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Emission of F10.7 Solar Radio Flux and UV Flux Changes in Relation with Sunspot Number during 1986 - 2017 Solar Cycles

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ABSTRACT

The present circumstances of sun based discharge at 10.7cm wavelengths demonstrate an orderly increment contrasted with the sunspot number (SSN). The 10.7cm sun based radio transition (F10.7) is a standout amongst the most broadly utilized records of sun powered action. The sunlight based attractive field transition measured for the whole sun oriented cycle is contrasted and the sun oriented file of the successful cycles for the years 1986-2017. Of these files the two most utilized are the relative sunspot number, covering over 400 years and the 10.7cm sunlight based radio motion (F10.7), which has been measured consistently since 1947. The information distributed in the official site of National Oceanic and Atmospheric Administration (NOAA) has been utilized as a part of the examination. The connection between sun oriented UV transition and 10.7 cm radio outflow has been considered, while the connection between the full UV and radio motions is non straight. The 10.7 cm radio outflow can in this manner be utilized as an intermediary for the UV transition. This investigation analyzes the relative sunspot number and 10.7cm sun powered radio transition lists exclusively with UV flux and furthermore the connection amongst them infers on the sun based conduct for the sun oriented cycle 21, 22, 23 and 24.

Keywords : Radio flux, SSN, 10.7 cm solar flux, UV flux, flux indices

I. INTRODUCTION

The F10.7cm flux is a Sun based transition to be estimated as the force of sun based radio outflows of 10.7 cm wavelength of recurrence at 2800 MHz this is generally utilized for the sunlight based extreme ultraviolet radiation (EUV) in the studies of exosphere (Kuznetsov et al 2010). The 10.7cm flux is utilized on an extensive variety of approach together with the cosmology, atmospheric climate, geo stationary orbital's, weather forecast, tele and satellite communication systems (Albert Anderson., 1964). The microwave transition at F10.7cm often utilized as the Sun based intermediary characteristically, which demonstrates that the wavelength variation of fluxes gives significant correlative data that improves their significance for the exospheric pattern. While a substitute for solar extreme ultraviolet radiation (EUV), 10.7cm flux is constantly an input factor for manipulating the density of atmosphere for the purpose of orbit in an aerospace and prediction of communication in the ionosphere (Cong Huang et al., 2009). The space climate regulation includes distinctive physical situations running from the sun to the earthly ionosphere and magnetosphere, which are altogether described by various physical conditions (Tapping 2013). Sun oriented transition from the whole sun powered circle at a recurrence of 2800 MHz is a thickness for each unit frequency at 10.7 cm of wavelength is close to the pinnacle of the sun powered radio discharge examination (Kretzschmar et al., 2011). It implies a compute of diffuse, coronal plasma of non-radiative warming caught by magnetic fields over dynamic areas, and is an exceptional pointer of general levels of solar activity (Saha et al 2011). The F10.7 cm of 2.8 GHz is the most significant electromagnetic band, for the reason that it can be utilized for the ground-based perceptions such as radio bands and space-borne perceptions in the UV band as a excellent substitute (Chatterjee 2001). This radio emission, as well as the aggregate outflow in different parts of the electromagnetic spectrum, have a cyclic variation of 27-day, which is represented as the slowly varying or sunspot reliant element of the emission of radio waves (Chatterjee & Das 1995). The Sun's electromagnetic radiation at a F10.7 cm is a critical factor for the level of Sun based activity measurements. The force of sunlight based F10.7 is

communicated by sun based radiation transition at 10.7 cm wavelength. Perceptions of 10.7cm started in 1947 and are accessible for over 60 years (John & Constantine., 1985).

