Transit of Sun Across Constellation Sagittarius and Variation of Secondary Gamma Radiation Flux in January, 2021 at Udaipur, India

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ABSTRACT

We experimentally observed the variation of secondary gamma radiation flux (SGR) at Udaipur (27^{o} 43' 12.00" N, 75^{o} 28' 48.01" E), Rajasthan, India during transit of Sun across constellation Sagittarius in month of January, 2021.In this experimental study we used ground based NaI (Tl) Scintillation detector. Cadences of data were collected at interval of half an hour. The data files were stored in computer for half hour duration around time 17.00 IST to 17.30 IST on January 8, 9, 11, 13, 14, 17 and 18. The objective in this study is to observe secondary gamma radiation flux during transit of the Sun across the constellation Sagittarius. Analyzed data reveal significant variation of secondary gamma radiation flux (SGR). We interpret such variation of SGR flux counts on the basis of combine gravitational lensing effect due to Sun and Sagittarius constellation on background radiation, gravitational pull effect by constellation and sun on background radiation and radiation from constellation Sagittarius.

Keywords: Cosmic radiation, Solar radiation, Secondary gamma radiation, Combine gravitational lensing, Combine gravitational pull

1. INTRODUCTION

Experimentally explicated cosmic rays are inherent high-energy charged particles, experimental outcomes revels that these are nuclei of atoms ranging from the lightest to the heaviest elements in the periodic table and move through space at nearly the speed of light (Longair 1992; Chaisson *et al.* 1990) (Mewaldt 2010) Primary cosmic radiation lies in the energy range from 109- 1020 eV or more (Kudela

2009). Simpson 1983 gave information about cosmic radiation's chemical abundances in different energy ranges, compared solar system abundances and estimated abundances for the local interstellar medium. About 89% of these are protons, 10% of nuclei of helium, and about 1% of others heavier elements. Also high energy electrons, positrons, and other subatomic particles are present originate in outside the solar system, distributed throughout the Milky Way galaxy. The intensity of primary cosmic radiation flux above 50 km from the surface of the Earth remains almost the same. Primary cosmic radiation produces denser ionization about 20 km from the Earth's surface, which is called "secondary" particles and called secondary cosmic radiation (Carl *et al.* 1936). These particles have X- rays, protons, alpha particles, pions, muons, electrons, neutrinos and neutrons. These particles increase rapidly as these moves downward in the atmosphere. After each interaction, the particles lose energy (Bhabha 1938 a), (Bhabha 1938 b). In this way, secondary cosmic particles shower down through the atmosphere to the Earth's surface (Allkofer *et al.* 1984). Secondary radiation has three components (A) electromagnetic components (B) hadronic component and (C) masonic component (Walter Heinrich 1937; Nordheim 1937) .The electromagnetic component has electrons and gamma particles. Hadronic component have low energy protons and neutrons. In contrast, masonic components have pions, muons. Therefore, penetrating primary cosmic radiation produced a secondary shower (Heitler 1938) This secondary radiation flux can be detected using an appropriate detector on the ground (Kodama 1983 ; Chilingarian *et al.* 2010)

A galaxy, a star, or a cluster of galaxies produces gravitational lensing effect (Walsh *et al.* 1979) (Mellier 1998 ; Narayan & Bartelmann 1996)

A. S. Eddington and collaborators proved this phenomenon in a famous experiment during a total solar eclipse in 1919.

To observe secondary radiation flux, many scientist groups conducted experimental studies during normal days and on days of special celestial events such as Solar eclipse, Lunar eclipse, the appearance of a comet in the sky, phases of the Moon, the closest approach of celestial objects, transit of celestial objects etc. with the help of the efficient counter system.

(Bhattacharya *et al.*1997; Kandemir *et al.* 2000; Nayak *et al.* 2010 ; Bhaskara *et al.* 2011). Pareek *et al.* 2013) conducted solar eclipse studies to observe radiation flux.

Lunar eclipses experimental studies were conducted by (Pareek *et al.* 2013; Raghav *et al.* 2011; Rao *et al.* 1967) Using scintillation counter experimental study of the comet was conducted by (Pareek *et al.* 2014) in the energy range of 10 keV to 5 MeV. Analyzed data showed an unusual variation of secondary cosmic radiation flux at the energy about1.127 MeV, 2.29 MeV and 3.66 MeV.

Pareek *et al.* 2012 conducted an experimental study for celestial event transit of Venus 6th June, 2012 at Udaipur, India. After analyzing it was observed 2 %. decrement in secondary solar radiation gamma ray flux.

