Ioffe Workshop on GRBs and other transient sources: 25 Years of Konus-Wind Experiment September 9–13, 2019, St. Petersburg, Russia

GRE

Central Engine from Early Multimessanger GRB observations

Vladimir Lipunov

Sternberg Astronomical Inst., Moscow State Univeity, Sternberg Astronomical Inst.,

Vladimir Lipunov, Central Engine from Early Multimessanger GRB

GRB Energy $E \sim 10^{51-53} \text{ erg}$ This energy is typical for collapse $E \sim 0.1 \text{ Mc}^2$, $M \sim 1-100 \text{ M}_{solar}$ Firstly pointed out by Blinnikov et al., 1984; Pachinsky, 1986 (!), Astrophys. J. 308, L43-L46

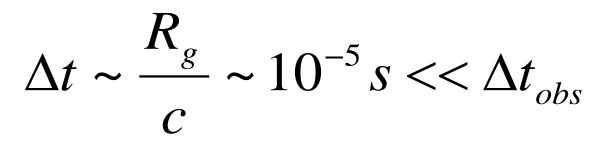
SPECTRUM

E_{peak} ~ 1 Mev Typical energy for relativistic collapse E ~ m_eC²

DURATION

 $\Delta t_{obs} \sim 0.1 - 100s$

Typical collapse time scale:



The MAIN Paradox

Vladimir Lipunov, Central Engine from Early Multimessanger GRB

2 SOLUTIONs

1. Back fall rotating envelope Woosly et cetera

$$V_{env} = HR < \left(\frac{2GM}{R}\right)^{\frac{1}{2}}$$
$$\Delta t \sim \frac{R^2}{2D} \quad \text{diffusion}$$

diffusion massive disk accretion

2. Magneto-rotational collapse(Spinar paradigma) $\Delta t \sim I_{core} \Omega / K$

> Where K – dissipation force moment Of the Viscosity + Magnetic Field

• Usual Collapse - Super Novae

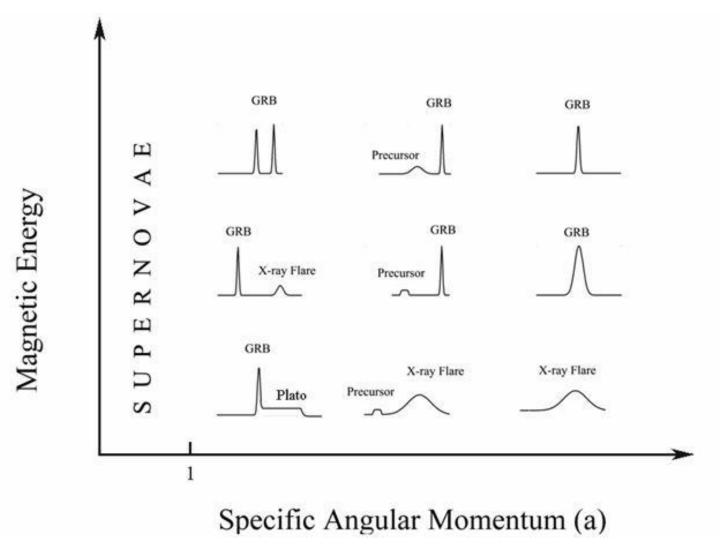
Magneto-Rotational Collapse – GRB

• Rate (SN) / Rate (GRB) ~ 100

Vladimir Lipunov, Central Engine from Early Multimessanger GRB

SN & GRB in Spinar Paradigma

Lipunov & Gorbovskoy, 2007, ApJ, 665, . L97



After 17 Aug 2017

Short GRB NS+NS merging And NS+BH ... Long GRB core collapse rotating massive star

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

IS THERE THE NEW PHYSICS IN GRB?

Kardashev limit

$$\frac{B^2}{8\pi R^3} = Mc^2, R = R_g = \frac{2GM}{c^2}$$

• Max. Energy = $eER \sim eBR \sim (1/137)^{1/2}$ Epl

10²⁷eV

Prolongated GRB activity fetures

1. early Precursors (up to 200сек)

2. follow-up X-ray Flares (up to 10000s)

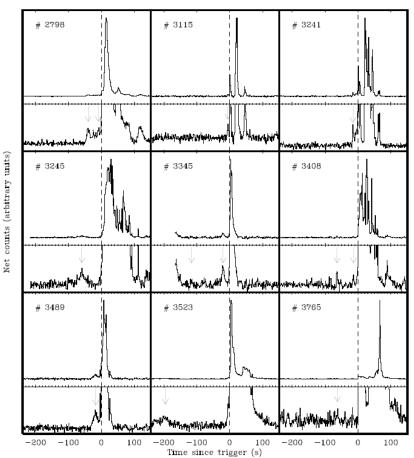
Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

Precursors

Lazzati, D. Precursor activity in bright, long BATSE gamma-ray

bursts. MNRAS 357, 722-731 (2005).

4 Davide Lazzati



Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

Spinar history

The Importance of the magnetic rotational effect was pointed firstly with connecting to energetic and evolution of the

QUASATS (Hoyle & Fauler, 1963; Kardashev, 1964; Ozernoy, 1966; Morison, 1969; Ozernoy & Usov, 1973)

SN explosion (Bisnovatiy-Kogan; 1971, LeBlance & Wilson 1970).

The formation of the quasi eqvilibrium object was noted - Spinar. (Lipunov (1983) proposed of the idea Spinar with stellar mass).

Spin-up and spin-down was considered by in the frame the magnetorotator (*Lipunov*, 1987).

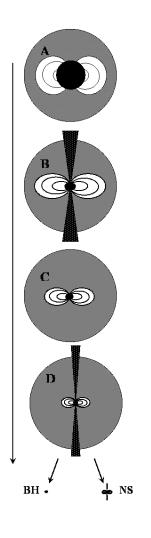
The relativistic Spinar was considered by, where was a first model GRB as the Spinar (*Lipunova G.V.*, 1997).

Prolongated GRB activity was predicted

- Lipunova, G.V. A burst of electromagnetic radiation from a collapsing magnetized star. *Astronomy Letters* 23, 84-92 (1997).
- Lipunova, G.V. & Lipunov, V.M.
 Formation of a gravitationally bound object after binary neutron star merging and GRB phenomena. *Astron. Astrophys.* 329, L29-L32 (1998).

Spinar Paradigma

(Lipunov & Gorbovskoy, 2007, ApJLetters, v.665, 97L)



$$a_{0} \equiv \frac{I\omega_{0}c}{GM_{core}^{2}} \qquad \alpha_{m} \equiv \frac{U_{m}}{GM_{core}^{2}/R_{A}}$$

$$E_{B} \approx GM^{2}/2R_{spinar} = (1/2a_{0}^{2})M_{core}c^{2}$$

$$\omega R_{B}^{2} = GM_{core}^{2}/R_{B}$$

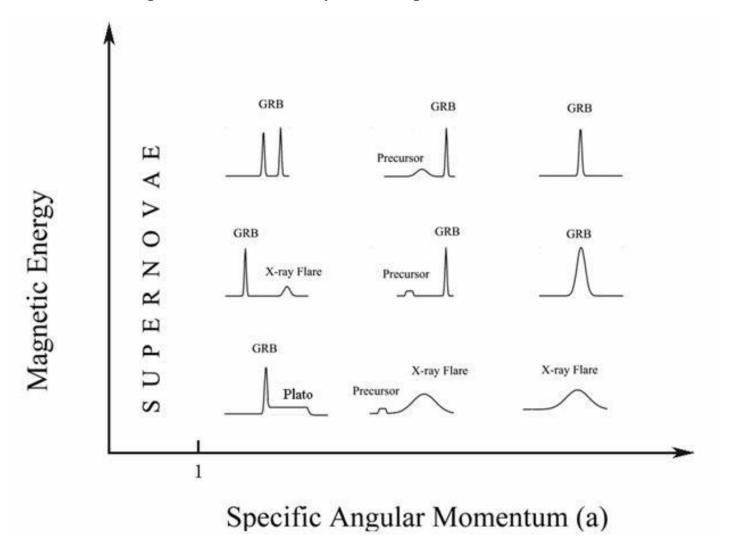
$$dI\omega/dt = -U_{m}$$

$$L = -\omega dI\omega/dt = U_{m}\omega \propto R^{-5/2}$$

$$L = \frac{\alpha_{m}}{a_{0}^{5}}\frac{c^{5}}{G}(1-t/t_{C})^{-3/5}$$

SN & GRB in Spinar Paradigma

Lipunov & Gorbovskoy, 2007, ApJLetters, v.665, 97L



Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

Nonstationary Relativistic Pseudo-Newtonian Spinar Model

(Lipunov & Gorbovskoy, 2008, MNRAS, V383 p1397)