The estimation of Sun's activity is near to the ground and elevated when sunlight based activity is elevated, with the relationship between the sun based F10.7 and relative sunspot number surpasses 0.98 (David Hathaway et al 2003). It has been addressed whether the levels of Sun's environmental action in two distinct layers concur with each other in view of that F10.7 and relative sunspot numbers are two diverse arrangements, one need to dissect the stages between the two utilizing distinctive methodologies (Ivan Kutiev et al 2013). The examination of dynamic locales is required to think about the magnetic field of the sun and the material science of magnetic movement. Its connected impact is associated with the contact of sun powered dynamic procedures on the Earth's magnetic field (Bruevich et al 2014). The accord of recreation demonstrates sensible understanding among the different production of sun powered winds magnetic field over the previous 170 years (Leif Svalgaard 2005). The present sunspot cycle 24 has been peculiarly ease back to grow, however significantly more abnormal infrared estimations of the focal dark sunspot umbral areas have demonstrated a diminishing effect in the most extreme quality of magnetic field (Livingston et al 2012; Varotsos et al 1992). Solar cycle 23 is described by a base action period that is special from multiple points of view. Amid this profound snooze period of the Sun, it went spotless for more than 265 days in the middle of 2008 - 2009. Aside from the sunspot number (SSN) that ensures the pinnacle of the solar cycle represents the Sun's activity reasonably than the sun based EUV and F10.7cm transitions are generally used to portray the varieties in the Sun's extreme ultra violet (EUV) irradiance. The unit of solar radio flux is mention as sfu where 1sfu = $10^{-22}Wm^{-2}Hz^{-1}$. Frequently it is hypothesized that the connection between EUV transition and F10.7cm solar flux is discreet over various sun oriented cycles in this way. Conversely a current report shows that the connection between the F10.7cm transition and the sun based EUV flux amid the most profound solar least is not quite the same as the past minima, the diminishing in two parameters being very less in F10.7cm and among 1-50nm only15% of EUV irradiance contrasted with the past least cycle. The investigation likewise shows that the F10.7cm transition is not a perfect marker of solar flux during 2007-2009. In another current investigation the IRI - 2007 model over assessments of electron thickness during the profound least cycle between solar cycle 23 and 24. Considering the essential reliance of the sun based EUV photons in the creation of ionization in the earthly ionosphere, in this manner it is critical to explore the ionospheric variety for the period of the profound least between the cycles 23 and 24 because it changes the F10.7cm flux, EUV transition, and SSN. As the sun based movement relating to the cycle 24 is venturing up it winds up plainly critical to analyze the variety of TEC over the inconsistency peak region over the dropping period of the solar cycle 23 and the recently began rising period of cycle 24 variations in the EUV and the F10.7cm solar transition over these periods (Chatterjee and Das., 1995).

II. DATA ANALYSIS

The information distributed in the Solar Geophysical Data Bulletins in the website of NOAA is accessible in broad space. In this examination we embrace the everyday estimations of previously mentioned frequencies from Lear month sunlight based Radio spectrograph for the cycle 21, 22, 23 & 24 from 1976 to 2017. The day by day information of 2800 MHz radio emanation, and additionally that of the relative sunspot number for a similar period, has been acquired from similar publications. The time arrangement of the month to month mean estimations of sunlight based files was utilized as a part of the examinations. The information of the 10.7 cm sunlight based radio transition was got from the official site. The sun spot numbers were got from the site, the day by day information for the relative sunspot number and F10.7 cm sun based transition are taken from the official site of the National Oceanic and Atmospheric Administration (NOAA) for the time of 1986 to 1996. The sunspot numbers and transition are considered together from 1986-1996.

III. RESULTS AND DISCUSSION

3.1. Decreasing Approach of Sunspot Cycle Distribution

The sunspot number is figured out by first tallying the groups of sunspot number and after that the quantity of individual sunspots. Month to month midpoints of the sunspot numbers demonstrate that the quantity of sunspots noticeable on the Sun waxes and melts away with a 11 year cycle approximately (Chakrabarty et al., 2012). There are a few cycles with various properties and periods, whereas in the 11-year cycle the 90th year cycle are the best known about them. The 11-year cycle shows up as a repetitive decrease in stains on the surface of the Sun at regular intervals. Its ninety year changes are related with intermittent decrease in the quantity of spots in the 11-year cycle in the 50 - 25%.

