DECREMENT OF SECONDARY GAMMA RADIATION FLUX DURING GREAT CONJUNCTION OF JUPITER AND SATURN ON DECEMBER 21, 2020 AT UDAIPUR, INDIA

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Abstract

The experimental study during great conjunction of Jupiter and Saturn on December 21, 2020 at Udaipur (27^0 43' 12.00" N, 75^0 28' 48.01" E), Rajasthan, India was conducted. Data files for half an hour between times 18 IST to 19.00 IST were collected from, December 19, 20, 21, 22, 24and 26, 2020 using ground based NaI (Tl) Scintillation detector. The analyzed data reveal significant decrement of secondary gamma radiation flux (SGR) about 2% during great conjunction of Jupiter and Saturn (December, 21) on comparison to the average integrated counts on another dates. We interpret such decrement of SGR flux counts on the basis of great conjunction of Jupiter and Saturn, obstruction effect produced by planet Jupiter on reflected solar radiation from planet Saturn.

***Key Words**: Primary cosmic radiation, solar radiation, conjunction of Jupiter and Saturn, reflected solar radiation form planet Saturn.*

Introduction

Electromagnetic radiation coming towards the Earth is called cosmic radiation (CR). Cosmic radiation travels nearly the speed of light. Such radiation has about 89% nuclei are protons, 10% nuclei of helium, and 1% of others heavier elements (Lithium, Beryllium and Boron) [1, 2, 3].Primary cosmic radiation lies is from 10^9- 10^{20} eV or more [4]. On comparison interstellar abundances of the elements and solar system with help of cosmic radiation we can understand about their origin and propagation process through interplanetary space and arrive on the Earth. Simpson (1983) [5] showed that chemical abundances of cosmic radiation in different energy range. He made comparison between solar system abundances and estimated abundances for the local interstellar medium. He observed carbon, nitrogen, oxygen and iron group are present both in the cosmic radiation and solar system abundances. The atmosphere of Earth above 50 km from the surface of the Earth, the intensity flux of primary cosmic radiation is almost same as in the interstellar space. About 20 km form surface of the Earth 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]. Therefore there is formation of shower of secondary particles. Secondary particles have X- rays, protons, alpha particles, pions, muons, electrons, neutrinos and neutrons. In each interaction the particles loose energy hence particles increase rapidly as these moves downward in the atmosphere and [7, 8]. In this way secondary particles shower down through the atmosphere to the Earth's surface [9]. Secondary radiation contains three components which are electromagnetic component, hadronic component and masonic component [10], [11], [12]. The electromagnetic component has electrons and gamma particles. Hadronic component has low energy protons and neutrons. Masonic component has pions, muons, neutrinos and kaons. Therefore, penetrating cosmic radiation produced shower of secondary particles [13]. Produced secondary radiation flux can be detected using appropriate detector on ground [14], [15].

Gravitational lensing is the phenomena in which due to gravitational field of the object electromagnetic radiation when passing near a massive object then bends towards object. The object could a galaxy, a star, or a cluster of galaxies [16] , [17], [18]. This effect was proved by A. S. Eddington and collaborators in a famous experiment during a total solar eclipse in 1919. The great conjunction of Jupiter and Saturn was occurred on December 21, 2020. On this date both planets look like a single star and the pair was at an angle of 0.1 degree. The last time both the planets comes closer on July 16, 1623 i.e. 397 years ago.

Such extra close Jupiter and Saturn conjunction will observe on March 15, 2080.

2. Celestial events and variation of radiation flux

Secondary radiation flux was observed by many scientist groups during normal days and on days of special celestial events such as Lunar eclipse, Solar eclipse, phases of moon, appearance of comet in sky, closest approach of celestial objects, transit of celestial objects etc. with help of efficient counter system. Many scientist groups conducted experimental studies to observe secondary radiation flux named Bhattacharya et al [19], Kandemir G. et al [20], Nayak. et al. [21], Bhaskar et al [22], Pareek et al [23].