In September 2000 the lunar phases ground-based experimental study was conducted by Pareek *et al.* 2014 using a Scintillation counter. During the passes of the Moon through the background of the Capricornus constellation, an abrupt change in the energy spectra was noticed on ninth and 10^{th} September 2000 due to the gravitational lensing effect.

Pareek *et al.* 2022 conducted an experimental study for the transit of the Sun across Constellations Libra, Virgo. The analysed result showed a variation of Secondary Gamma Radiation Flux in Months November 2018 and September 2019 respectively at Udaipur, India.

Also, for transit of the sun across constellation Libra in October and November 2020 at Udaipur Pareek *et al.* 2021 conducted an experimental study and observed the same result of variation of secondary gamma radiation flux.

To unveil the hidden secrets of high energy astronomy, technical advances, over more than half century, have been achieved so that we could able to pinpoint how astronomical observations and physical concepts interact. For this purpose, a large number of experimental studies carried out to collect good quality data of CR (Cosmic radiation) and SEP (Solar energetic particles) with the help of advanced technologies by astronomers, for different celestial events occurring at various points of time. However due to these events, it is found that the characteristics of GCR and SEP are modulated and manifested in the ground based observation for the terrestrial secondary gamma rays (SGR) flux. These SGR signals carrying the signatures of modulated GCR and SEP are measured by efficient scintillation detectors.

In this experimental study, we want to see the effect on secondary flux of cosmic and solar radiation due to the collection of stars in specific shape in constellation Sagittarius during transit of Sun across this constellation at Udaipur India.

2. METHODOLOGY

Experimental Set-up and Observations: Scintillation detector Model SD 152 F flat type (Figure 1) (make: Nucleonix) was employed to detect secondary gamma radiation flux (SGR) produced by the SEP and CR. The SGR were incident on a NaI (Tl) of 2” x 2” diameter optically coupled with photo multiplier tube (PMT). This PMT is connected with USB interface with multi-channel analyzer (MC 1000) having 1024 channels built-in high voltage and shaping amplifier. The entire integrated assembly was used to collect secondary gamma radiation flux and the detector pointed in the line of site of the sun. This counter system was used to collect the counts as a function of time. The scintillation detector was kept on the terrace of Astronomy Laboratory of Department of Physics, Bhupal ‘Nobles’ University Udaipur (Rajasthan) India. For this experimental study, the data files were stored in a computer for half an hour around time 17.00 IST to 17.30 IST on January 8, 9, 11, 13, 14, 17, and 18. These dates cover almost half the month of January to verify the results of previous such experimental studies (Pareek *et al.* 2022; Pareek *et al.* 2021)

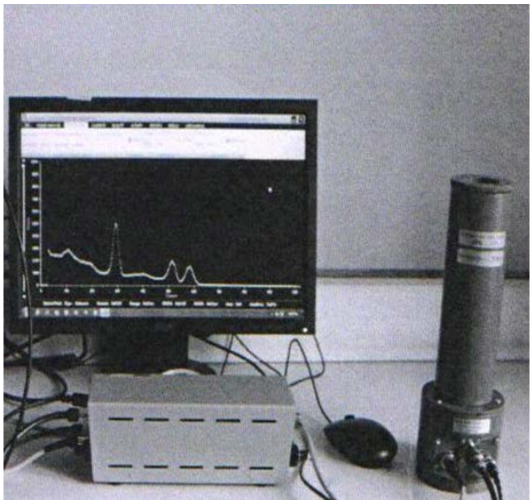

Figure 1 (Scintillation Counter System)

3. ANALYSIS, RESULTS AND DISCUSSION

We started observation from January 8. The dates of observation were January 8, 9, 11, 13, 14, 17, and 18. As depicted in Figure 2 the panels of SGR flux integrated data files between channel and dates of month January were taken around time from 17.00 IST to 17.30 IST.

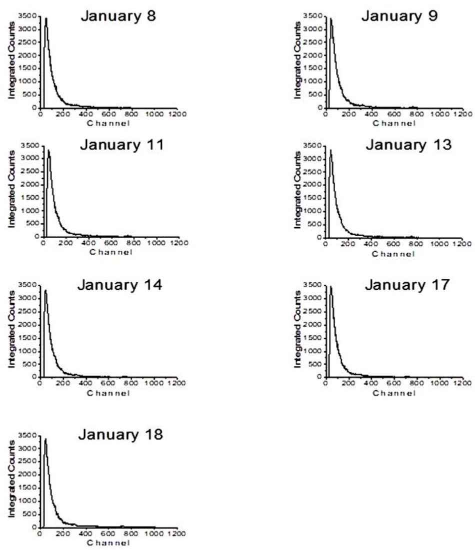

Figure- 2 (Panels of SGR flux integrated data files)

We made table 1, using panels of SGR flux integrated data files of concerning dates January 8, 9, 11, 13, 14, 17, and 18.