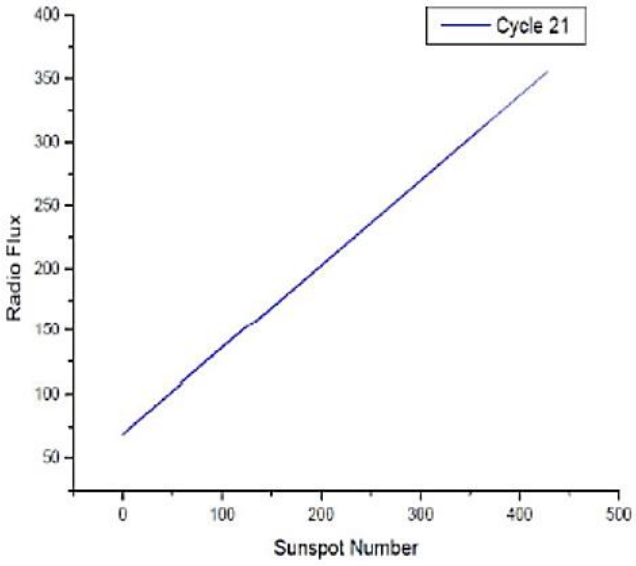
In seventeenth century, however there was a delayed diminishment in Sun's action called the Maunder least, which kept going generally from 1645 to 1700. Amid this period, there were just around 50 sunspots rather than the standard 40-50 thousand sunspots. The two hundred years of sunspot cycle has taken for discussion. It consists of 18 solar cycle activity with the maximum and minimum phases of all the solar cycle. Amongst the solar cycle 19 shows a great enhancement over the others with above 350 sunspot numbers. The recent solar cycle which is the 24th cycle is the least favoured cycle with less sunspot events and activity with less than 180 sunspot numbers. This shows completely a contradiction from the previous cycles. The present cycle leads to a future prediction of sunspots cycle may evolve with more quantities and groups which leads the pinnacle to reach above 350 levels. More the sunspot number more the solar activity concentration.

3.2. Solar Radio Flux Variation with Sunspot Number

The relationship between the sunspot number and solar radio flux at 2.8 GHz displays quiet a straight result in the nonexistence magnetic movement of sunspot that correlate with the solar radio flux. The sunspot number can be plotted against the values of radio flux on daily basis a linear plot has then been fitted. The solar radio flux component is calculated from the expression as follows.

$$\text{Radio Flux} = 68.84 + 0.67 \text{ x Sunspot Number} \quad \text{- - - (1)}$$

From the above equation (1) the radio flux has been calculated from the sunspot number for 200 years of long sunspot cycle from the year 1818 to the present year 2017. The linear plot in figure (1) of sunspot number and solar radio flux displays a straight line for solar cycle 21, 22, 23 and 24 where the radio flux varies from 75 sfu to 450 sfu and the sunspot number ranges from 0 to 600 which ensure that both the radio flux and sunspot number varies simultaneously. The pattern of plot between the sunspot number and the solar radio flux mostly gives the straight line view which ensures that the 10.7cm radio flux is a factor which is highly dependent on the sunspot number and vice versa. Similarly the correlation between solar radio flux and sunspot number has been calculated for solar cycle 21, 22, 23 and 24 which is pictorially represented. In solar cycle 21 the solar radio flux varies below 380 sfu with sunspot number 450 in a straight line and for solar cycle 22 the variation is depicted below 360 sfu with sunspot number 440. The arrangement of above solar cycles shows that there is a decrease in the next cycle compared to the previous solar cycle. Almost same result we got for the next two cycles, for solar cycle 23 the solar radio flux varies below 340 sfu with sunspot number 370 for the solar cycle 24 which is comparatively less than all the three cycles which is 240 sfu radio fluxes with 240 sunspot number.