Pareek et al. [23] conducted solar eclipse study to understand the interaction of GCR&SR flux with gravitational fields of the Sun and well-established shadowing effect of the moon. To observe variation in secondary radiation flux many experimental studies were conducted by scientist groups during lunar eclipse named Pareek et al. [24], Raghav et al. [25], J.N. Ananda Rao et al. [26], Pareek et al. [27], Pareek et al. [28] Pareek et al. [24] did experimental study of lunar eclipse to observe variation of secondary cosmic and solar gamma radiation flux at some energy. Such results can be explained on the basis of bending of primary cosmic radiation and solar radiation by combined gravitational lensing effect of Sun and Earth, backscattered Secondary flux form the Moon, combined magnetic field of the Sun and the interplanetary magnetic field. Pareek et al [29] also conducted the experimental study during celestial event of transit of Venus June 6, 2012 at Udaipur India and observed 2 %decrement in secondary solar radiation gamma ray flux. Phases of Moon experimental study was conducted by Pareek et al., using Scintillation counter in the month of September 2000 [30].This experimental study was conducted to understand information about the GCR, SR modulation at the time of new Moon, Full Moon and different phases of the Moon with different background of constellation in the sky. Results showed that due to gravitational lensing effect abrupt change in energy spectra on 9th and 10th September 2000, when Moon was in background of Capricornus

constellation.

An experimental study was conducted by Pareek et al [31] for transit of the Sun across Constellations Libra, Virgo analysed result showed variation of Secondary Gamma Radiation Flux in Month November, 2018 and September, 2019 respectively at Udaipur, India. Another experimental study was conducted by Pareek et al [32] for transit of the Sun across constellation Libra in the month of October and November, 2020 at Udaipur and observed the same result of variation of secondary gamma radiation flux Pareek et al [33] conducted experimental using scintillation counter in month of October, 2020 at Udaipur, India to observe variation of secondary gamma radiation flux during closest approach of Mars towards Earth, Mars at opposition and transit of Moon across different constellations, planets An experimental study was conducted by Pareek et al. [34] during appearance of Comet Hyakutake in the month of March, 1996 using scintillation counter. Analyzed results showed variation of secondary cosmic radiation flux in energy spectrum of specific energies of about1.127 MeV, 2.29 MeV and 3.66 MeV. With help of EUV satellite from this comet Extreme ultraviolet (EUV) emission was detected [35]. From Comet Hyakutake Mumma, M.J. et al. [36], Peterson, K. [37] and Huebner, W.F. [38] reported large quantities of the gases ethane, methane, Co present and also water in icy form.

With the fact that during different celestial events happening in sky, modulate terrestrial secondary flux we, attempted to see effect of great conjunction of Jupiter and Saturn on December 21, 2020 on secondary gamma radiation flux at surface of the Earth.

3. Experimental Set-up and Observations

Scintillation detector of (SD 152 F) flat type (Figure 1) of Nucleonix make used in this experimental study to detect the secondary gamma radiation flux. 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) with usb interface built in high voltage and shaping amplifier. 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 between times 18 IST to 19.00 IST from December 19, 20, 21, 22, 24 and 26, 2020

