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Discovery of superluminal velocities of X-rays and Bharat Radiation challenging the validity of Einstein's formula E= mc^2

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Abstract: *The current paper reports discovery of superluminal velocities of X-rays, and Bharat Radiation in 12.87 to 31 nm range from solar spectra. The discovery challenges the 100 year old Albert Einstein's assertion that nothing can go faster than velocity of light c in vacuum while formulating $E = mc^2$ in his special theory of relativity reported in 1905 [1]. Several solar spectra recorded at various wavelengths by Woods et al in 2011 demonstrated GOES X-rays arriving earlier than 13.5 nm emission, which in turn arriving earlier than 33.5 nm emission [2]. Finally, the investigators faced difficulty in concluding that short wavelengths traveled fast because of lack of information whether all the three emissions originated from the same source and at the same time. Very recently the author has reported GOES X-rays (7.0 nm) cause 13.5 nm (Bharat Radiation), which in turn causes 33.5 nm Extreme ultraviolet (EUV) emission from same excited atoms present in solar flare by Padmanabha Rao Effect [3, 4]. Based on these findings, the author succeeded in explaining how the solar spectral findings provide direct evidences on superluminal velocities of GOES X-ray and 13.5 nm Bharat Radiation emissions, when 33.5 nm EUV emission is considered travelling at velocity of light c. Among X-ray wavelengths, the short wavelength 7.0 nm X-rays traveled faster than 9.4 nm X-rays, while X-rays go at superluminal velocities. Among Bharat radiation wavelengths, short wavelengths showed fast travel, while Bharat Radiation goes at superluminal velocities as compared to 33.5 EUV emission.*

Keywords: *Albert Einstein, special theory of relativity, energy-mass equivalence, E=mc^2, velocity of light c, superluminal velocities, solar spectra, GOES X-rays, 13.3 nm, 33.5 nm, EUV, Bharat Radiation, relativistic mass, Cherenkov radiation, Solar flare.*

I. Introduction

The author reports discovery of superluminal velocities of X-rays and Bharat Radiation based on first and definite solar spectral evidences reported by Woods et al in 2011 [2]. The discovery challenges Albert Einstein's assertion that nothing goes faster than the velocity of light c in vacuum, while formulating $E = mc^2$ in the special theory of relativity reported 100 years ago in 1905 [1]. The new evidences on X-rays and Bharat Radiation traveling at superluminal velocities suggest the need to modify the formula to suit high energy electromagnetic radiation. Otherwise, the formula still holds well in many instances. The concept that mass and energy are related to each other originated well before Hasenöhrl and Einstein papers [5]. In the 1905 paper, Einstein wrote the formula as m=L/c2, but changed into $E = mc^2$ replacing L with E in his work in 1906 and 1907 [6]. The theory of special relativity was confirmed by many experiments on subatomic particles at high speeds [7]. The formula helped in postulating the existence of neutrino.

Albert Einstein's famous formula $E = mc^2$ directly applies to a subatomic particles having rest mass, and pinpoints the particle requires infinite energy to travel at the speed of light [1]. This speed limit has been set to a particle like electron. There is a reason why the speed limit could not be attributed to high energy radiation such as X-ray. The properties of X-rays discovered by W. C. Roentgen in 1895 seemed to have not fully understood when Einstein proposed the special theory of relativity in 1905. As such, Einstein's formula does not have any answer whether velocity of X-rays exceeds that of light. However, because of the set speed limit, it is widely believed that X-rays and gamma rays also travel at the same velocity of light, despite X-rays possessing higher energy than light. The current study not only provides spectral evidences on superluminal velocities of X-rays but also provides theoretical explanation.

