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ENHANCEMENT OF SECONDARY RDIATION FLUX DURING PERIHELION APPROACH OF COMET C/2021 A1 (LEONARD) TOWARDS EARTH IN MONTH OF DECEMBER, 2021 AT UDAIPUR, INDIA

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Abstract
Experimental study carried out during perihelion approach of comet C/2021 A1 (Leonard) towards Earth in month of December, 2021 at Udaipur (27^0 43' 12.00" N, 75^0 28' 48.01" E), Rajasthan, India. Dates for observations were December 13, 14, 15, 16, 17, 18 and 19 using ground based NaI (Tl) Scintillation detector and half an hour data files were stored in computer. The analyzed data reveal significant enhancement of secondary radiation flux (SRF) about 2.3 % on date December 13 on the Earth on comparison to the average integrated counts on another dates. We interpret such enhancement of SRF on the basis of perihelion approach of comet towards Earth, formation of secondary radiation in the atmosphere of the Earth due to comet.

Key Words: *Primary cosmic radiation, solar radiation, perihelion approach of comet towards Earth, formation of secondary radiation in the atmosphere of Earth.*

Introduction

Cosmic radiation travels nearly the speed of light and about 89% nuclei are protons, 10% nuclei of helium, and 1% of others heavier elements [1, 2, 3]. Energy range of primary cosmic radiation from 10^9- 10^{20} eV or more [4]. Simpson (1983) [5] showed that at different energy range has different chemical abundances of cosmic radiation. Above 50 km from the surface of the Earth, the intensity flux of primary cosmic radiation remains almost same. From surface of Earth about 20 km secondary radiation produces a denser ionization. High-energy primary radiations undergo collisions with atoms of the upper atmosphere, and produce a cascade of lighter particles known as secondary radiation [6]. In each interaction the particles loose energy hence particles increase rapidly as these moves downward in the atmosphere [7, 8]. In this way secondary radiation down through the atmosphere to the Earth's surface [9]. Secondary radiation contains one of component known as electromagnetic component [10], [11],[12]. The electromagnetic component has electrons and gamma particles. Therefore, penetrating cosmic radiation produced shower of secondary radiation [13]. Secondary radiation flux detected using appropriate detector on ground [14], [15]. In case of Gravitational lensing electromagnetic radiation bends [16], [17], [18]. A. S. Eddington and collaborators in a famous experiment during a total solar eclipse in 1919 proved this phenomenon. The comet C / 2021 A1 (Leonard) was discovered by G. J. Leonard at the Mount Lemmon observatory on January 3, 2021. In the month December 2021 this comet was closest to the Earth and reached its nearest point called perihelion approach towards Earth on December 12, 2021. On this date this comet was about 34.9 million km from Earth. Orbital period of this comet around the Sun is around 80000 years. Orbit of Comet around the sun is elliptical.

Celestial events and variation of radiation flux

To observe secondary radiation flux Bhattacharya et al [19], Kandemir G. et al [20], Nayak. et al. [21], Bhaskar et al [22], Pareek et al [23] conducted research study. Pareek et al. [23] conducted solar eclipse study. During lunar eclipse named Pareek et al. [24], Raghav et al. [25], J.N. AnandaRao et al. [26]. Pareek et al [27] also conducted the experimental study during transit of Venus June 6, 2012 at Udaipur India. In this study they observed 2 %. decrement in secondary radiation flux. Pareek et al., using Scintillation counter in the month of September 2000 [28] conducted Phases of Moon experimental study. In the month of March, 1996 an experimental study was conducted by Pareek et al. [29] during appearance of Comet Hyakutake using scintillation counter. Results showed unusual variation of secondary cosmic radiation flux. With help of EUVE satellite from this comet Extreme ultraviolet (EUV) emission was detected [30]. From Comet Hyakutake Mumma, M.J. et al. [31], Peterson, K. [32] and Huebner, W.F. [33] reported large quantities of the gases ethane, methane. With the fact that during different celestial events happening in sky, modulate terrestrial secondary flux we, attempted to see effect of perihelion approach of comet C / 2021 A1 (Leonard) towards Earth in month of December, 2021 on secondary radiation flux at surface of the Earth.