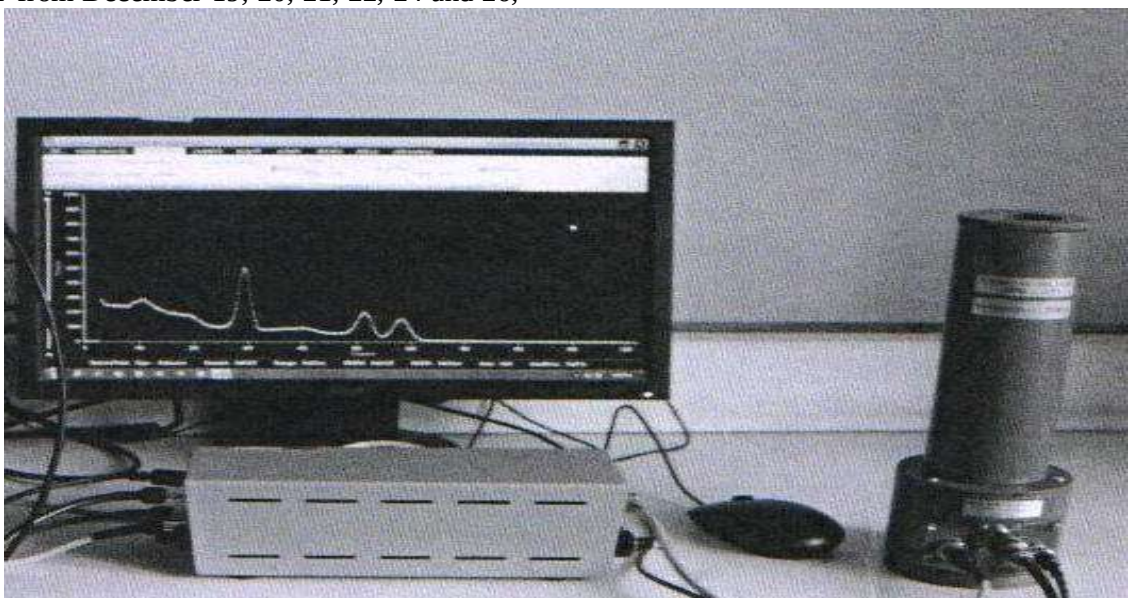

Figure 1 (Scintillation Counter System)

4. **Analysis and Results**

As depicted in figure- 2 the panels of SGR flux integrated data files between channel and integrated counts from, December 19, 20, 21, 22, 24 and 26 , 2020

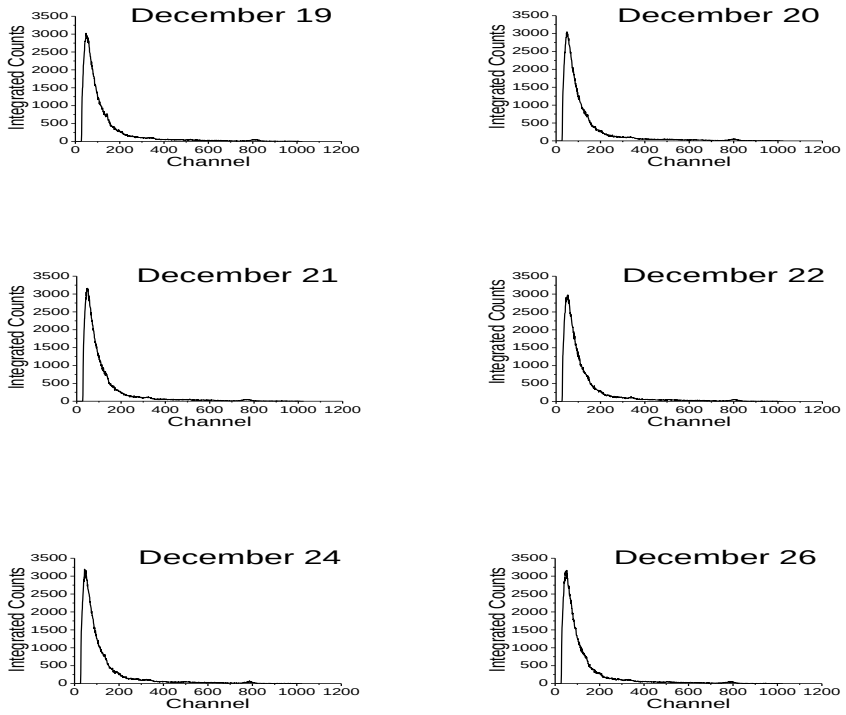

Figure- 2 (Panels of SGR flux integrated data files)

Using Figure 2 we made the table 1which represents integrated counts of secondary gamma radiation flux with respect to dates (19, 20, 21, 22, 24 and 26 December, 2020).