$$\frac{d^{2}R}{dt^{2}} = F_{gr} + F_{c} + F_{nuclear} + F_{diss}$$

$$F_{gr} = -\frac{GM}{x^{3}} \frac{(x^{2} - 2ax + a^{2})^{2}}{(\sqrt{x}(x - 2) + a)^{2}} \qquad x = 2R/R_{g} \qquad \text{Mukhopadhyay, 2002}$$

$$F_{nuclear} = \frac{1}{\rho} \frac{dP}{dr} = \frac{P}{\rho R}$$

$$P = \rho(\sqrt{c^{4} + b\rho^{2/3} + (Q/M)^{2}} - c^{2}) \qquad b = \left(\frac{4\pi}{3}\right)^{2/3} G^{2}M_{class}^{4/3}$$

$$F_{diss} = -\frac{1}{\tau} \frac{dR}{dt} \qquad \tau = 2\pi\chi/\omega \qquad x = 0.04.$$

$$K = \int_{R_{min}}^{\infty} \frac{B_{z}B_{g}dS}{4\pi} = \frac{1}{2} \int_{R_{min}}^{\infty} B_{z}B_{g}RdR \qquad K = \kappa_{t}\frac{\mu^{2}}{R_{t}^{3}} \qquad R = Rc = (GM/\omega^{2})^{1/3} \qquad \text{see Lipunov, 1987}$$

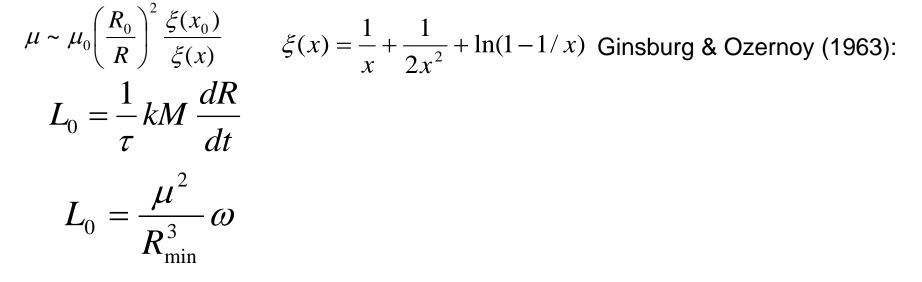
$$\frac{dI\omega}{dt} = -\frac{\mu^{2}}{R_{c}^{3}} = -\frac{\kappa_{t}\mu^{2}}{GM\omega^{2}}$$

χ

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

Magnetic Field Evolution and Central Engine Power

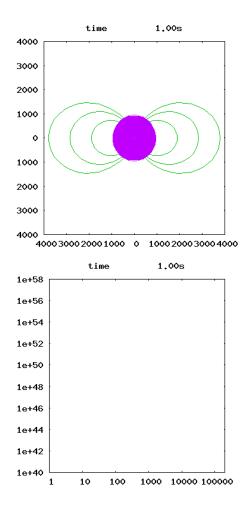
$$\mu \sim BR^3 \sim BR^2 R \sim R \qquad \mu = \mu_0 \frac{R - R_{\min}/2}{R_0 - R_{\min}/2}$$



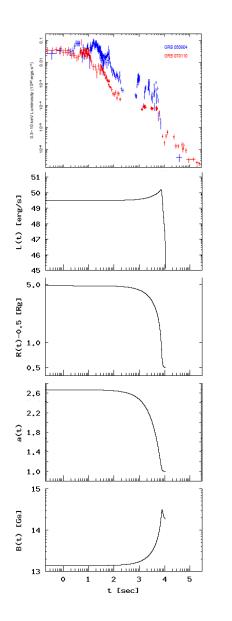
$$L_{\infty} = \alpha^2 L_0$$
 $\alpha = \sqrt{\frac{x^2 + a^2 - 2x}{x^2 + a^2}}$ Thorne et al., 1986

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

Spinar Collapse Video



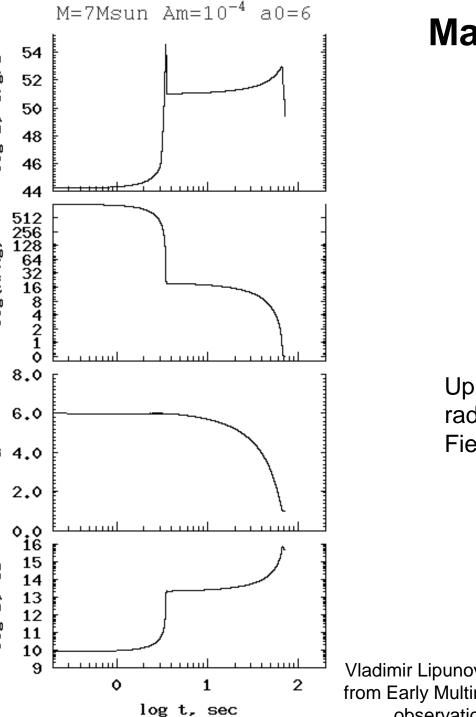
Vladimir Lipunov, Central Engine from Early Multimessanger GRB



Extralong X-ray Plato

Lipunov & Gorbovskoy, 2007, ApJLetters, 665, 97L

Among several hundred gamma-ray bursts, two GRB070110 and GRB050904 do not fit into the usual picture of the formation of X-Ray afterglow. Both bursts revealed an extensive plateau lasting up to 6000-7000 seconds in their own frame of reference. Troja et al. (2007) suggested that such a long manifestation of activity was associated with the features of the central engine and specifically with the formation of a neutron star after the collapse of small mass nucleus (less than the а Oppenheimer-Volkov limit).



Massive Core Collapse (M > MOV).

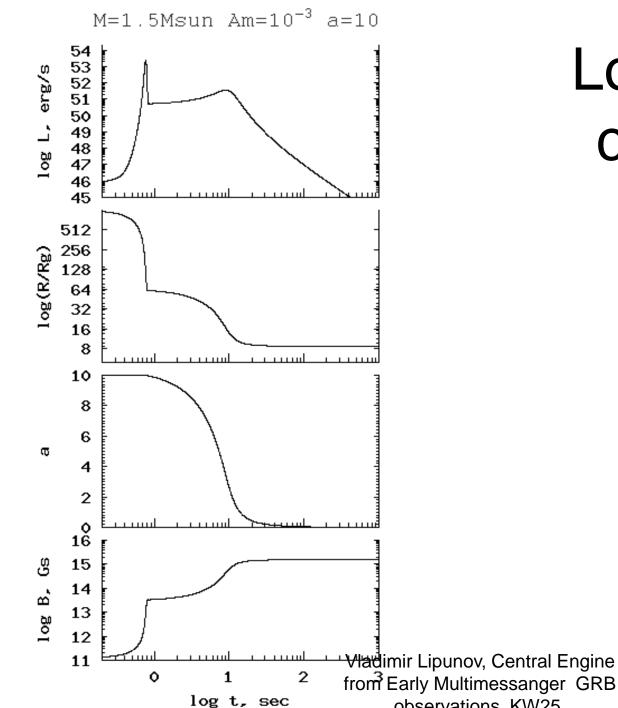
7 Solar Mass Core Collapse

Up to down: energy release, Spinar radius, Kerr parameter and Magnetic Field for far observer frame

