RNAAS RESEARCH NOTES OF THE AAS

AAS IOP

Absence of Bursts between 4 and 8 GHz from FRB 20200120E Located in an M81 Globular Cluster

Vishal Gajjar[1], Daniele Michilli[2,3], Jakob T. Faber[1,4], Sabrina Berger[2,3], Steve Croft[1,5], Aaron B. Pearlman[10,11,2,3,6], Ketan R. Sand[2,3], Paul Scholz[7], and Andrew P. V. Siemion[1,5,8,9]

Published July 2021 • © 2021. The Author(s). Published by the American Astronomical Society.
Research Notes of the AAS, Volume 5, Number 7
Citation Vishal Gajjar *et al* 2021 *Res. Notes AAS* **5** 166

Abstract

We report the non-detection of dispersed bursts between 4 and 8 GHz from 2.5 hr of observations of FRB 20200120E at 6 GHz using the Robert C. Byrd Green Bank Telescope. Our fluence limits are several times lower than the average burst fluences reported at 600 and 1400 MHz. We conclude that these non-detections are either due to high-frequency bursts being weaker and/or scintillation-induced modulated. It is also likely that our observations were non-concurrent with any activity window of FRB 20200120E.

1. Introduction

Fast radio bursts (FRBs) are millisecond-duration pulses of extragalactic origin. FRB 121102A has been detected across a wide frequency range, from 400 MHz (Josephy et al. 2019) to 8 GHz (Gajjar et al. 2018), giving insights into the burst emission properties (Michilli et al. 2018); no other FRB has been detected across such a large range of frequencies. The newly discovered FRB 20200120E was found to have a dispersion measure (DM) of 87.8 pc cm^{-3}, which is the lowest reported among all FRBs (Bhardwaj et al. 2021). Recently, Kirsten et al. (2021) announced a precise localization of three bursts from FRB 20200120E coinciding with a globular cluster in the M81 system. Thus, FRB 20200120E provides an excellent opportunity to conduct deep observations at higher frequencies (>4 GHz). A detection at higher frequencies would offer the opportunity to (a) compare frequency-dependent burst rates, (b) measure scatter-independent rotation measure and polarization position angle, and (c) investigate frequency-dependent burst widths, sub-burst components, and downward-drifting behavior. Here, we report observations of FRB 20200120E from the Green Bank Telescope (GBT), using the *C*-band receiver at 4–8 GHz.

2. Observations and Analysis

We have an ongoing observing campaign with the GBT to trigger *C*-band observations for any repeating FRB reported by the CHIME/FRB project[12] with localization uncertainty smaller than the GBT beam ($2\overset{\prime}{.}5$). The observations of FRB 20200120E were taken for 2.5 hr. We utilized the Breakthrough Listen (BL) backend, which is a state-of-the-art 64-node GPU cluster (MacMahon et al. 2018), deployed primarily to conduct the most comprehensive search for evidence of intelligent life in the universe (Worden et al. 2017). Recorded baseband voltages were converted to SIGPROC-formatted filterbank files (Lebofsky et al. 2019). As FRBs are known to show limited spectral coverage (Gajjar et al. 2018; Zhang et al. 2018), we divided our 4 GHz band into eight 500 MHz wide sub-bands, searched independently to improve the chance of detecting spectrally limited bursts (Faber et al. 2021). We used SPANDAK, a similar search pipeline to that described by Gajjar et al. (2018), to blindly search for single pulses, with search parameters listed in Table 1.

Table 1. Summary of Observations and Single Pulse Searches of FRB 20200120E Across 4–8 GHz

Observations and Search Parameters			
Source Name	FRB 20200120E	DM_{range}	0–1000 pc cm^{-3}
R.A.(J2000)	$09^h57^m56\overset{\prime\prime}{.}7$	Widths	0.3–76 ms
Decl.(J2000)	$+68°49'31\overset{\prime\prime}{.}8$	S/N	>10
Frequency	4–8 GHz	$F_{UL}^{\text{full band}}$	35 mJy ms
$T_{sampling}$	~350 μs	$F_{UL}^{\text{sub-band}}$ ($\Delta\nu$ ~ 500 MHz)	100 mJy ms
Obs. MJD (59259+)	0.969687500–1.072951388	burst-rate$_{UL}$	<0.4 hr^{-1}

Note. The $F_{UL}^{\text{full band}}$ and $F_{UL}^{\text{sub-band}}$ stand for minimum detectable fluence assuming a 1 ms wide top-hat burst for the full band and any one of the sub-bands, respectively.

3. Results and Conclusion

We did not detect any significant dispersed burst across the full band (4–8 GHz) nor in any of the eight sub-bands. Upper limits on the fluences are listed in Table 1. Bhardwaj et al. (2021) reported an average burst fluence ~2210 mJy ms at 600 MHz. Kirsten et al. (2021) reported multiple bursts at 1.4 GHz with an average burst fluence ~500 mJy ms and burst rate ~0.68 hr^{-1}. These fluences and burst rates are higher than our current fluence limits and our inferred burst rate. However, it is plausible that bursts at 6 GHz are intrinsically weaker (or absent) than those detected at lower frequencies. Nimmo et al. (2021) and Majid et al. (2021) reported that bursts from FRB 20200120E exhibit sub-burst structure at <100 ns scales, similar to "nanoshots" seen in giant pulses (GPs) from the Crab pulsar. Hankins (2000) compared simultaneous detections of several hundred GPs from the Crab pulsar at 1.4 and 5 GHz and found the average instantaneous spectral index to be steep ($\alpha \sim -2$). If the bursts from FRB 20200120E are indeed similar to GPs from the Crab pulsar, such a steep spectrum would render burst fluences at 6 GHz below our detection threshold. Furthermore, the expected diffractive scintillation bandwidth varies from 200 MHz to 3.5 GHz across our observed band toward the source (see Majid et al. 2021). If the bursts are spectrally narrower than this scintillation bandwidth then they are likely to be 100% modulated, which could yield non-detections. It is also possible that FRB 20200120E exhibits enhanced burst activity windows (seen from other repeating FRBs; Price et al. 2018; Zhang et al. 2018) and our observations were non-concurrent with such active phases. However, in the absence of any other reported non-detection, we are unable to verify if FRB 20200120E indeed exhibits such prolonged inactive phases. Future simultaneous multi-frequency multi-epoch observations may provide insights into the burst properties around 6 GHz.

Breakthrough Listen is managed by the Breakthrough Initiatives, sponsored by the Breakthrough Prize Foundation. The Green Bank Observatory is a facility of the National Science Foundation, operated under cooperative agreement by Associated Universities, Inc. J.T.F. and S.C. were supported by the National Science Foundation under grant No. 1950897.

Footnotes

12 https://www.chime-frb.ca/repeaters

+ Show References

Back to top