a pair of time consecutive GCR is filled in a 1D histogram for the eclipse day and other days (8am to 11am). Plot shows that sudden dip (2.6%) in SCGR is not frequent on other days.

Lunar eclipse on 31 January 2018

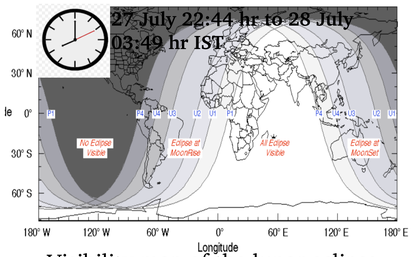


Visibility map of the lunar eclipse

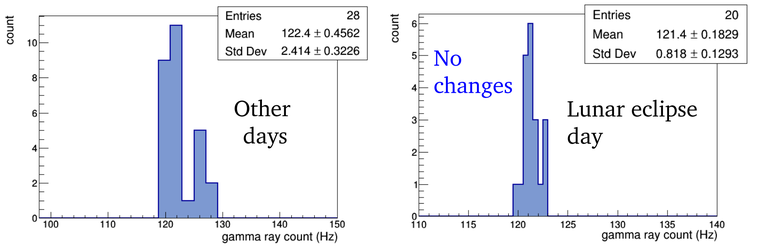


GCR distribution during lunar eclipse and other days in the energy range 25 keV to 3 MeV

Lunar eclipse on 27 July 2018



Visibility map of the lunar eclipse



GCR distribution during lunar eclipse and other days in the energy range 50 keV to 3 MeV

Highlights

- Measurement of SCGR using NaI(Tl) detector during an annular solar eclipse (26 Dec 2019) has been carried out at high altitude (Ooty, India - 2240 m above sea level) for the first time.
- SCGR flux (or GCR) in the energy range 150-500 keV : decrement of 2.6 %
- Energy range 0.5-1 MeV : decrement of 3.3% ; Energy range 1-1.5 MeV : decrement of 3.8%
- Local weather parameters like temperature, pressure and humidity were monitored.
- Lunar eclipse on 31 January 2018 : 3.8% increase in SCGR flux (or GCR)
- Lunar eclipse on 27 July 2018 : No changes in SCGR flux

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