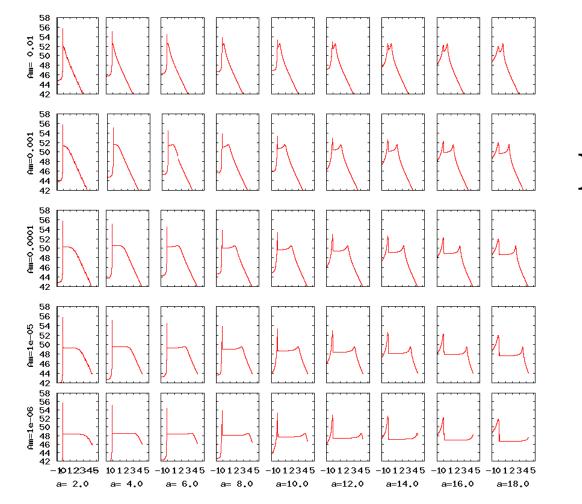
Vladimir Lipunov, Central Engine from Early Multimessanger GRB

7 Solar Mass Core Collapse Luminosity for different Kerr parametyers





Low mass collapse M<Mov



Low Mass Core Collapse . (Neitron Stars Formated)

Vladimir Lipunov, Central Engine from Early Multimessanger GRB

5 UNSOLVED OBSERVATIONAL GRB PROBLEMS

- I. The discovery of the most distant objects in the Universe.
- II. Prompt optical Short GRB emission detection.
- III. Optical emission Precursor detection.
- IV. Polarization measurement of the prompt optical, X-ray and Gamma GRB emission. +
- V. High time resolution observations of the prompt optical/UV/IR emission.

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

Global MASTER Robotic Net



Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

MASTER Net Dteceted 10 types of the OTs from NEO to redshift z ~ 5.

Сверхновые



Антивспышки

Короткие гамма-всплески

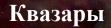


Длинные гамма-всплески



Красные Новые

Микроквазары



Сотел/2014 Колитори Робот-телеска Колитори СТЕЛ Опасные астероиды Engine from Early

etersburg, Russia, 12 sep 2

Интеграл

Большой южноафриканский телескоп, Южная Африка 10 м

> Телескоп В. Гершеля, Испания 4,2 м

MASTER

5 4 1

<u>Б</u>ТQ,

S M

Россия -

Телико Хобби-Эберли, США 9.2 м

-

Pepmu

Большой Канарский Телескоп, 10.4 м

ESO, 3.6 м





ММТ Обсерватория, США 6.5 м

MASTER and Huge Physical Experiment



ANTARES



Ice-Cube (Антарктида)

5

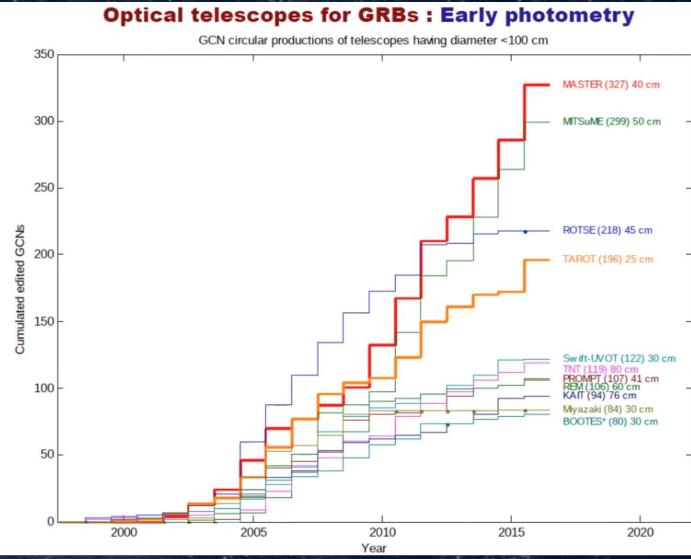


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равита

ионно-

Alain Klotz[^] Talk "TAROT: follow-up of LIGO, GRB, IceCube, ANTARES" International Conference is devoted to the 15 th Anniversary MASTER project "Bursting Universe by Robots Eyes" SAI MSU 14-18 Aug. 2017



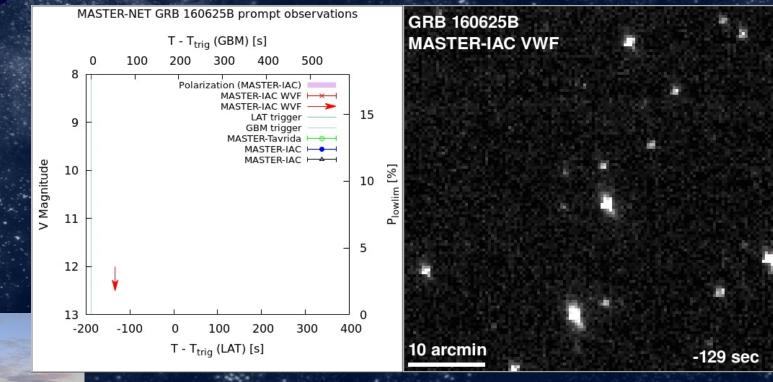
etersburg, Russia, 12 sep 2

GRB 160725B Troja et al., *Nature,2017, 547, 425-427*

Fermi



MASTER-IAC



 Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

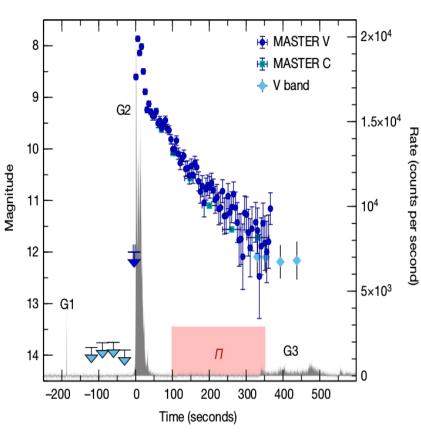


Figure 1 | **Prompt** γ **-ray and optical light curves of GRB 160625B.** The γ -ray light curve (black; 10–250 keV) consists of three main episodes: a short precursor (G1), a bright main burst (G2), and a fainter and longer-lasting tail (G3). Optical data from the MASTER Net telescopes and other ground-based facilities¹⁹ are overlaid for comparison. Error bars represent 1σ ; upper limits are 3σ . The red box marks the time interval over which polarimetric measurements were taken. Within the sample of nearly 2,000 bursts detected by the GBM, only six other events have a comparable duration (https://heasarc.gsfc.nasa.gov/W3Browse/fermi/fermigbrst. html). Most GRBs end before the start of polarimetric observations. Viadimir Lipunov, Central Engine from Early

Jet structure

Internal shock

External shock

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019 "The optical identification of events with poorly defined locations: the case of the Fermi GBM GRB 140801A *Lipunov, Gorosabel, Pruzhinskaya et al., MNRAS,* **455**, 712-724L. 2016

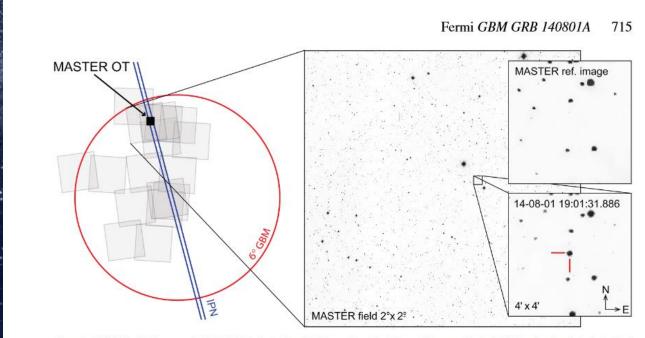


Figure 1. MASTER OT discovery of GRB 140801A in the *Fermi* GBM error-box. The left panel illustrates the final GRB localizations [red circle: 3° of statistical error (3- σ) and 3° of systematic error GBM; blue lines: $3-\sigma$ IPN]. Grey squares are fields covered by MASTER. The black square is the location of the MASTER OT. The right panels show MASTER images of the OT position: discovery image (bottom), reference image (top). The IPN localization was published after the MASTER discovery circular (Gorbovskoy et al. 2014; Hurley et al. 2014).

 Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

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[Previous | Next | ADS]

MASTER-OAFA: Fermi GRB faded optical counterpart detection

ATel #10063; T. Pogrosheva, V. Lipunov (Lomonsov MSU), R. Podesta (OAFA), H. Levato (ICATE), D. Buckley (SAAO), E. Gorbovskov, N. Tlurina, P. Balanutsa, A. Kuznetsov, O. Gress, V. Kornilov, V. Vladimirov, V. Chazov, I. Gorbunov, A. Krylov, V. Shumkov, D. Kuvshihov (Lomonsov Moscow State University, SAI) on 9 Feb 2017; 21:08 UT Credential Certification: Natal Y Twirna (tiurin@sai.msu.ru)

Subjects: Optical, Request for Observations, Gamma-Ray Burst, Transient

Tweet Recommend 2

MASTER OT J072307.30-521446.6 discovery - possible optical counterpart of Fermi 508295323 GBM trigger

During Fermi GBM 508295323 trigger (GRB TIME: 2017-02-09 01:08:38.08 UT https://gcn.gsfc.nasa.gov/other/508295323.fermi) inspection

MASTER-OAFA auto-detection system (Lipunov et al., "MASTER Global Robotic Net", Advances in Astronomy, 2010, 30L) discovered new OT source (Podesta et al. GCN #20650) at

(RA, Dec) = 07h 23m 07.30s -52d 14m 46.6s on 2017-02-09 02:07:07.478UT with unfiltered m_OT=17.4 (mlimit=18.1m).

The second image is on 02:14:07.83 UT with m_OT=17.4.

There are only 2 inspection images of this area, the GRB ERROR was 3.22 deg radius, and we were observing the error-box since 2017-02-09 01:10:30 UT (112s after the trigger time).

There is no minor planet at this place. There is no any sources in VIZIER database inside 5".

We have reference image without OT on 2017-01-29.17249 UT with 19.6 unfiltered magnitude limit.

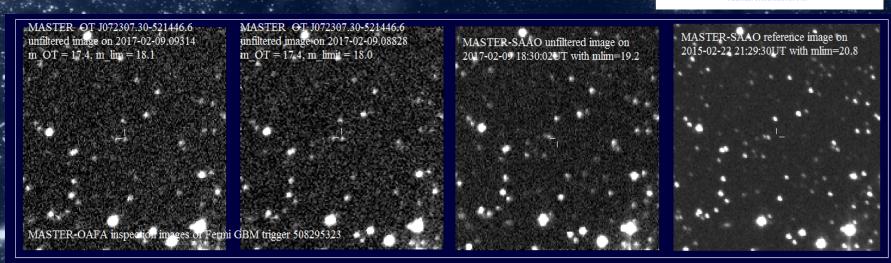
MASTER-SAAO reobserved error-bix on **2017-02-09 18:37:14UT** unfiltered **mlim=18.7** (sunset in SAAO, Sun altitude is -12.0). There is no OT brighter **18.7m**. **Deep photometry and spectral observations are required**. The discovery and reference images are available at: http://masters.aimsu.rr/static/OTI/072307.30-321446.6.png

List of Optical Transients discovered by MASTER

MASTER Global Robotic Net

One more FERMI GRB 170209A

OT detected inside 600 sq. Degree error box At MASTER-OAFA



 Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

MASTER-OAFA May/2016.

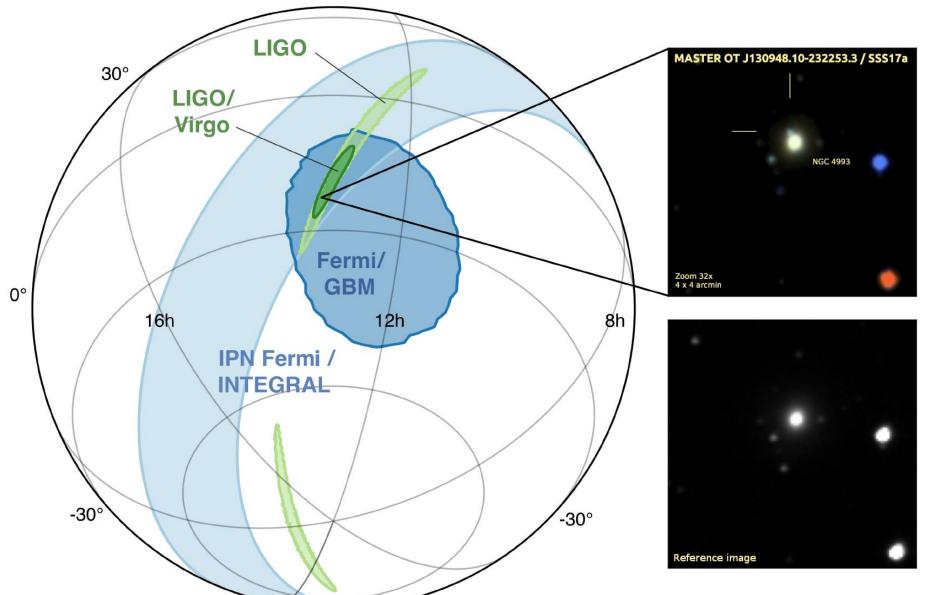
Observatorio Astronomico Felix Aguilar (OAFA), San Juan University, Argentina

Left-rught: Federico Podest, Carlos Safe, Helpman, Ricardo Podesta, Vladimir Lipunov, Igor Gorbunov, Evgeniy Gorbovskoy Первый снимок аргентинский МАСТЕР сделал в 22:54:18 UT то есть через 10.22 часа после столкновения и как выяснилось позже, телескопы МАСТЕРа прошли мимо галактики NGC 4993.



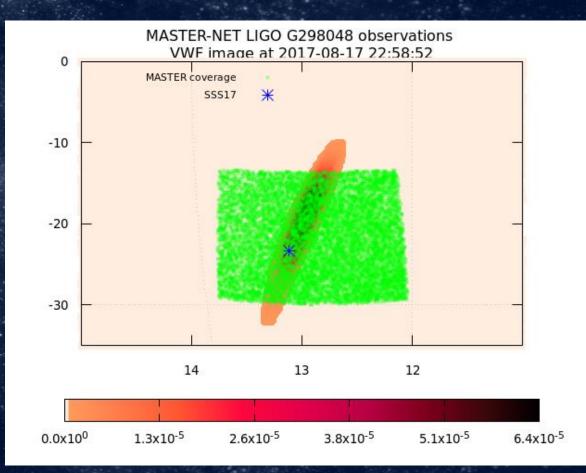
V.Lipunov, The Discovery of gravitational waves: prediction & observationl, The Third Zeldovich meeting, April 23-27, 2018, Minsk, Belarus

Independ optical Localization GW



V.Lipunov, The Discovery of gravitational waves: prediction & observationl, The Third Zeldovich meeting, April 23-27, 2018, Minsk, Belarus

First pointing in Argentina MASTER Wide field cameras started at 22:54:18 UT, 10.22 yaca after merging in NGC 4993.