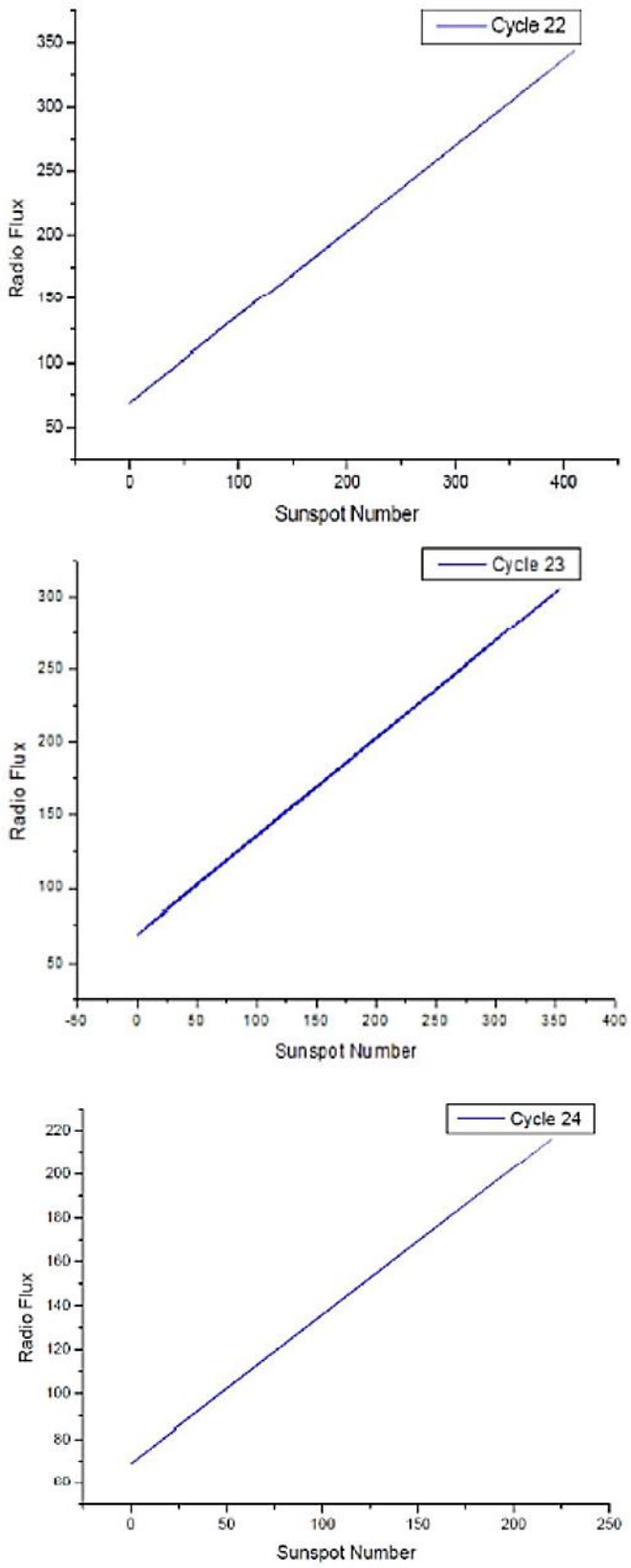


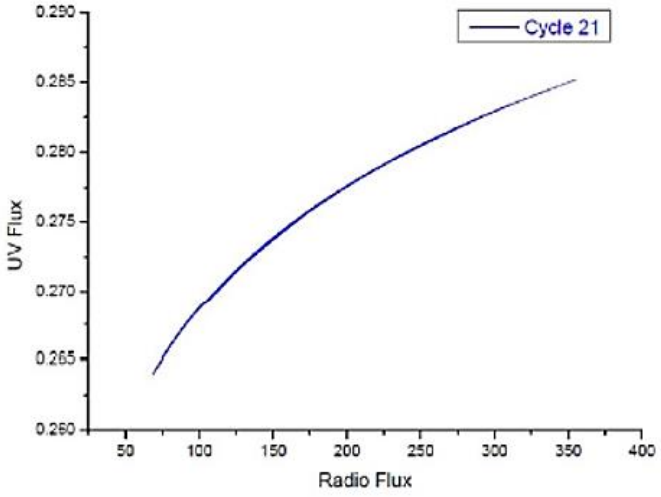
Figure 1. Presents the relationship between the radio flux and sunspot number for the intense solar events in the solar cycles 21, 22, 23 and 24

3.3. UV Flux Variation with Solar Radio Flux

The relationship between the solar UV flux and solar radio flux at 2.8 GHz displays quiet a straight result in the nonexistence magnetic movement of sunspot that correlate with the solar radio flux. The UV flux can be plotted against the values of radio flux on daily basis. The linear plot has then been fitted with a slight curved line. The two solar flux components are calculated from one another and it is specified by the expression as follows.