There is a valid reason why $E = mc^2$ in the present form is not applicable to high energy radiation such as X-ray. X-ray or γ- ray continuously moves as long as its energy lasts, so X-ray or γ- ray photon will not have rest mass energy. Therefore, the formula fails when X-ray or γ- photon is presumed to have zero rest mass energy or zero mass. Anyhow, no experimental data is available in literature on the mass of light, X-ray, and γ- photons. Notably, velocity dependence on photon energy, the big breakthrough emerged from the current spectral evidences holds the key that photons have some definite mass, regardless of the fact how small it is. It is not possible to say more details on the mass of a photon. Most interestingly, the superluminal velocities of X-rays and Bharat Radiation agree with the modified Einstein's formula discussed later in this paper, in which the author assumes light, X-ray, or γ- photon have equal mass 1 [8, 9].

In 2002, RHESSI mission scientists at NASA's Goddard Space Flight Center announced solar X-rays coming from the base of the flaring region well before the initial brightening in the EUV [10]. Their key measurements have been absolutely correct, yet could not claim X-rays traveled faster than EUV particularly when there was no theoretical support and unsure whether X-rays and EUV originated from the same source at the same time. Anyhow, on literature survey the author did not come across any published paper on the important observation made by RHESSI mission scientists. In the recent past, the author explained by the modified Einstein's formula that X-rays coming well before the initial brightening in the EUV observed by RHESSI mission scientists was due to X-rays traveling faster than EUV, against the traditional wisdom that X-rays and EUV travel at the same speed c [8, 9].

Similar announcement on X-ray emissions of flares arriving earlier than EUV has come from University of Colorado's Laboratory for Atmospheric and Space Physics in Boulder in 2010; however expressed their difficulty in explaining the event in terms of physics [11]. For the first time in the last 100 yrs, Woods et al in 2011 provided unclenching solar spectral evidences reproduced in Figures 1 to 3 here on GOES X-rays arriving earlier than 13.3 nm emission, which in turn arriving earlier than 33.5 nm emission [2]. These spectra given on time scale are so simple to understand on arrival of these specific wavelengths from their peak positions. Despite best experimental results, they did not conclude GOES X-rays traveled at superluminal velocities than 33.5 nm. Probably, interpretation of 17.1 nm and 30.4 nm emissions posed a problem as it needed information on their exact sources. The key information on these emissions has come from the latest publication in which the author has succeeded in explaining that the solar line emissions are caused by γ, β, and X-ray energies of ^{235}uranium fission products [3, 4]. Accordingly, GOES X-rays could be of 7.0 nm wavelength, 13.3 nm represents Bharat Radiation emission ranging from 12.87 to 31.0 nm, and 33.5 nm represents EUV emission [4]. Previously, the author was able to explain that 7.0 nm GOES X-rays generated 13.3 nm Bharat Radiation, which in turn generated 33.5 nm EUV emission on valence excitation within the same excited atoms present in solar flare [4,12]. Therefore, all the three emissions emerged from same excited atoms present in the same solar flare and also reached the same detector assembly. Moreover, as the distance from solar flare to the detector assembly is huge, chances for any statistical errors would be the least. Since the experimental conditions seem to be flawless from various points of view and conducive for proper interpretation of data, spectral findings in Figure 1 doubly ensured that 7.0 nm GOES X-rays have actually traveled faster than 13.3 nm Bharat Radiation, which in turn traveled faster than 33.5 nm EUV emission. That means 7.0 nm GOES X-ray and 13.3 nm Bharat Radiation emissions have traveled at superluminal velocities, when 33.5 nm EUV emission is considered to have traveled at velocity of light c.