Experimental Set-up and Observations

In this experimental study to detect the secondary radiation flux we used Scintillation detector of (SD 152 F) (Figure 1) of Nucleonix make. The NaI (Tl) crystal of size 2" x 2" optically coupled with photo multiplier tube. This integral line was connected to 1k multi-channel analyzer MC 1000 of Nucleonix make has 1024 channels.

This Scintillation counter system kept open to collect the counts as a function of time on the roof of Astronomy Laboratory of Department of Physics, Bhupal Nobles' University Udaipur (Rajasthan) India. The data files were stored in computer for half hour duration on dates December 13, 14, 15, 16, 17, 18 and 19.

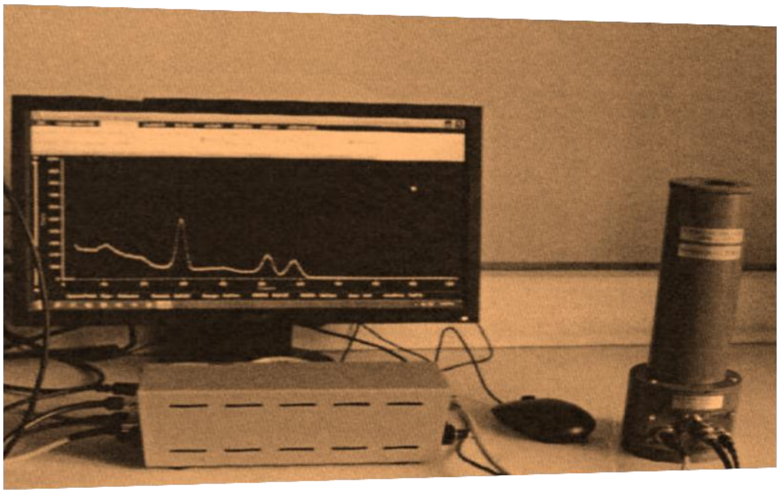

Figure 1 (Scintillation Counter System)

Analysis and Results: As depicted in figure- 2 the panels of SRF integrated data files between channel and integrated counts for half hour duration on dates December 13, 14, 15, 16, 17, 18 and 19.

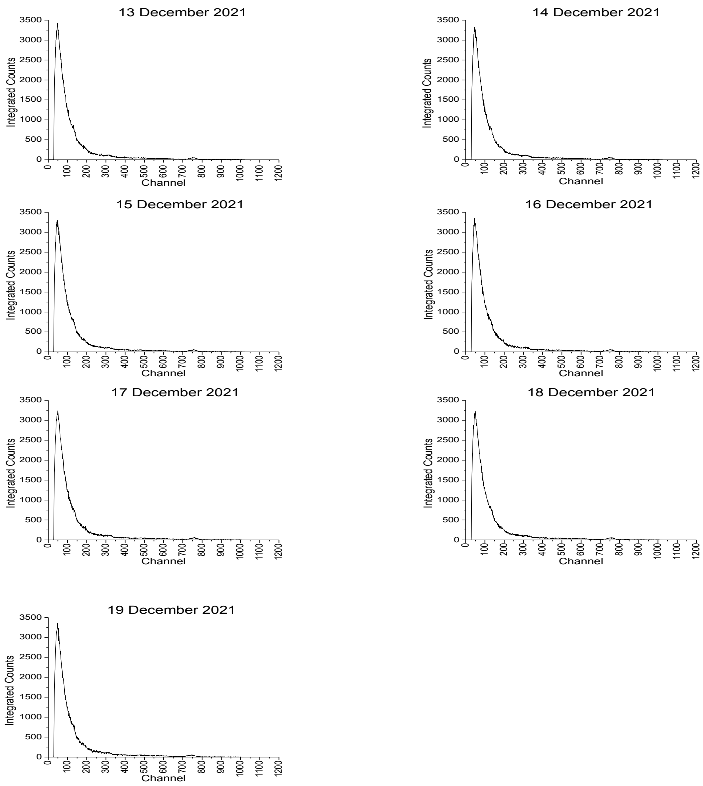

Figure- 2 (Panels of SRF integrated data files)