$$\text{UV Flux} = 0.2164 \text{ x } (\text{Radio Flux})^{0.047} \quad \text{- - - - - (2)}$$

From the above equation (2) the UV flux has been calculated from the solar radio flux for 200 years of long sunspot cycle from the year 1818 to the present year 2017. The linear plot in figure (2) of radio flux and solar UV flux displays a slightly curved line where the radio flux varies from 75 sfu to 450 sfu and then the UV flux varies from 0.264 Wm-2nm-1 to 0.288 Wm-2nm-1 which ensures that both the flux values vary simultaneously. Similarly the correlation between UV flux and radio flux has been calculated for solar cycle 21, 22, 23 and 24 which is pictorially represented in figure.



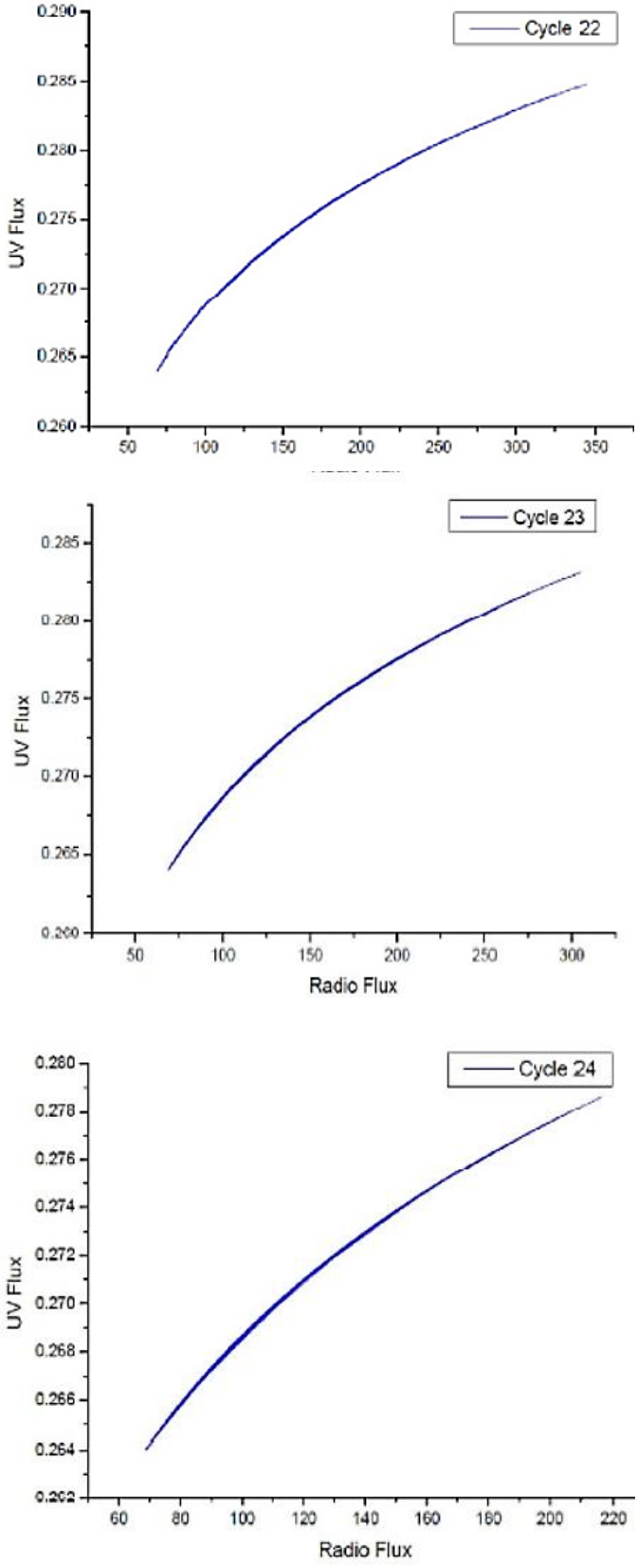


Figure 2. Presents the relationship between the radio flux and UV flux for the intense solar events in the solar cycles 21, 22, 23 and 24

In solar cycle 21 the solar radio flux varies by 380 sfu with a slight curve and for solar cycle 22 the variation is depicted below 380 sfu which is 360 sfu. The combination of these cycle shows that there is a decrease in the next cycle compared to the previous cycle. Almost same result we got for the next two cycles, for solar cycle 23 the solar radio flux varies below 340 sfu and 240 sfu for the solar cycle 24 which is comparatively less. So the outcome from the figure shows that it is highly comprehensive with the number of sunspots in the solar activity cycle.