All the solar spectra recorded from 5 solar flares on 5 different days by Wood et al in 2011 reproduced in Figure 2 have demonstrated earlier arrival of 13.3 nm Bharat Radiation than 33.5 nm EUV emission at the detector, confirming superluminal velocity of 13.3 nm Bharat Radiation, when 33.5 nm EUV radiation is considered to have traveled at velocity of light c. Their spectral measurements in Figure 3 confirmed early arrival of solar 70A GOES X-ray band over 133A Bharat Radiation band, agreeing with the findings of Figure 1. Similarly, 133A Bharat Radiation band also showed early arrival than 335A EUV band. The 70A GOES X-rays arrived earlier than 94A X-rays, implying short wavelengths traveled fast even among solar X-rays. Short wavelengths have shown early arrival even among 171A, 177A, 180A, 195A, 202A, and 284A Bharat Radiation spectral bands. In nutshell, among X-rays and Bharat Radiation traveling at superluminal velocities, it is noticed that higher the energy faster its travel.

II. Results and discussion

Ever since Einstein reported his formula in 1905, no clear experimental evidence was reported on superluminal velocity of an electromagnetic radiation, such as X-rays. Furthermore, there has been no well documented theory suggesting superluminal velocities of electromagnetic radiation at certain wavelengths. For the first time the author has theoretically shown superluminal velocities of X-rays by modification to Einstein's formula, as a brief comment [9].

In 2002, RHESSI mission scientists at NASA's Goddard Space Flight Center announced solar X-rays coming from the base of the flaring region well before the initial brightening in the EUV [10]. It has been a most important and correct observation, yet various problems restrained the scientists from drawing the necessary conclusion that X-rays traveled at superluminal velocities. Prior to the current study, scientists have been unsure whether EUV started subsequent to X-rays from solar flare. Understanding the source of different wavelengths arriving from solar flare became a puzzling issue in proper interpretation of valuable experimental data.

In 2005, the MAGIC gamma-ray telescope on La Palma in the Canary Islands measured the light released by a galaxy around 500 million light years away. Contrary to what RHESSI mission reported, the MAGIC gamma ray telescope scientists found that higher energy photons arrived four minutes behind their lower energy counterparts suggesting the speed of light may change depending on its energy [13]. The investigators concluded that their measurements showed a difference in the speed of light; however, keeping in mind that Einstein predicted speed of light is a constant they thought it is possible to produce flares that release lower-energy radiation before higher-energy radiation. There can be some possible errors in the measurements by MAGIC gamma-ray telescope, because high energies are expected to arrive well before low energies, according to the findings of RHESSI mission and the spectral findings in Figures 1to 3 in the current study.

From the theoretical point of view, high energies are expected to have high velocities as shown later in the current paper. Next, NASA's Fermi Gamma-ray Space Telescope analyzed the radiation at different wavelengths from a gamma-ray burst associated with a highly energetic explosion in a distant galaxy [14]. The results did not support the speed of light varying linearly with photon energy or quantum-gravity theories.

Thomas N. Woods from University of Colorado's Laboratory for Atmospheric and Space Physics in Boulder made an announcement on X-ray emissions of solar flares arriving earlier than EUV in 2010 [11]. Their observations have been very correct; however expressed difficulty in explaining the event in terms of physics. Woods et al in 2011 could clearly demonstrate significant time difference in the arrival of different wavelengths at the detector from solar flare [2]. Despite making important observations, uncertainties prevailed whether certain wavelengths really showed early arrival or due to their early start. The author's assessment that GOES X-rays could be of 7.0 nm emission in the recent publication [4] helped in interpretation of their spectral data reproduced in Figures 1 to 3 of the current paper. The author has already reported that 13.3 nm emission represents Bharat Radiation as it ranges from 12.87 to 31 nm, while 33.5 nm (Fe XVI) emission represents EUV, since EUV wavelengths begin from 31 nm [3].

Superluminal velocities of GOES X-rays and Bharat Radiation

As the spectral data from C8.8 solar flare on 2010 May 5 in Figure 1 is measured from 11 to 15 hrs, it became very easy to know which wavelength of electromagnetic radiation showed early arrival over the rest from their peak positions. GOES X-ray peak situated left to dotted line (top) while 13.3 nm peak (in blue, Fe XX) centered on dotted line (below) clearly demonstrated early arrival of GOES X-rays over 13.3 nm emission at the detector from C 8.8 solar flare. Likewise, a comparison of 33.5 nm peak (in green, Fe XVI) on right side to the dotted line with 13.3 nm peak (in blue) centered on dotted line demonstrated early arrival of 13.3 nm emission over 33.5 nm emission (below). In nutshell, GOES X-rays arrived earlier than 13.3 nm emission, which in turn arrived earlier than 33.5 nm emission.