Sr.No.	Date	Integrated Counts
1	19	256989
2	20	253291
3	21	251811
4	22	254275
5	24	259324
6	26	260943

Table 1

Using figure 2 and table 1 of SGR flux integrated data files, we made figure 3 which represents integrated counts of secondary gamma radiation flux with date for the month of December, 2020.

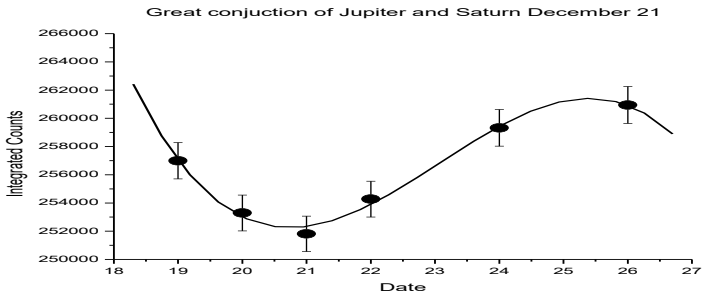

Figure 3 (Integrated counts of secondary gamma radiation flux)

Table 1 and figure 3 showed that on the dates December 19, 20, 21, 22, 24 and 26 the integrated counts were 256989, 253291, 251811, 254275, 259324 and 260943 respectively for half hour duration between times18.00 IST to 19.00 IST. The great conjunction was on the date December, 21. The average of integrated counts of normal dates December 19, 20, 22, 24 and 26 were 256964. To see the variation in secondary gamma radiation we used the following formula:

$$\% \text{ of variation} = \frac{\text{Average counts of normal days - Counts on date of great conjunction}}{\text{Average counts of normal days}} \times 100$$

Using this formula, we observed on the great conjunction date (December 21) about 2 % decrement of secondary gamma radiation flux on comparison to average counts of normal dates (December 19, 20, 22, 24 and

Discussions

Table 1 and figure 3 clearly showed that integrated counts on the date December, 21 were lowest on the comparison to other normal days.

The probable reasons in this present experimental study for the decrement of SGR flux counts

are as follows:

On date December, 21 the planets Jupiter and Saturn was in the position of great conjunction and we got lowest integrated counts in the whole experimental study. This surprising result was unique and it could be understood due to obstruction effect produced by planet Jupiter on reflected solar radiation by planet Saturn. Due to this less reflected solar radiation entered towards atmosphere of the Earth. Therefore formation of secondary radiation less. This caused decrement in the secondary gamma radiation flux.

On other normal days the integrated counts were high on comparison to the date December 21.

This experimental study is unique and first time we reported such decrement of secondary gamma radiation flux at the surface of the Earth during great conjunction of planets Jupiter and Saturn.

Conclusion

From points (1) and (2) we can understand decrement of secondary gamma radiation flux about 2 % at surface of the Earth on December, 21during great conjunction.

References

[1]. Longair M.S., (1992) High energy Astrophysics 1 second edition Pub. Cambridge