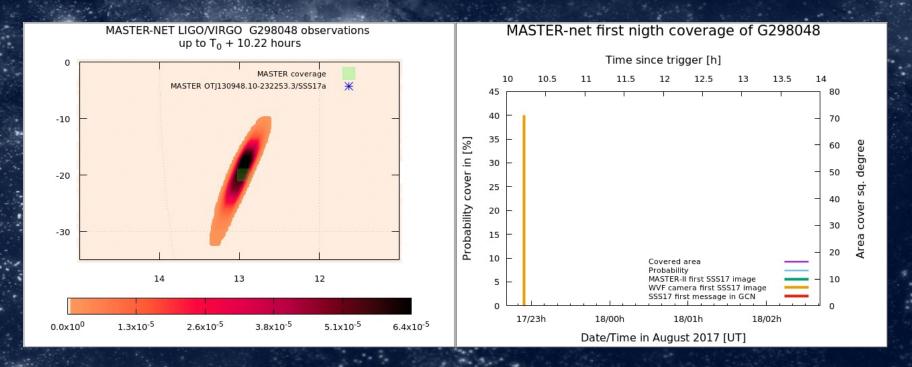


The MASTER-OAFA with two MASTER-VWF cameras, began imaging the new BAYESTAR-HLV (Singer, Price 2016, Singer et al. 2016) localization map of LIGO/Virgo G298048 (LIGO Scientific Collaboration and Virgo Collaboration 2017a, b, c) at 2017-08-17 22:54:18 UT, immediately after sunset. Observations started for the first field at RA, DEC = 12h 59m 00.00s -19d 59m 38.00s.

First image host galaxy NGC 4993 after NSs Merging at 10.22 hours UT 2017-08-17 . Upper OT limit 15.2 V.

MASTER-OAFA VWF camera NGC 4993 first image. 2017-08-17 22:54:18. Upper limit 15.5 m. 5 x 225 exposure.

MASTER-OAFA inspection. Kilonova started imaging at 2017-Aug-17 11:59:56 UT (02:59:56 Moscow Time) Lipunov, Kornilov, Gorbovskoy et al., ApJlett, MASTER optical detection of the first LIGO/Virgo neutron stars merging GW170817.



MASTER OT J OTJ130948.10-232253.3/SSS17a detection in NGC4993 by MASTER-OAFA

Lipunov, V., Gorbovskoy, E., Kornilov V., et al., 2017c, GCN, 21546, 1

MASTER-OAFA first image of SSS17 2017-08-17 23:59:54, 180 s exptime

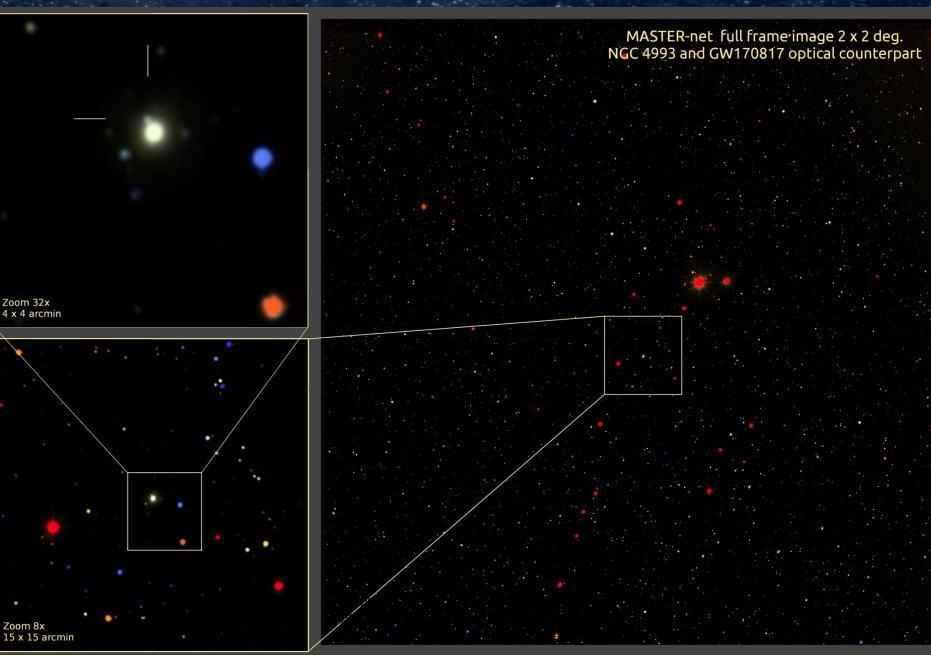
Difference image

Reference image

Color composed Kilonova image by W, B,V,R, I MASTER-SAAO+OAFA



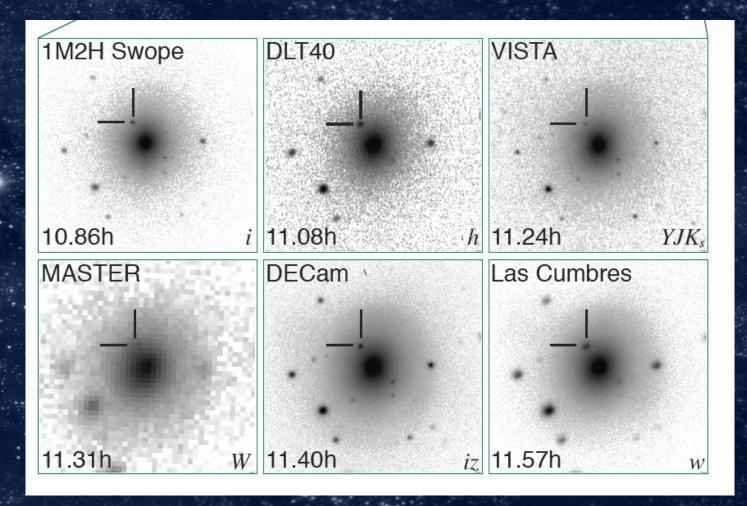
Composed MASTER image



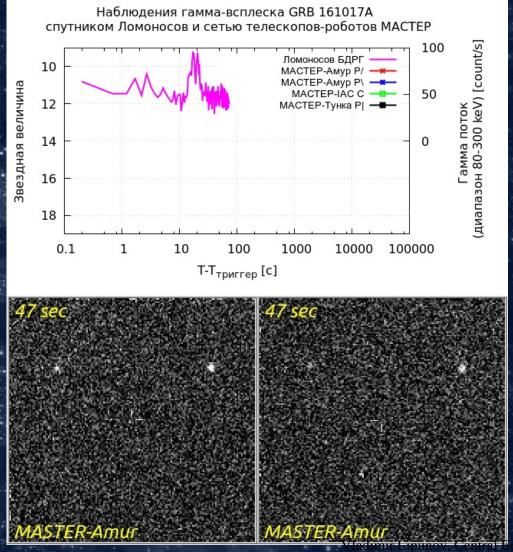
MASTER-OAFA One year – one superdiscovery



Abott et al., 2017, MULTI-MESSENGER OBSERVATIONS OF A BINARY NEUTRON STAR MERGER, ApJlett,



Sadovnichy, et al The Astrophysical Journal, Volume 861, Issue 1, article id. 48, 12 pp. (2018). At 17:52:17 UT on 17.5



At 17:52:17 UT on 17 Sep 2016, the Lomonosov BDRG Gamma-ray Burst Monitor triggered GRB 161017A (E. Troja et al.,, GCN 20064). GRB 161017A has several peaks LC, total duration ~100s,the energy range 70-300 keV.

MASTER-Amur robotic telescope (MASTER-Net: http://observ.pereplet.ru) located in Blagoveschensk was pointed to the GRB161017A 21 sec after

notice time and 47 sec after Swift trigger time at 2016-10-17 17:52:38 UT in two polarizations. On our first (10s exposure) set we marginally found optical transient at Yurkov et al. (GCN 20063) and Troja et al. (GCN 20064) position. The 5-sigma upper limit has been about 14.5 mag.

The OT was became brighter up to maximum at 3-4 set .

MASTER-Tunka robotic telescope (MASTER-Net: http://observ.pereplet.ru) located in Tunka (Baykal lake) was pointed to the GRB161017.74 75 sec after notice time and 103 sec after trigger time at 2016-10-17 17:53:34 UT.

We imaged OT late.