Next, for proper interpretation of this important spectral data, it is required to know the sources of these wavelengths listed in Figure 1. The author has recently reported that GOES X-rays could be of 7.0 nm wavelength, 13.3 nm represents Bharat Radiation emission, and 33.5 nm represents EUV emission [4]. In terms of wavelength, 7.0 nm represents lower wavelength than 13.3 nm, but wavelength difference is not high. That is why 7.0 nm GOES X-rays arrived slightly earlier than 13.3 nm emission but difficult to measure time difference precisely in terms of minutes from the spectra. Moreover, due to short wavelength the 7.0 nm GOES X-rays took very less time than 33.5 nm EUV emission in arriving at the detector from the solar flare.

The spectral data in Figure 1 has clarified that the GOES X-ray, 13.3 nm Bharat Radiation and 33.5 nm EUV emissions originated from C8.8 solar flare on 2010 May 5. From the recent study, it became possible to pinpoint GOES X-rays have generated 13.3 nm Bharat Radiation emission, which in turn generated 33.5 nm EUV emission on valence excitation from within the same excited atoms present in solar flare by Padmanabha Rao Effect [4]. This has provided the key information on the origin of GOES X-ray, 13.3 nm, and 33.5 nm emissions from same excited atoms present in solar flare almost at the same time. Moreover, the detector assembly remained the same in the case of all these three emissions. The experimental conditions are conducive for proper interpretation of results. More importantly, enormous distance between solar flare and the detector provided accurate and reliable results on the arrival time of different wavelengths. On this basis, it became possible to draw the conclusion that GOES X-rays reached the detector faster than 13.3 nm emission, which has reached faster than 33.5 nm emission. Figure 1 does not include visible light spectrum so difficulty arose in comparing the velocities of GOES X-ray, 13.3 nm and 33.5 nm emissions with the velocity of light c.

When 33.5 nm EUV emission is considered to have traveled at the velocity of light just for ease in interpretation, the spectral data unfolded that 7.0 nm GOES X-rays traveled faster than 13.3 nm Bharat radiation emission, which in turn has traveled faster than 33.5 nm EUV emission. Figure 1 thus unfolds superluminal velocities of 7.0 nm GOES X-rays and 13.3 nm Bharat radiation on the basis spectral evidences reported by Woods et al in 2011 [2].