University press,
[2]. Chaisson, Eric and Mcmillan, (1999) Steve, Astronmy today, 3rd Edition, Prentice Hall
[3].Mewaldt, R. A., (2010), cosmic rays. California institute of technology.http://www.srl.caltech.edu/personnel/dick/cos_encyc.html.
[4]. Kudela, K., (2009) On energetic particles in space.Actaphysicaslovaca 59,537-652
[5]. Simpson, J. (1983). Elemental and isotopic composition of galactic cosmic rays, annual
reviews of nuclear and particle science, 33, 323-381.
[6]. Carl D. Anderson and Seth H. Neddermeyer, (1936) Cloud Chamber Observations of Cosmic Rays at 4300 Meters Elevation and Near Sea-Level, Physical Review 50, 263.
[7]. Bhabha (1938 a) Nuclear forces, heavy electrons and the β-decay. Proc.Roy.Soc.Lond.A
166 (1938) 501
[8]. Bhabha, (1938b) Nuclear forces, On the theory of heavy electrons and nuclear forces, Nature 141 117 DOI: 10.1038/141117a0
[9]. Allkofer, O. C. and Grieder, P. K. F. (1984) Cosmic Rays on Earth.
https://inis.iaea.org/search/search.aspx?orig_q=RN:15054748
[10]. Walter Heinrich Heitler, (1937) On the analysis of cosmic rays, Proceeding of the Royal
Society A, , 161,261.
https://doi.org/10.1098/rspa.1937.0145
[11]. L. W. Nordheim, (1937) On the Absorption of Cosmic-Ray Electrons in the Atmosphere, Physical Review, 51, 1110.
https://doi.org/10.1103/PhysRev.51.1110
[12]. Pfotzer (1936) Messungen der Ultrastrahlung in der Stratosphäremiteiner
Dreifachkoinzidenzapparatur, Z. Phys. 102, 23, 41.
[13]. W. Heitler, (1938) Showers produced by the penetrating cosmic radiation, Royal Society, Vol. 166, Issue 927..Page(s): 529-543.
https://doi.org/10.1098/rspa.1938.0108
[14]. Kodama M., (1983) Ground Albedo Neutrons Produced by Cosmic Radiations, Physical
Society of Japan, Journal, 52, 1503-1504
[15]. A. Chilingarian, A. Daryan, K. Arakelyan, A. Hovhannisyan, B. Mailyan, L. Melkumyan, G. Hovsepyan, S. Chilingaryan, A. Reymers, and L. Vanyan, (2010) Ground-based observations of thunderstorm-correlated fluxes of high-energy electrons, gamma
rays, and neutrons, Physical Review D, 82(4), 043009
[16]. D. Walsh.et al., (1979) nature, 279 (5712): 381-4 May, 31
[17]. Mellier, Y. (1998) : Probing the universe with weak lensing.
https://arxiv.org/abs/astro-ph/9812172
[18]. Ramesh Narayan, Matthias Bartelmann,(1996): Lectures on gravitational lensing. https://arxiv.org/abs/astro-ph/9606001
[19]. Abhijit Bhattacharyya, Sukumar Biswas, Barun K. Chatterjee, Mala Das, Pradipta K. Das, Tapan K. Das, Tarun K. De, M.H. Engineer, Rabi N. Mukherjee, SibajiRaha, S.C. Roy, Swapan K. Saha, A.K. Sen, Bikash Sinha & Debapriyo Syam, (1997) Variation of γ-Ray and Particle Fluxes at the Sea Level During the Total Solar Eclipse of 24 October, 1995, Astrophysics and Space Science volume 250, pages313–326
[20]. Kandemir, G, (2000) The Last Total Solar Eclipse of the Millennium in Turkey, ASP Conference Series, Vol. 205,.
[21]. Nayak, Pranaba K, et al. (2010), Astroparticle Physics, Volume 32, Pages 286 – 293.
[22]. AnkushBhaskara, AvadhutPurohit, M. Hemalatha, ChintamaniPai, Anil Raghav, ChetanGurada, S.Radha, VirendraYadav, Vishal Desai, Abhishek Chitnis, PadmanabhSarpotdar, AnirudhaPatankar, (December 2011) A study of secondary cosmic ray flux variation during the annular eclipse of 15 January 2010 at Rameswaram, India, Astroparticle Physics, Volume 35, Issue 5, Pages 223-229,
[23]. DevendraPareek, S.N.A. Jaaffrey, K.P. Talesra, Ravi Yadav, Sonia Ameta, (June, 2013) Experimental study of Variation of Secondary Cosmic Gamma Ray Flux and Energy during Partial Solar Eclipse of 4th January 2011 at Udaipur, India, Research journal of physical
sciences, Vol. 1(5), pages 22-30,
[24]. Devendra Pareek, S.N.A. Jaaffrey, (May, 2013) Experimental Study of Variation of Secondary Cosmic Gamma Ray Flux during

Total Lunar Eclipse April 4, 1996 and July 16, 2000, Research journal of physical sciences, Volume 1(4), Page no. 22-27, 2013