MASTER-IAC robotic telescope located at Teide jbservatory (Tenerife, Canary, Spain) was pointed to the GRB161017A 32942 sec after trigger time at 2016-10-18 03:00:53 UT. We found optical transient on coaded images w25

GRB 180728A: MASTER-SAAO observations:

Detected by SWIFT BAT Starling et al GCN 23046

OT discovered by MASTER Lipunov et al GCN 23048

2018-07-28 17:29:38 UT

Reference image

Difference



MASTER-SAAO robotic telescope located in South Africa (South African Astronomical Observatory) was pointed to the GRB180728A

22 sec after notice time and 38 sec after trigger time at 2018-07-28 17:29:38 UT

in two polarizations. On our first (10s exposure) set we found new optical object (transient) within SWIFT error-box **MASTER OT J165415.75 - 540239.27**, CeRA, DEC = 16h 54m 15.75s, -54d 02m **39.27s** $m \sim 14.5$ Multimessanger GRB observations, KW25. St Petersburg, Russia, 12 sep 2019

GRB 180728A: MASTER-SAAO observations:

Detected by SWIFT BAT Starling et al GCN 23046

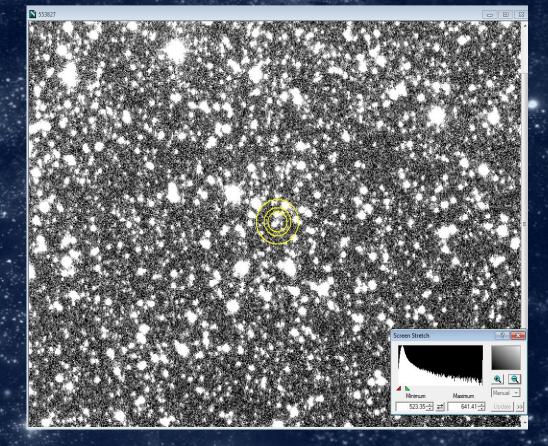
Z = 0.117 ESO VLT (Rossi et. al GCN 23055)

Very close GRB

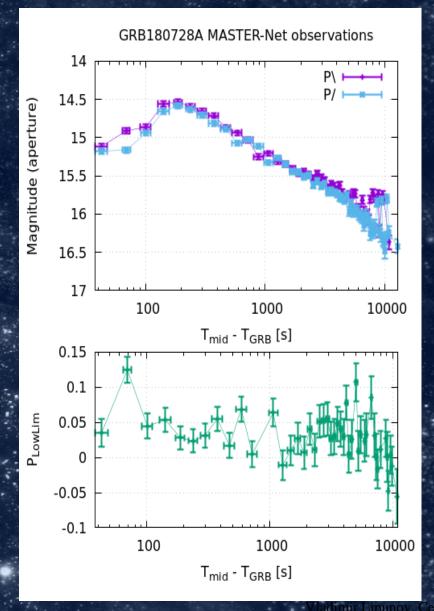
Gal. latitude: -7.0 d Gal. longitude: 334.2 d

Supernova SN 2018fip discovered 12 days after trigger by X-shooter instrument on the ESO/VLT (Izzo et al. GCN 23142)

Vladimir Lipunov, Central Engine from Earl Multimessanger GRB observations, KW25 St.Petersburg, Russia, 12 sep 2019



GRB 180728A: MASTER-SAAO observations:

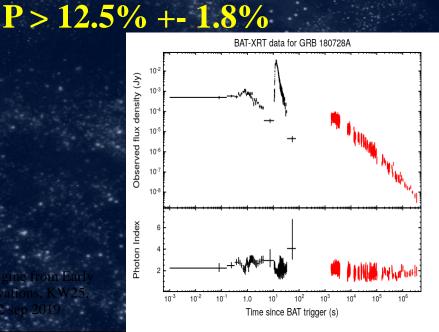


Detected by SWIFT BAT Starling et al GCN 23046

OT discovered by MASTER Lipunov et al GCN 23048

 $T_{90} = 8.68 + 0.3 \text{ s}$

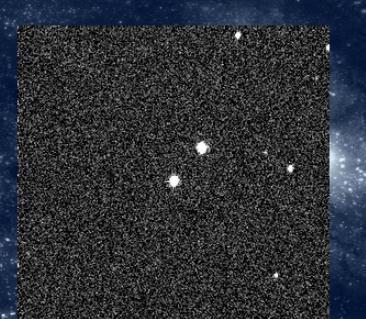
Second point polarization low limit



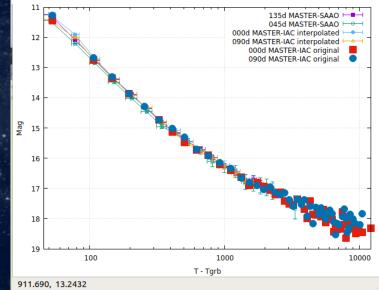
GRB 190114C: MASTER-NET 4 tube observations

(Troja et al. in preparation):

Detected by Swift BAT Gropp et al GCN 23688



GRB 190114C MASTER optical light curve in 4 polarizations

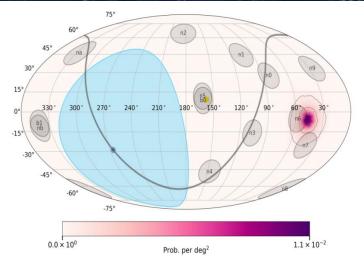


V. Tyurina et. Al GCN 23690

MASTER-IAC robotic telescope (Global MASTER-Net: http://observ.pereplet.ru, Lipunov et al., 2010, Advances in Astronomy, vol. 2010, 30L) located in Spain (IAC Teide Observatory) was pointed to the GRB190114.87 25 sec after notice time and 47 sec after trigger time at 2019-01-14 20:57:51 UT. On our first (10s exposure) set we found 1 optical transient within SWIFT error-box brighter than 16.54.

T-Tmid		Expt.	Ra	Dec	Mag
52	2019-01-14 20:57:51				

Example 2019-08-29 19:55:53.13 GCN 25551



GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 1956553,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 195655,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 195655,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 195655,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 195655,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 195655,13 UT GLAST Burst Monitor - Trigger 588801356 - 2019, Aug 29, 195655,13 UT GLAST Burst Monitor - Trigger 588801,200 GLAST Burst Monitor - Tri

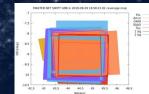
MASTER NET FERMI GRB in 2019-08-29 19:55:53.13 coverage map Kis. Amur OAFA -2 SAAO Tav. 1 sig -4 2 sig DEC[deg] -6 -8 -10 -12 -14 36 40 44 50 52 54 38 42 46 48 RA[dea]

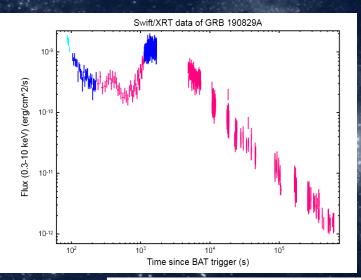
Vladimir Lipunov, Central Engine from Early Multimessanger, GRB observations, KW25.