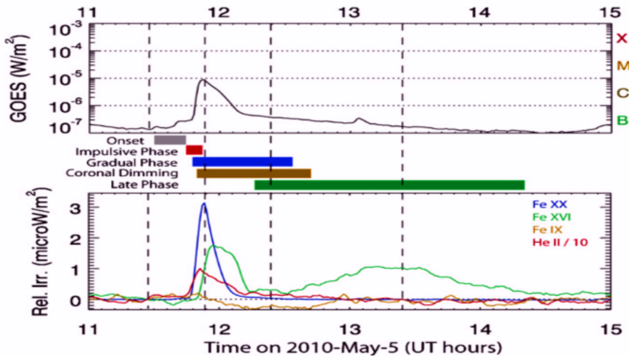
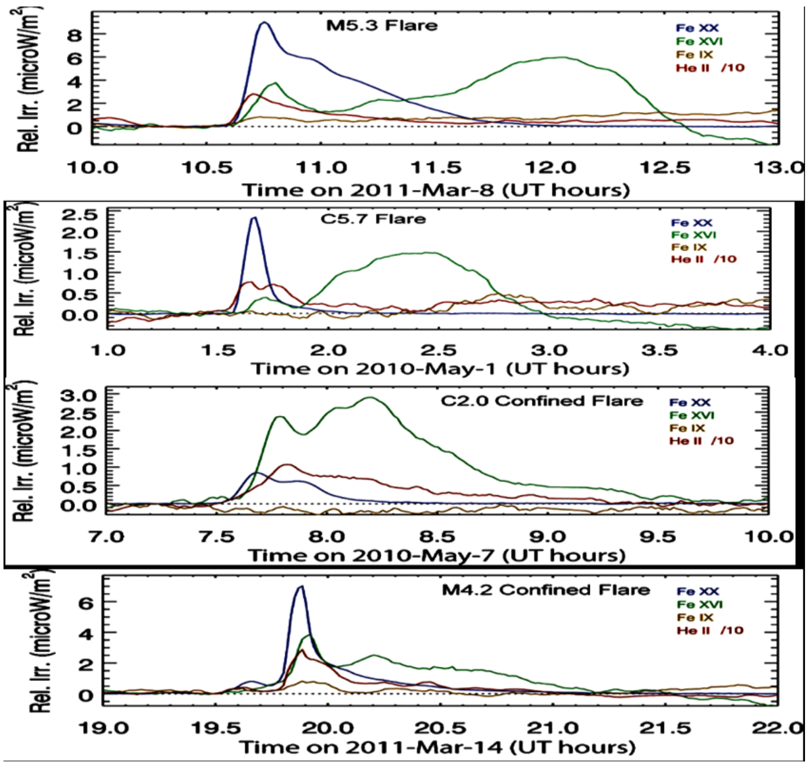


Fig.1 These spectra of C8.8 flare on 2010 May 5 are reproduced from the publication of Woods et al in 2011 [2]. GOES X-ray peak situated left to dotted line (top) showed earlier arrival than blue peak (Fe XX), which is centered on dotted line (below). The blue peak (Fe XX) showed earlier arrival than green peak (Fe XVI), which is on right side to the dotted line (below). Blue peak (Fe XX) represents 13.3 nm emission and green peak (Fe XVI) represents 33.5 nm emission (Figure 3). The above spectra provide the first and direct experimental evidence on earlier arrival of short wavelength 13.3 nm than 33.5 nm emission at the detector from solar flare.

There are reasons why the brown and red spectra are not compared with GOES X-ray, Fe XX, and Fe XVI spectra of Figure 1. The spectrum in light brown, labeled Fe IX represents 17. 107 nm Bharat Radiation emission and was reported to have been caused by 606.31 keV β energy (E_{max}) from ^{131}I, an ^{235}uranium fission product [4]. As this is an independent emission unconcerned with the successive GOES X-ray, 13.3 nm Bharat Radiation and 33.5 nm EUV emissions, no comparison was made. Similarly, the spectrum in red, labeled He II/10 represents 30.4 nm Bharat Radiation emission and was reported to have been caused by 9500 keV β energy (E_{max}) from ^{133}In. It is unconcerned with the successive GOES X-ray, 13.3 nm Bharat Radiation and 33.5 nm EUV emissions; hence no comparison was made.

The five sets of spectra in Figure 2 provide further evidences on earlier arrival of 13.3 nm emission than 33.5 nm emission from the independent measurements made from 5 different solar flares present on different days. These spectral evidences support the finding in Figure 1 on earlier arrival of 13.3 nm over 33.5 nm emission. In clear words, by virtue of short wavelength the 13.3 nm emission traveled faster than 33.5 nm emission. In nutshell, Figure 2 provided further evidences on superluminal velocity of 13.3 nm Bharat Radiation over 33.5 nm EUV emission.



