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ARTICLE

Transit of the Sun across Constellations Libra, Virgo and Variation of Secondary Gamma Radiation Flux in the Months of November 2018 and September 2019, Respectively at Udaipur, India

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Abstract: We reported a significant variation of secondary gamma radiation flux (SGR) in month November 2018 and month September 2019 at Udaipur during transit of Sun across constellations. The data was collected as a function of time using a ground-based NaI (Tl) scintillation detector. We interpret such variation of SGR flux on the basis of combined gravitational pulling along with gravitational lensing effect on background radiation by the Sun, constellations and radiation from constellations.

Keywords: Cosmic radiation, Sun, Solar radiation, Secondary gamma radiation, Libra constellation, Virgo constellation, Planets, Gravitational pulling, Gravitational lensing.

Introduction

High-energy charged particles named cosmic radiation travel at nearly the speed of light. Composition of cosmic radiation is about 89% protons, 10% helium and about 1% other heavier elements [8]. Such radiation is isotropically distributed and propagates through space while arriving on the Earth [5]. When cosmic radiation (CR) and solar radiation (SR) collide with atoms of the atmosphere of the Earth, they produce "secondary" radiation. Such radiation contains pions, muons, neutrinos, gamma radiation, electrons and positrons. Presence of gamma radiation in secondary radiation is known as secondary gamma radiation (SGR), which can be detected using an appropriate detector on ground [3, 7].

It was observed that when the electromagnetic radiation passes near a massive object, then due to gravitational field of the object, it bends. This phenomenon is called gravitational lensing. This object may be a galaxy, a star or a cluster of galaxies [4, 9, 10]. This phenomenon was proved by A. S. Eddington and collaborators in a famous experiment during a total solar eclipse in 1919.

Due to gravitational force of the celestial object, it provides gravitational pull-on background radiation.

Many scientist groups, such as Bhattcharya et al. [2], Kandemir et al. [6], Nayak et al. [11], Bhaskar et al. [1] and Pareek et al. [12], observed the variation of secondary radiation flux during solar eclipse.

During lunar eclipse, Pareek et al. [13] observed a variation in secondary gamma radiation flux. Such interesting finding during lunar eclipse can be explained on the basis of bending of primary cosmic radiation and solar radiation combined with gravitational lensing effect of Sun and Earth and back-scattered secondary radiation from the Moon.

Pareek at al. [14] conducted an experimental study using a scintillation counter for phases of the Moon in the month of September 2000. This experimental study had been planned to observe

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gravitational lensing effect. During observation, the Moon passes background of Capricornus constellation on September 9 and 10, 2000. On these dates, we observed an abrupt change in the energy spectra of secondary gamma radiation due to gravitational lensing effect.

With the fact that during different celestial events happening in the sky, the flux of cosmic and solar radiation is modulated, we attempted to see the combined gravitational lensing and gravitational pulling effect of celestial objects on radiations from constellations. We conducted a ground-based experimental study using a scintillation detector at Udaipur, India during transit of the Sun across constellations.

Experimental Setup and Observations

In the experimental studies for months of November 2018 and September 2019, we used a scintillation detector (GR611M) to collect the secondary gamma radiation flux. NaI (Tl) crystal was 50 mm in thickness and 44.5 mm in diameter and optically coupled with a photo multiplier tube and connected to a high-tension voltage supply of 2000 Volts DC (HV 502). Using the negative polarity of a linear amplifier (LA 520), a negative signal of about 0.5 Volt was amplified to a 5-Volts positive pulse. This signal was fed to an analog digital counter circuit (SC 530). This digital circuit has a counter circuit (CT 541A) to count the secondary cosmic radiation particles. The scintillation counter was kept open to collect the counts every date for three hours and with the same LLD. This scintillation counter was shielded with lead. This setup [Fig. 1] was placed in the Astronomy Laboratory of the Department of Physics. Data was collected in the month of November 2018 from 2:00 PM to 5:00 PM and in the month of September 2019 from 12:00PM to 3:00 PM at Udaipur, India.

FIG. 1. Experimental setup.

Analysis and Results

Depicted in Table 1 are the integrated counts of secondary gamma radiation flux for the month of November 2018.

Using Table 1, we made Fig. 2 to show the relationship between the dates of the month of November and the integrated counts of secondary gamma radiation flux:

TABLE 1. Integrated counts of secondary gamma radiation flux for November 2018.

Sr. No.	Date	Integrated Counts
1	13	2159
2	14	2120
3	16	1395
4	17	971
5	19	990
6	20	958
7	26	1120
8	27	997
9	28	326
10	30	422

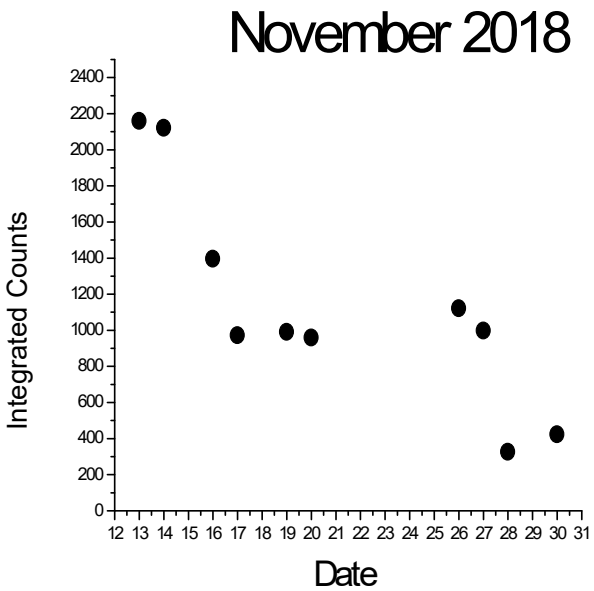

FIG. 2. Relationship between the dates of November 2018 and integrated counts of secondary gamma radiation.