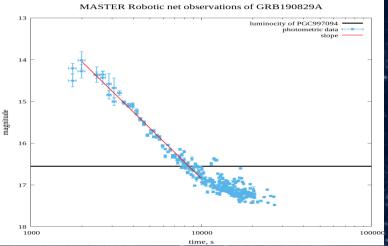


Swift, GRB190829A

GCN 25552 (19/08/29 20:25:37) Ttrig= 19:56:44.60 UT











Fermi 588801358 GCN 25551 (19/08/29 20:06:10 UT) Ttrig=2019-08-29 19:55:53.13

Swift BAT,XRT (UVOT-) GCN 25552 (19/08/29 20:25:37) Ttrig= 19:56:44.60 UT

MASTER GCN 25553 (19/08/29 21:31:14)

MASTER-Kislovodsk 1259 sec after notice time (1290 from trigger)

Dabancheng-0.5m optical afterglow detection (GCN 25555 19/08/29 21:36:30, started at 20:49:03 UT (52.3 min after the burst), x150s **OT** MASTER bright and decay OT detection (GCN 25558 19/08/29 22:35:55

GROWTH India detection of afterglow GCN25560 19/08/29 22:55:45 g + r, starting 51 min after, 16.9

 NOT optical afterglow detection and spectroscopy
 GCN 25563 19/08/30 03:42:22,

 r-band
 19/08/30 02:03:52 18.9

 10.4m GTC
 GCN 25565 19/08/30 06:40:25 i = 18.42 19/08/30 3:00UT, z =0.0785

VHE gamma-ray emission with H.E.S.S. GCN 19/08/30 07:08:37 T0 + 4h20, >5sigma gamma-ray excess compatible with the direction of GRB190829A



25652 GRB 190829A: MASTER confirmation of G

25657 GRB 190829A: Liverpool Telescope observations of a slow s rise

25660 Konus-Wind observation of GRB 19



Low Resolution Imaging Spectrograph (LI

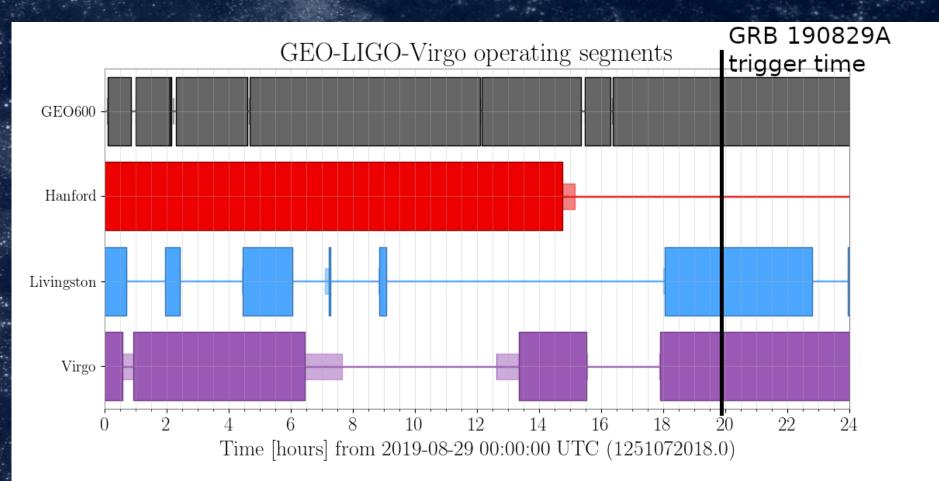
25

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019



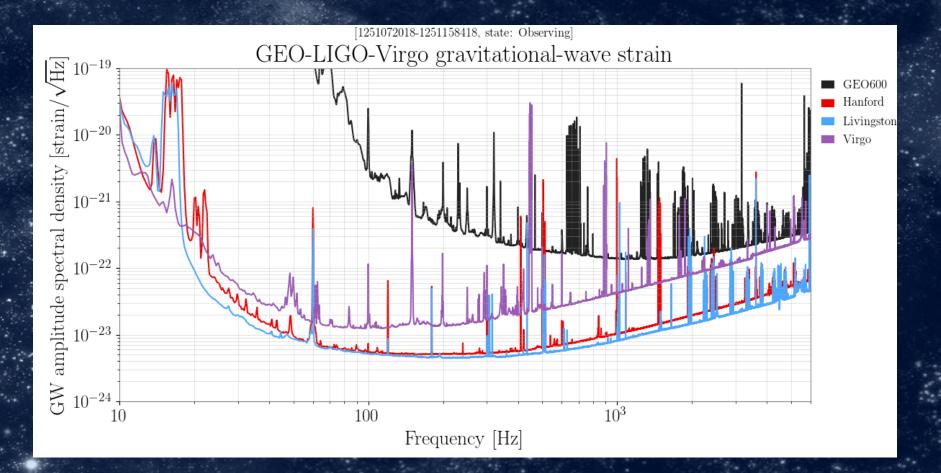
ΡΑΕΟΤΑ LVC

(Грав.Волновые детекторы)

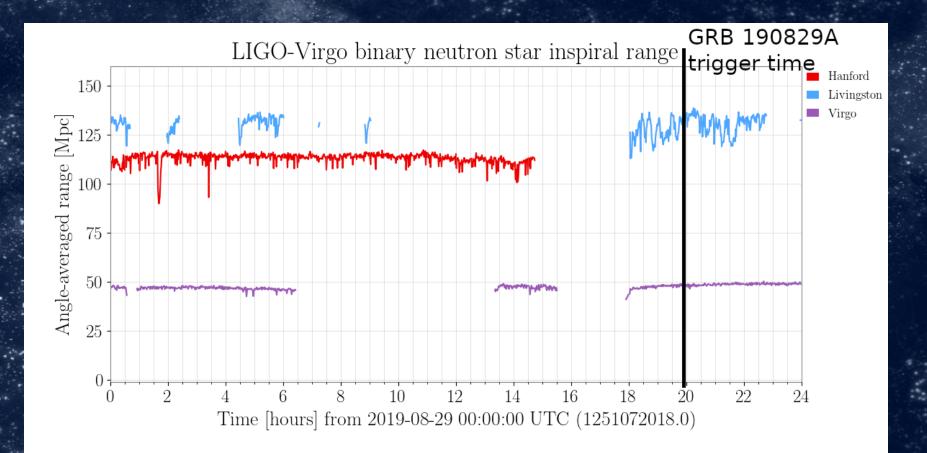


adimir Lipunov, Central Engine from Ea ultimessanger GRB observations, KW2

увствительность L



Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St Patersburg, Puseia, 12 pap. 2010 Чувствительность LVC в момент гамма-всплеска по нейтронным звездам



 Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

MASTER Net MASTER Database: LIGO alert list

Please use the reference to MASTER DataBase as Lipunov et al., 2010, MASTER Robotic Net, Advances in Astronomy, vol. 2010, pp. 1-7

MASTER II:

Search:

w | Processing | Search gle sets | Single images steroid | Transient | Comet

MASTER WFC:

1

Raw | Processing | Search by orbit elements | Search SN | Asteroid | Transient | Two tube | Short transient | Tr. difference | Comet | Nova M31 | GRB | LIGO

Manual control | Planner | Planner Results | Planner NET proc_data

✓ Search Net

General: SN list | Sky map | Add a Meteo | MASTER pa Users list | Users statistic |

Where satel='LVC' and id in (select max(id) AS id Order by: grbtime desc Preview: No 🗸 Search Reset

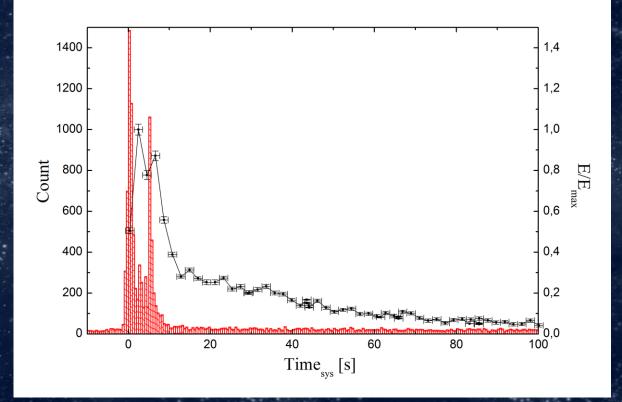
LVC EVENTS TABLE FROM GCN

Pages: [1] ... 2

select set sphere_output(HMS); select set_sphere_output_precision(1); SELECT id, grbtime, noticetime, coord2000, satel, errorbox, type, name as gname, data path, superiler, dist, bas, bbh, gap, terr, nsbh FROM ligo where satel=LVC and id in (select max/id) AS id from ligo GROUP BY name) ORDER BY grbtime desc OFFSET 0 LIMIT 50								
Nº ≑	Name +	Trigger +	Notice +	Detector +	Path	Distance +	BEST +	links +
				1110				