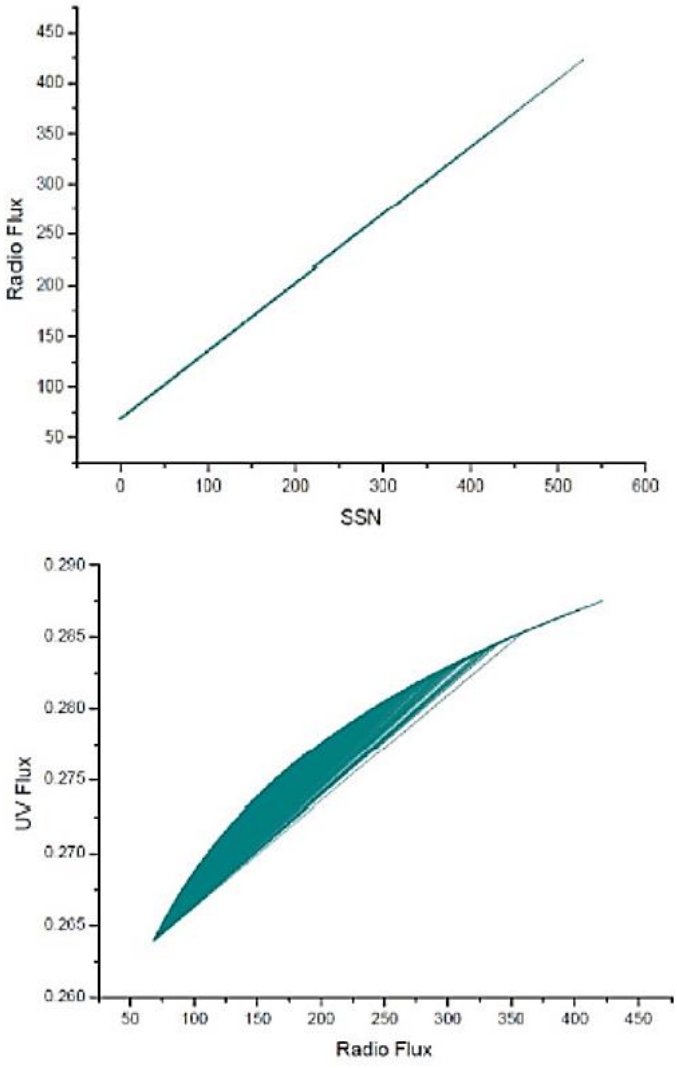


Figure 3. The comparison of the solar radio flux and UV flux, over 200 years of long sunspot number cycle from the year 1818 to the present year 2017.

The above figure (3) represents the comparative representation from the year 1818 to 2017 for the

solar radio flux and UV flux in association of sunspot number cycle which greatly shows that there was a great abundance of radio flux emission during the middle period along with the UV flux which a leaf like structure. The more the intense event the greater the emissions of radio flux.

IV. CONCLUSION

The outcomes portrayed in the paper are items on the information driven investigation. The straight forward elucidation of the intermittent changes makes the sun powered cycle 22 incredibly with double crests amid the year 1989 and 1991. The conceivable, late reassessment of past sunlight based movement ought to give a superior hypothetical survey to sun oriented cycle 23 and sun powered cycle 24. The day by day comparison of the 10.7 cm radio flux values and the relative sunspot numbers emphasizes that the 10.7 cm radio flux values are responding to the magnetic field which intensify the sunspots. The massive connection among the 10.7cm radio outflow and the UV motion bolsters the 10.7cm radio emanation might be utilized as an intermediary for the UV transition correspondingly to its utilization for different sorts of sun powered movement. It additionally shows that comparative systems are in charge of the era of the warm segment of both the radio and UV outflow.

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