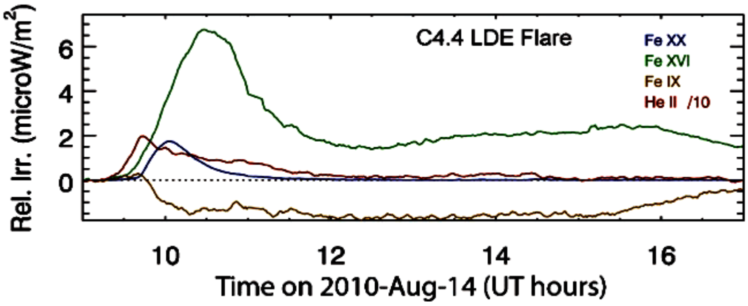


Fig. 2. These five spectra here are reproduced from the paper published by Woods et al in 2011 [2]. Earlier arrival of blue peak (Fe XX) than green peak (Fe XVI) at the detector is consistently evident from 5 different solar flares present on different days. Blue peak (Fe XX) represents 13.3 nm emissions and green peak (Fe XVI) represents 33.5 nm emissions (Figure 3). All these spectra provided further evidences on earlier arrival of short wavelength length 13.3 nm than 33.5 nm emission at the detector from solar flare.

The findings of Figure 3 further support the findings of Figures 1 and 2. A comparison of red bands unfolds earlier arrival of 70A GOES X-ray band than 133A Bharat Radiation band, which shows earlier arrival than 335A EUV band at the detector. Confirming the findings of Figure 1, the spectral Bands in Figure 3 provided direct evidence on GOES X-rays (70A) traveling faster than 133A Bharat Radiation emission, which in turn traveling faster than 335A EUV emission. Figure 3 confirmed the findings of the spectra in Figure 1on superluminal velocities of GOES X-ray and 133A Bharat Radiation emissions, when 335A EUV emission is considered to have traveled at the velocity of light just for sake of convenience.

Figure 3 also showed measurement of two X-ray wavelengths. Owing to short wavelength, 70A GOES X-ray band showed earlier arrival than 94A X-ray band. These spectral bands have provided the first evidence on short wavelength 70A X-rays traveling faster than 94A X-rays, though X-rays as such travel at superluminal velocities. The 13.3 nm Bharat Radiation traveling at superluminal velocities became evident from the spectra of Figure 1. Figure 3 provided measurements of 171A, 177A, 180A, 195A, 202A, and 284A Bharat Radiation bands. Among Bharat Radiation bands shorter wavelengths showed earlier arrival, when compared blue bands among the pairs 171A and 180A; 180A and 195A; 195 and 202A, 202A and 284A; and 211A and 284A. On comparison of right edges of green bands, earlier arrival of 284A Bharat Radiation band than 335A EUV band can be evident. In the entire range of Bharat Radiation wavelengths from 128.7 to 310A, the current study has shown that 171 to 284A traveled at superluminal velocities as compared to 335A EUV band. Figure 3 suggests that the entire range of Bharat Radiation from 128.7 to 310A might travel at superluminal velocities. Notably, the short wavelengths of Bharat Radiation showed high velocity even at superluminal velocities.

