Search of Gamma Ray Bursts detected by GBM alike to GRB170817A

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ABSTRACT

Since the detection of Gravitational Waves (GW), a new window of multi-messenger astronomy was opened. The first GW event with an electromagnetic counterpart was GRB 170817A, an under luminous burst with properties of a short burst that was detected by Fermi-GBM, among other observatories. This burst revealed two different spectral components in the GBM energy range, a short-lasting non-thermal pulse at early times followed by a soft thermal component. Previous studies have identified similar bursts based on these spectral and temporal features similar to GRB 170817A. In this work, we extend the search for short bursts alike GRB170817A in the northern sky detected from 2018 to 2020. The initial search based on temporal restrictions gave 56 possible candidates. From these, only two bursts were consistent with the spectral behavior. Here we report their spectral features of those two objects.

INTRODUCTION

With the detection from LIGO/VIRGO of a Gravitational Wave (GW) signal from a neutron star merger which was followed by GRB 170817A a new era in the multi-messenger astronomy started [1]. Gamma Ray Bursts (GRBs) are energetic sources which radiate isotropic-equivalent energy in the range of 10^{49} to 10^{55} ergs. Their prompt emission is detected in the gamma-ray and X-ray energy bands. GRBs have been historically classified depending on their duration. Based on this criteria two types have been clearly differentiated, the long type GRBs with duration longer than 2 s and the short type of bursts with duration shorter than 2 s

GRB 170817A was detected ~ 1.7 s after the GW signal and was classified with as a short duration GRB but with atypical properties such as being an under luminous burst by 3-4 orders [2]. This burst presented two different components, a non thermal pulse at early times followed by a soft tail that is described with a thermal component. Because of the importance that GRB 170817A has in multi messenger astronomy several works have searched for bursts with similar spectral and temporal properties. These studies contribute to the expectancy of detection of more events with GW counterparts by other experiments specially for those with high field of view as the HAWC gamma-ray observatory.

METHODOLOGY

he Fermi Gamma-ray burst monitor (GBM) is the instrument on-board the Fermi observatory which primary science objective is to make spectral and temporal analysis of GRBs [3]. It consists of 12 thallium activated sodium iodide (NaI(Tl)) and two bismuth germanate scintillators (BGO) and detects gamma-rays in the energy range between ~8 keV up to ~40 MeV. The NaI(Tl) detectors are the ones that determines the direction of the GRBs and measures the low energy photons in the energy range between 8 keV to 1 MeV. In order to select GRBs with similar properties of GRB 170817A we followed the manual procedure presented in [3], a study that was made using data from the 10 yr GBM burst catalog. We extended the analysis to bursts detected from July 2018 to October 2020 and that were observed in the northern hemisphere.The observational properties for a burst to be considered as alike to GRB 170817A are inferred from the light curves (LC) in three different energy bands; from 8-50 keV, 50-300 keV and 300-1000 keV..

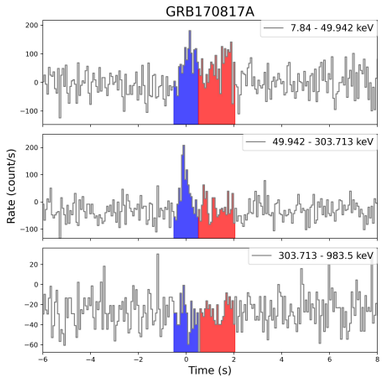

Fig. 1. LC of GRB 170817A

It can be seen that two different notorious episodes in LCs appear (See figures 1 and 2). One is a luminous peak that is present at initial times (blue episodes) of the bursts and that highlights in the energy range of 50 to 300 keV. The second episode is a weak tail (red episodes) observable after the initial peak in the energy range from 8 to 50 keV. After identifying the two episodes from the LCs we made the spectral analysis of the candidates.

After identifying the two episodes from the LCs we made the spectral analysis of the candidates fitting three different photons models: Comptoniezed (Compt), Power-Law (PL) and Black Body (BB). The best spectral parameters can be determined optimizing the Castor C-statistic

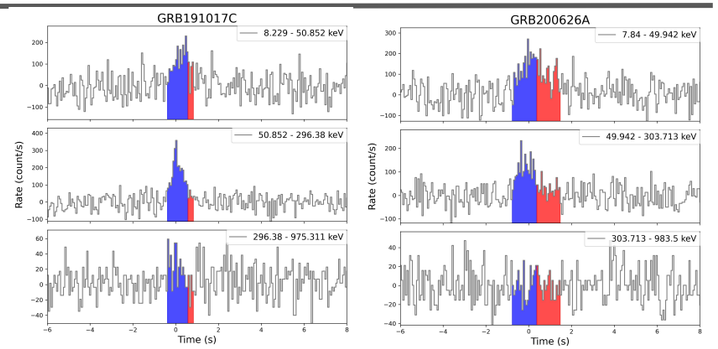

Fig. 2. LCs of GRB 190817A and GRB 200626A

RESULTS

From the burst in the northern hemisphere in two years of data considered for this work (2018-2020) two present observational and spectral similarities to GRB 170817A. These burst are GRB 190717C and GRB 200626A. The LCs of these objects can be seen in Figure 2 and the spectral properties are listed in the table below. It can be seen that the initial peak represented in blue in the LCs is best fitted with a Compt function while the soft tail is best fitted with a BB, hinting two different mechanism of emission. This search contributes to the prospect of detection of short GRBs by observatories in the northern hemisphere as counterparts of a GW event.

GRB	time (s)	Model	Epeak (keV)	Index	kT	C-stat/DOF
GRB 170817A	-0.512:0.512	Compt	181.7 ±85.6	-0.84 ± 0.4		256.76/253
	0.512:2.048	BB			9.69 ± 1.16	320.74/254
GRB 191017C	-0.32:0.64	Compt	484.6 ± 214	-0.93 ± 0.17		263.91/253
	-0.32:0.64	BB			34.97 ± 2.02	320.39/256
	-0.32:0.64	PL		-1.27 ± 0.05		270.86/254
	0.64:0.896	Compt	79.04 ± 42.3	-0.55 ± 1.33		290.76/253
	0.64:0.896	BB		17.06 ± 3.64		291.41/254
	0.64:0.896	PL		-1.74 ± 0.28		292.39/254
GRB 200626A	-0.768:0.384	Compt	455.9 ± 33.7	-0.81 ± 0.05		31038/247
	-0.768:0.384	BB			32.61 ± 0.2	34996/248
	-0.768:0.384	PL		-2.03 ± 0.02		40106/248
	0.384:1.472	Compt	300 ± 18.7	-0.5 ± 0.08		56991/247
	0.384:1.472	BB			29.25 ± 0.17	50934/248
	0.384:1.472	PL		-2 ± 0.02		51958/248

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