Table 1: Integrated counts of secondary gamma radiation flux

Sr. No.	Date	Integrated Counts
1	8	269426
2	9	263379
3	11	253115
4	13	253006
5	14	254623
6	17	253264
7	18	252964

Figure 3 represents integrated counts of secondary gamma radiation flux with date for January 2021.

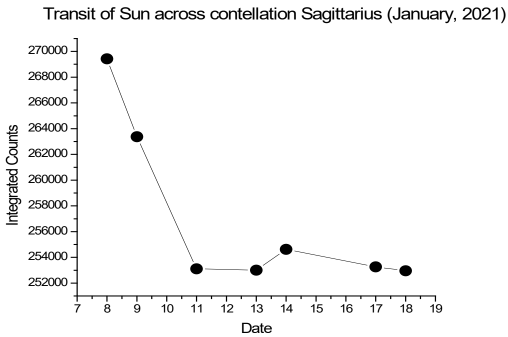

Figure 3 (Integrated counts of secondary gamma radiation flux from Scintillation Counter)

Table 1 and figure 3 clearly showed that on January 8 there were the highest counts 269426 in this experimental study. On this date, the sun was in the constellation Sagittarius. After this date integrated counts start to decrease from 263379 to 253006 and then slight increase in the integrated counts 254623 on January 14. On January 17 and 18 again the integrated counts start to decrease. The probable reasons in this present study for the variation of SGR flux counts are as follows:

1. On January 8 the sun was in the constellation Sagittarius and then moved away from this constellation. Therefore on January 8 due to combined gravitational lensing, gravitational pull by the Sun and constellation Sagittarius on background radiation, more radiation bent. Also, on this date, radiation from the constellation Sagittarius was more. The more radiation may produce more shower of secondary gamma radiation particles in the atmosphere of the Earth.

2. After January 8, we observed fewer counts because the Sun was shifted away from the constellation.

3. On 14th January, we observed a slight increase in counts because on this date celestial bodies Saturn, Jupiter, Mercury, Moon, and sun close to each other. Collectively these celestial bodies produce more gravitational lensing and more radiation bent. Therefore, more secondary flux is produced in the atmosphere of the Earth.

We reported such variation of secondary gamma radiation flux the first time due to such a close combination of five celestial bodies in the sky on date January 14.

4. CONCLUSION

Variation of secondary gamma radiation flux during transit of Sun across constellation Sagittarius is another signature. In my previous experimental studies from another constellations observed such variation of secondary flux (Pareek *et al.* 2022 ; Pareek *et al.* 2021).

Therefore this experimental confirms the results of previous such experimental studies.

The previous such experimental studies (Pareek *et al.* 2022) reported variation of SGR flux during transit of Sun across constellations Libra constellation in month November, 2018 and Virgo constellation in month September, 2019 at Udaipur. The data were collected as a function of time using ground based NaI (Tl) scintillation detector. In month November 2018, secondary gamma radiation flux decreases from dates 13 November to 20 November. On 13 November the Sun was in the Libra constellation while on another dates the Sun was shifted away from this constellation and so there were decreasing in secondary gamma radiation flux. For the Month September, 2019 we started observation from 4 September. In this experimental study secondary gamma radiation flux increased because from 4 September onwards the sun was approaching towards Virgo constellation.

Also in the research experimental study (Pareek *et al.* 2021) from November 2, 2020 the Sun was approaching towards Libra Constellation. On date November 12 the Sun was in the constellation Libra, and we observed the highest counts in this experimental study.

Results of above experimental research studies encouraged us to observe such variation due to transit of Sun across another constellation. Therefore we conducted the present experimental study.

In this research study on the date January 8 the Sun was in constellation Sagittarius and we observed the highest counts in this study as shown in Figure 3. Such type of effect one can understand with help of combined gravitational lensing effect and gravitational pulling effect on the background radiation due to Constellation Sagittarius, Sun and radiation from constellation Sagittarius.

Further on date January 14 we again observed slight increase in the counts. On this date five celestial bodies close to each other. Collectively these celestial bodies produce more gravitational lensing and more radiation bent. Therefore, more secondary flux is produced in the atmosphere of the Earth.

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