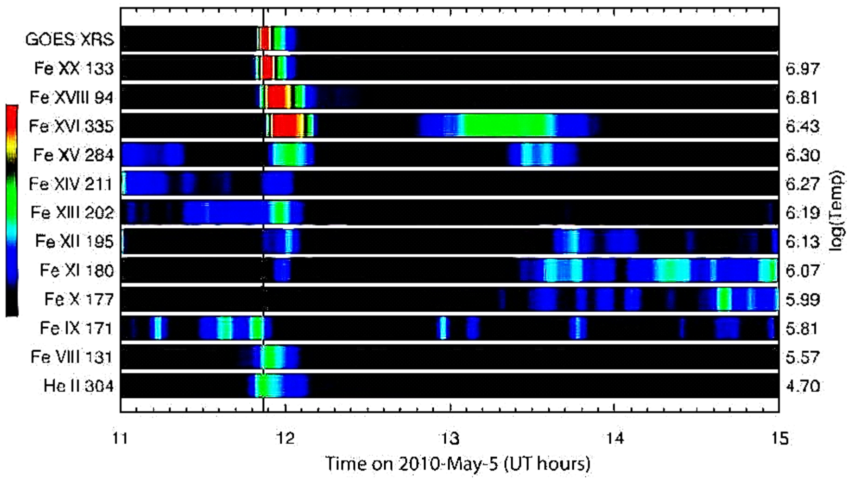


Fig 3. This figure is reproduced from the paper published by Woods et al in 2011 [2]. The author has reported recently that GOES X-rays are of 70A, the wavelengths from 12.87 to 31 nm are of Bharat Radiation, and 335 A is of EUV emission [4]. A comparison of right side edges of red bands unfolds earlier arrival of 70A GOES X-ray band than 133A Bharat Radiation band, which shows earlier arrival than 335A EUV band. A comparison among X-ray wavelengths shows earlier arrival of 70A GOES X-ray band than 94A X-ray band. Among Bharat Radiation bands shorter wavelengths showed earlier arrival, when compared blue bands among the pairs 171A and 180A; 180A and 195A; 195 and 202A, 202A and 284A; and 211A and 284A. On comparison of right edges of green bands, earlier arrival of 284A Bharat Radiation band than 335A EUV band can be evident.

In nutshell, GOES X-rays and Bharat Radiation wavelengths traveled at superluminal velocities, when EUV is considered to have traveled at velocity of light c. Among X-rays and Bharat Radiation which go at superluminal velocities, it has been found that higher the energy faster its travel. If this argument is extended to EUV, UV, visible light, near infrared radiations, EUV is expected to travel faster than near infrared radiation.

As the spectral measurements in Figures 1 to 3 did not include measurements of UV, visible light, near infrared radiations it is not possible to provide experimental evidence to prove the point. The reason is that as most of their intensities would be absorbed in upper atmospheres, it is extremely difficult to make measurements of these wavelengths. The spectral measurements in Figures 1 to 3 have shown only the 33.5 nm EUV emission spectrum in the entire optical range of wavelengths. Therefore, 33.5 nm is taken as velocity of light c just for convenience. Truly speaking since EUV occupies one end of optical spectrum, so it may not represent velocity of light c. In such a case, re-defining c is needed whether velocity of light can be attributed to middle of optical spectrum. As short wavelengths, say X-rays go faster than Bharat radiation, EUV is expected to go faster than UV, visible light or infra red radiation. This questions the finiteness of light velocity c in special relativity. The superluminal velocities of X-rays and Bharat Radiation in Figures 1 to 3 also question the stipulation in special relativity that nothing would go faster than light. Every theory needs periodical validation with the advancement of knowledge. The current study suggests modifications to Einstein's formula $E= mc^2$. To facilitate the formula to be applicable to electromagnetic radiation and moving elementary particles such as electron, and neutrino, c can be changed to v, a variable velocity.

Most importantly, Bharat Radiation bands in Figure 3 are originated from various ^{235}uranium fission products present in the solar flare; hence a comparison on their arrival is justified. The 131A and 133A Bharat Radiation wavelengths are caused by solar X-rays [4]. The 171A Bharat Radiation emission was caused by 606.31 keV β ($E_{\beta max}$) energy of ^{131}I, previously labeled as Fe IX. The 177A Bharat Radiation emission was caused by 661.657 keV γ energy of ^{137}Cs, previously believed to be Fe X. The 180A Bharat Radiation emission was caused by 724.199 keV γ energy of ^{95}Zr, previously labeled as Fe XI. The 195A Bharat Radiation emission was caused by 795.864 keV γ energy of ^{134}Cs, previously believed to be Fe XII. The 202A Bharat Radiation emission was caused by 847.025 keV γ energy of ^{134}I, previously labeled as Fe XIII. The 284A Bharat Radiation emission was caused by 1596.21 keV γ energy of ^{140}La, previously believed to be Fe XV. The 304A Bharat Radiation emission was caused by 9500 keV β ($E_{\beta max}$) energy of ^{133}In' previously believed to be He II.