The dates of observation were 13, 14, 16, 17, 19, 20, 26, 27, 28 and 30 November 2018. The secondary gamma radiation flux decreased from 2159 to 958 counts from 13 November to 20 November. On 26 November, the counts were 1120 and then decreased on 30 November.

For the month of September 2019, we started observation from 4 September. The dates of observation were 4, 5, 11, 19, 20, 21, 23 and 28 September 2019. The secondary gamma radiation flux increased from 1916 to 2200 counts. From 4 September onwards, the Sun was approaching Virgo constellation and on 28 September, we observed highest counts because the Sun, planet Venus and planet Mercury were in constellation Virgo. All these events produced combined gravitational lensing effect and gravitational pulling effect on background radiation. For the month September 2019, the integrated counts of secondary gamma radiation are given in Table 2.

TABLE 2. Integrated counts of secondary gamma radiation flux for September 2019.

Sr. No.	Date	Integrated Counts
1	4	1916
2	5	1987
3	11	1960
4	19	2055
5	20	2093
6	21	2048
7	23	2156
8	28	2200

Using Table 2, we made Fig. 3 to show the relationship between the dates of the month of September and the integrated counts of secondary gamma radiation flux:

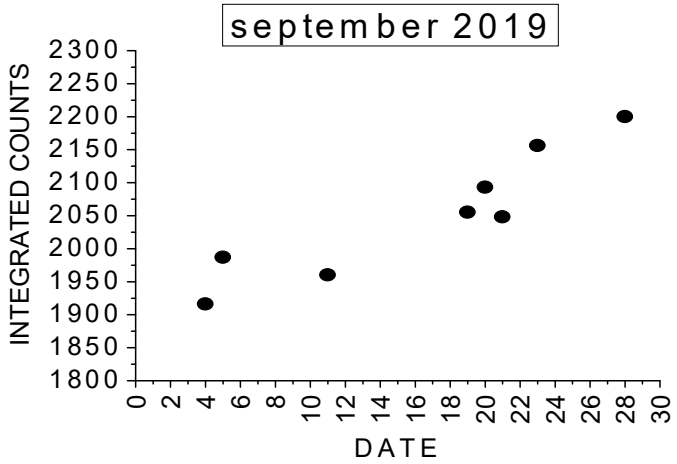

FIG. 3. Relationship between the dates of September 2019 and integrated counts of secondary gamma radiation.

Discussion

For the Month of November 2018

1. On 13 November, the Sun was in the Libra constellation and on other dates, the Sun was shifted away from this constellation; so there was a decrease in counts. This clearly represents the combined gravitational lensing effect and gravitational pulling effect on the background radiation due to constellation Libra and the Sun.
2. On 13 November, radiation coming from constellation Libra exposed the Sun to gravitational lensing effect. Therefore, more radiation was bent, which may produce a stronger shower of secondary gamma radiation particles in the atmosphere of the Earth.
3. On 26 November, again there was an increase in the integrated counts. On this date, the Sun was close to planets Jupiter and Mercury. Therefore, due to combined gravitational lensing and gravitational pulling by the Sun and planets Jupiter and Mercury, there was an increase in the counts of secondary gamma radiation flux.

Therefore, on 13 and 26 November, more radiation came and bent. This bent radiation impringed deep inside the atmosphere of the Earth, which produced more secondary gamma radiation particles that give such variation in November.

For the Month of September 2019

1. From Table 2 and Fig. 3, we concluded that from 4 September onwards, integrated counts increased and on 28 September, the highest counts were observed. From 4 September onwards, the sun was approaching Virgo constellation and on 28 September, the Sun, planet Venus and planet Mercury were in constellation Virgo. All these events produced combined gravitational pulling effect and gravitational lensing effect on background radiation.
2. From 4 September onwards, the Sun was approaching Virgo constellation and radiation coming from constellation Virgo exposed the Sun gravitational lensing effect. Therefore, more radiation was bent, which may have produced a stronger shower of secondary gamma radiation particles in the atmosphere of the Earth.

As mentioned in points 1 and 2, background radiation and radiation from constellations bent. This more bent radiation penetrated deep inside the atmosphere of the Earth, hence producing secondary gamma radiation that gave such variation in the integrated counts of secondary gamma radiation in the month of September.

These experimental studies are unique and for the first time, such variation of secondary gamma radiation flux during transit of the Sun across constellations was reported.

Conclusion

These experimental studies gave the conclusion that due to combined gravitational pulling and gravitational lensing effects of the celestial objects and radiation from constellations on the surface of the Earth, the secondary gamma radiation flux varies during transit of the Sun across constellations.

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