Using Figure 2 we made the table 1 which represents integrated counts of secondary radiation flux with respect to dates.

Sr. No.	Date	Integrated Counts
1	13	260143
2	14	255089
3	15	255287
4	16	253997
5	17	254605
6	18	252375
7	19	254156

Table 1

Using figure 2 and table 1 of SRF integrated data files, we made figure3 which represents integrated counts of secondary radiation flux with date for the month of December, 2021.

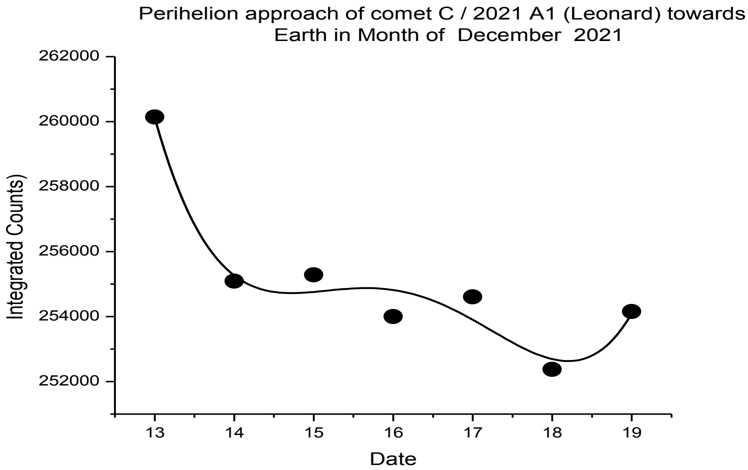

Figure 3 (Iintegrated counts of secondary radiation flux)

Table 1 and figure 3 showed that on the dates December 13,14,15,16,17,18 and 19 the integrated counts were 260143, 255089, 255287, 253997, 254605, 252375 and 254156 respectively for half hour duration. The average of integrated counts of dates December 13, 14, 15,16,17,18 and 19 are 254251.5

To see the variation in secondary gamma radiation we used the following formula:

Counts on date December 13 close approach of comet towards Earth - Average counts of other observation dates

% of variation = -- -------------- ---------X 100

Average counts of other observation dates (December 14, 15, 16, 17, 18, 19)

Using this formula we observed about 2.3 % enhancement of secondary radiation flux on the December 13 on comparison to average counts of other dates (December 14, 15, 16, 17, 18, 19

Discussions

Table 1 and figure 3 clearly showed that integrated counts on the date December, 13 were highest on the comparison to other normal days. The probable reasons in this present experimental study for the enhancement of SRF counts are as follows:

1. On date December, 13 the comet was close towards Earth and we got highest integrated counts. It could be understand that when strong impact of high energy cosmic radiation and solar radiation on the nucleus of comet. It contains water, Methane, Ethane and other gases. Therefore there may formation of secondary radiation flux from these materials. Produced secondary flux when entered towards the Earth atmosphere caused further production of secondary flux and this enhances secondary flux.
2. On December, 13 comet tail expanded towards Earth atmosphere therefore more charged particles entered in the atmosphere of the Earth and more secondary radiation flux produced in the atmosphere of the earth.

3. Other than date December, 13 we got less integrated count because the comet started to move away from Earth

Conclusion

From points (1) and (2) we can understand enhancement of secondary radiation flux about 2.3 % at surface of the Earth on December, 13.

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