Modified Einstein's formula

The author has shown how the experimentally observed superluminal velocities of X-rays and Bharat Radiation shown in Figures 1 to 3 can be explained by the Albert Einstein's modified formula. Although mass (m) restricts the use of Albert Einstein's formula to X-ray and Bharat Radiation photons known to have no mass, it can be made relevant on postulating that photons have negligible but equal mass. Therefore, m is given value 1 to all photons including X-ray, Bharat Radiation, EUV, UV, visible, and near infrared photons [9].

For a light photon having mass (m) = 1 and energy at eV level, $E = c^2$ (Eq.1).

X-ray photon also will have m equals to 1 like a light photon. However, X-ray has much higher energy at keV or MeV level than a light photon. Solar spectra in Figures 1 to 3 have already shown X-rays traveled at superluminal velocities than EUV, implying higher the energy greater the velocity. Therefore, c of light is replaced with variable velocity (v).

Energy of a photon $E = v^2$ (Eq. 2, modified Einstein's formula).

The major success in the current theory lies in its ability to explain the spectral findings in Figures 1 to 3, which unfolded that higher the energy greater the velocity of a photon. The modified formula supports the superluminal velocities of X-rays and Bharat radiation when EUV emission is considered to have traveled at velocity of light c for sake of convenience, against the wide belief gamma rays, X-rays and light travel at the same speed.

The current study is not the aimed in precise estimation of the velocity of GOES X-rays over 13.3 nm emissions. Precise calculations can follow later when more data is available.

Superluminal velocities of neutrinos

Neutrinos are said to be massless but estimated to have a mass less than one-hundred-thousandth that of an electron [6]. Since mass of a neutrino is believed be so negligibly small**,** its mass is taken as 1 like the case of a γ-ray X-ray, Bharat Radiation or light photon. Then Einstein's modified formula 2 can be applied to neutrinos. Fermilab uses a neutrino beamline that has an energy spectrum of 0.5 to 8 giga electronvolts. The neutrino energy 0.5 to 8 GeV is very high as compared to that of γ- ray emissions from commonly used radioisotopes. If the neutrino energy is applied in Formula 2, neutrino definitely travels at superluminal velocity and many more times than the superluminal velocity of X-rays or Bharat Radiation. Therefore, it should not be a surprise when scientists at CERN claimed neutrinos traveled at superluminal velocities [9]. Precise calculation of neutrino's superluminal velocity is not possible here because its mass is approximated.

Equation 2 does not support the view that rise in mass of a neutrino (relativistic mass) at high velocity due to very high energy at GeV level. The author explains that the raise in mass of a neutrino or electron seems to be incorrect. Einstein's formula remains unchanged when mass of an electron m is simply multiplied with some number and c^2 is divided with the same number. The rewritten formula unfolds that gain in the mass of an electron leads to fall in speed.

Einstein's formula can be made useful in proper understanding the physics of a neutrino. The mass of a neutrino has been approximated to be less than one-hundred-thousandth that of an electron [6]. Einstein's formula remains unchanged when mass m is simply divided with 100,000 and c^2 is multiplied with 100,000 but leads to a better understanding of a fast moving neutrino. The rewritten formula holds the key that in the case of a neutrino, c^2 rises by 100,000 times implying that c cannot be finite in Einstein's formula. Therefore, if c is replaced with variable velocity v, Einstein's formula still holds good in the case of a moving elementary particle such as neutrino. In such a case, neutrino travels nearly 316 times faster than an electron. In nutshell, by virtue of negligibly small mass, neutrino travels faster than electron, as well as X-ray and Bharat radiation photons, which go at superluminal velocities.

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