[25].Anil Raghav, AnkushBhaskar, VirendraYadavNitinkumar,Bijewar Chintamani Pai, AshishKoli, Nilam Navale, Gurinder pal Singh, NitinDubey, SushantPawar, Pradnya Parab, Gandhali Narvankar, VaibhavRawoot, VikasRawat, SatishBorse, Nagnath Garad, Carl Rozario, Nitin Kaushal, ShailendrakumarTiwari, M. R. Press, Confirmation of secondary cosmic ray flux enhancement during the total lunar eclipse of 10 December 2011, journal of geophysical research: Space Physics/ Volume 118, Issue, 10, 6426-6433.

[26]. Ananda Rao J. N, (1967) Variation in the background counting rate at Tirupati during the periods of solar and lunar eclipses, Physics Letters A, 25, 2, 74.

[27]. Pareek, Devendra; Sengar, Pallavi; (28.01.2021)Decrement of Secondary Gamma Radiation Flux during Lunar Eclipse June 16, 2011, Indian Journal of Science and Technology; 14(3):245–250 https://doi.org/ 10.17485/IJST/v14i3.2232

[28]. Pareek, Devendra; Sengar,Pallavi; Enhancement of Secondary Gamma Radiation Flux Energies in the Energy region 1400 keV to 1500 keV during Lunar Eclipse on June 16, 2011 at Udaipur, India. Accepted for publication in the Jordan journal of Physics and will publish in Vol 15 No2/2022

[29]. Pareek, Devendra, S.N.A. Jaaffrey, Himadri T. Daspattnayak, Manish Shrimali, (May-2017) Variation of Secondary Cosmic Gamma Ray Flux during Venus Transit on June 6, 2012 at Udaipur, India, Global journal for research analysis, Ahmedabad, Volume 6, Issue 5, Page no. 500-501

[30]. Pareek, Devendra, S.N.A. Jaaffrey(May-2014)Experimental Study of Phases of Moon For Observing Variation of Secondary Cosmic Gamma Ray Flux, Energy and X-Ray Flux in the Month of September 2000 at Udaipur, India, International journal of scientific research, Ahmedabad, Volume 3, Issue 5, Page no. 6-10

[31]. Pareek, Devendra; Sengar,Pallavi; Transit of the Sun across Constellations Libra, Virgo and Variation of Secondary Gamma Radiation Flux in Month November, 2018 and September, 2019 respectively at Udaipur, India. Accepted for publication in the Jordan journal of Physics and will publish in Vol 15 No2/2022

[32. Pareek Devendra, Purohit Prajesh (2021) Transit of the Sun across constellation Libra and variation of secondary gamma radiation flux in the month of October and November, 2020 at Udaipur, India. Indian Journal of Science andTechnology 14(8): 718-724. https://doi.org/10.17485/IJST/v14i8.263

[33]. Pareek, Devendra; Sengar,Pallavi; Variation of secondary gamma radiation flux during closest approach of Mars towards Earth, Mars at opposition and transit of Moon across different constellations, planets in month of October, 2020 at Udaipur, India. Accepted for publication in the Jordan journal of Physics and will publish in Vol 15 No4/2022

[34]. Pareek, Devendra, S.N.A. Jaaffrey. (April-2014)Experimental Study of Emission of X –Ray and Variation of Secondary Cosmic Ray Flux at Some Energy during appearance of Comet Hyakutake March, 1996, International journal of scientific research, Ahmedabad, Volume 3, Issue 4, Page no. 411-413

[35]. M. J Mumma et al. (1997) Astrophys. J. 491, L125-L128

[36]. M.J Mumma et al., (1996) Science Vol. 272 no. 5266, pp. 1310-1314

[37]. K. Peterson Science (1996) Vol. 272 no. 5266, pp. 1263- 1264

[38]. W.F. Huebner(1990) "Physics and Chemistry of comets." Astronomy and Astrophysics Library, Springer Verlag Publication.