THE GN-Z11-FLASH EVENT CAN BE A SATELLITE GLINT

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INTRODUCTION

Recently, Jiang et al. (2020) presented a short duration flash in a MOSFIRE (McLean et al. 2008) K-band spectrum of a galaxy at redshift $z \sim 11$ (Oesch et al. 2016). The galaxy is referred to as GN-z11, and the transient is designated GN-z11-flash. The transient specific flux was $0.057$ mJy in the K-band, and it was visible in a single 179 s exposure. Jiang et al. (2020) argue the source of the transient was a GRB prompt UV flash. Kann et al. (2020) further showed that the properties of the flash are consistent with a prompt optical emission from a GRB.

Shortly after, Steinhardt et al. (2021) suggested a more probable explanation, by presenting other MOSFIRE K-band images where flashes are seen, arguing that the source of these transients were reflections off artificial satellites. In response, Jiang et al. (2021) argue that such flashes are typical of Low Earth Orbit (LEO) satellites, and that those would not be a viable explanation for GN-z11-flash, as it was (a) a point-like object in the raw image, and (b) observed inside the Earth’s shadow, as seen by satellites up to 4000 km above the ground. Jiang et al. (2020) also exclude a high-orbit satellite as the cause of GN-z11-flash as the observation was made at a declination of $\sim 60^\circ$.

However, both Nir et al. (2020) and Corbett et al. (2020) presented samples of high-orbit satellite glints that can explain GN-z11-flash. They showed that high orbit satellites, or space debris, rotating at a period of a few minutes, can cause $O(1)$ flashes, that would appear as point sources under reasonable seeing conditions. These flashes would be indistinguishable from fast astrophysical transients in single images.

ANALYSIS

To appear point like in a slit image, an object moving at an angular velocity $v$ and angle $\theta$ to the slit, under $s$ seeing size, must have a flash shorter than $\Delta t \lesssim s/\sqrt{v \cos \theta}$. For GN-z11-flash, we take $s = 0.6''$.

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$2$ We take $s = 0.6''$ as this was the seeing during the observation of the flash. We take $v = 150''$ s$^{-1}$ for a geosynchronous satellite moving directly overhead. The actual transverse velocity could be lower if the object is closer to the horizon or if its orbit is eccentric and spends more time at higher declinations, (e.g., Tundra orbits).

$3$ The rate in the equatorial region found by Nir et al. (2020) is about an order of magnitude larger than that found by Corbett et al. (2020), most likely due to the deeper limiting magnitude of the former. This suggests that the rate of glints similar in brightness to GN-z11-flash at high declinations could be $\approx 10$ times larger than that given by Corbett et al. (2020).

$4$ To estimate the angular area that could be associated with a galaxy, we can assume that each galaxy takes up an area $\sim 0.5$ arcsec$^2$, including the size of the galaxy and the width of the seeing. Gardner & Sivakoff (2004) estimate the number of galaxies in the Hubble Deep Field to be on the order of $500$ arcmin$^{-2}$, so the total sky area covered by galaxies is on the order of a few percent.
In addition, Padmanabhan & Loeb (2021) suggested that GN-z11-flash is caused by a shock breakout event in a population III star in GN-z11. However, this, as well as any physical model, requires the release of about $4.5 \times 10^{48} \text{erg}$, in $\sim 15$–$35 \text{s}$, in a narrow band between $\sim 1700$ and $2000 \text{Å}$ (all numbers given in the rest frame).

3. SUMMARY

A few conclusions based on these recent results are:

- Glints can be seen at the position of GN-z11-flash, as high orbit satellites would be above Earth’s shadow at that time and direction.

- Short duration flashes from rotating objects can cause flashes shorter than 0.1 s, that would appear point-like under $0.6''$ seeing conditions.

- High orbit satellites do have high declination orbits. The rate of glints from such objects is at least $2.4 \times 10^4$ per day per sky, it is most likely higher by at least an order of magnitude, considering that fainter glints are more abundant.

- The rate of such glints coincident with the area of distant galaxies on the sky is on the order of 200 per day per sky.

Thus we suggest that given the current information, a satellite origin can not be ruled out, and the rate of such events is higher than that of GRBs.

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