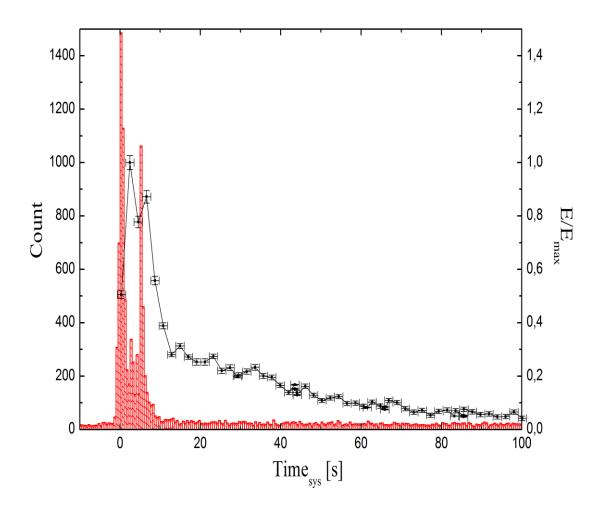
S1908290 2019-08-20 211:05:56 2019-08-20 211:31:84:4497 LVC Imaster/data/ligo/db/S190828/151/21 IS7:208 4:46:0109 5:9500 The => Sest => 1074 S1908281 2019-08-20 60:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05 2019-08-20 01:51:05:02 02:73:04 U/C //master/data/ligo/db/S1908146/U/L1 206.01:4:7:00:32 NBH The => Sest => 10714 S19080161 2019-08-10:10:10:10:22:73:442 U/C //master/data/ligo/db/S19082401:51/2 287.402:2:15:13:58 NBH The => Sest => 10714 S19080468 2019-08-20 40:51:16:10:10:22:73:442 U/C //master/data/ligo/db/S19082401:51/2 283.58 NBH The => Sest => 10675 S19080468 2019-07-20 20:31:23:20:20:31:23:20:400 U/C //master/data/ligo/db/S19072401:51/2 283.58 NBH The => Sest == 106:50:50:50:50:50:50:50:50:50:	Nō ↔	Name •	rigger •	Notice +	Detector +	Path	Distance •	BEST *	IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
19749 51908281 2019-08-28 06:55:09 2019-08-28 07:41:09.270 V/C //master/data/ligo/db/5190828/1512/1 100:3.# 242.95.1 BBH This => past => 19725 S1908286 2019-08-28 06:31:4:09.270 2019-08-22 01:39:45.784479 V/C //master/data/ligo/db/51908227(150/1/ 24.94.49 ±142.025 HT HT >> past => Diff S1908226 2019-08-12 01:29:59 2019-08-22 01:39:65.752:00 L/C //master/data/ligo/db/5190816/101/1 24.06.01 ± 10:3.92.2 NSH This =>> past => Diff S190814bv 2019-08-16 13:10:1.1.071 L/C //master/data/ligo/db/5190816/101/1 26.0.01 ± 10:0.32.2 NSH This => past => Diff S190814bv 2019-08-16 13:10:32.1.071 L/C //master/data/ligo/db/5190824/151/2 26.0.01 ± 7:0.050.750 L/C //master/data/ligo/db/5190724/151/2 28.7.42.8.51.884 NSH This => past => Diff S190728 2019-07-28 0:33:28.3.40024 L/C //master/data/ligo/db/5190724/151/2 28.7.42.8.51.884 NSH This => past => Diff S190728 2019-07-01 02:33:2019-07-21 12:02:33:28.3.40024 L/C //master/data/ligo/db/5190724/152 27.7.28.2.13:28.482 Diff </th <th>10778</th> <th>S190901ap</th> <th>2019-09-01 23:31:01</th> <th>2019-09-02 12:26:41.280418</th> <th>LVC</th> <th>/master/data/ligo/db/S190901ap/152/3/</th> <th>240.869 ± 78.6482</th> <th>BNS</th> <th>This => Best =></th>	10778	S190901ap	2019-09-01 23:31:01	2019-09-02 12:26:41.280418	LVC	/master/data/ligo/db/S190901ap/152/3/	240.869 ± 78.6482	BNS	This => Best =>
19749 5190828[2019-08-28 06:34-05 2019-08-28 06:34-05 2019-08-28 06:34-05 1800-28	10754	S190829u	2019-08-29 21:05:56	2019-08-29 21:13:18.446497	LVC	/master/data/ligo/db/S190829u/150/1/	157.208 ± 45.0109	3-5Msur	
10228 CW1 100816_FERMI (2019-08-24 21:53:45.784479 UVC //matter/data/ligo/db/S100822c/150/L 24.28.449 ± 142.625 This => best => best => both 10722 S190822c 2019-08-22 01:28:19 2019-08-22 01:38:05.752006 LVC //matter/data/ligo/db/S100822c/150/L 34.9392 ± 9.5232 BNS This => best => both 10714 S190814bv 2019-08-15 16:10:37.734442 LVC //matter/data/ligo/db/S190814bv/152/J 267.402 ± 51.884 NSMH This => best => both 10647 S190080ee 2019-07-28 06:45:100 2019-07-28 06:35:28.34022 LVC //matter/data/ligo/db/S190728q/152/ 277.782 ± 170.813 BMH This => best => both 1055 S190720h 2019-07-24 00:03:36 2019-07-24 15:21:04:25:110 LVC //matter/data/ligo/db/S190720a/151/ 1070.883.88 ± 65:52.383 BMH This => best => best => both 10578 S190720a 2019-07-07 01:20:33.64:2418 LVC //matter/data/ligo/db/S190720a/151/ 000.827 ± 23.356 BMH This => best => best => both 10578 S190706a/150 1707.66 ± 1445:120 LVC //matter/data/ligo/db/S190707a/151/ 000.827 ± 23.356 BMH This => best => both 1058 <th>10744</th> <th>S190828l</th> <th>2019-08-28 06:55:09</th> <th>2019-08-28 07:41:09.870678</th> <th>LVC</th> <th>/master/data/ligo/db/S190828l/151/2/</th> <th>1609.3 ± 426.351</th> <th>BBH</th> <th>This => Best =></th>	10744	S190828l	2019-08-28 06:55:09	2019-08-28 07:41:09.870678	LVC	/master/data/ligo/db/S190828l/151/2/	1609.3 ± 426.351	BBH	This => Best =>
190822c 2019-08-22 01:28:99 2019-08-22 01:38:05.72008 UVC //master/data/ligo/db/51908126/150/1/ 34.9392 94.73 10714 \$190816i 2019-08-16 13:01:32 2019-08-16 13:12:11.0371 LVC //master/data/ligo/db/5190816/150/1/ 266.401 ± 100.320 NSHH This => 0est => 10716 \$1908086e 2019-08-14 21:01:39 2019-08-16 13:13:21.0371 LVC //master/data/ligo/db/5190816/150/1/ 266.412 ± 100.320 NSHH This => 0est => 10643 \$1907284 2019-07-28 06:51:0 2019-07-28 06:51:0 2019-07-28 00:51:32 2019-07-28 00:51:32 2019-07-28 00:51:32 2019-07-28 00:51:32 2019-07-24 15:51:100:20:406 LVC //master/data/ligo/db/5190724/15:107.08 2019-07-28 15:52:50:80 HT This => 0est => 10579 \$190720a 2019-07-02 2019-07-24 15:51:100:20:100 LVC //master/data/ligo/db/51907264/150/150 206.92 ± 164.93 HT This => 0est => 10578 \$1907061 2019-07-02 2019-07-24 15:04:10:0406/10 //master/data/ligo/db/51907064/150/150 2019-07-24 15:04:08 LVC //master/data/ligo/db/51907064/150/150 2019-07-24 15:04:08 LVC //master/data/ligo/db/5190	10749	S190828j	2019-08-28 06:34:05	2019-08-28 08:08:41.489804	LVC	/master/data/ligo/db/S190828j/152/3/	1802.53 ± 422.884	BBH	This => Best =>
S190816i 2019-06-16 13:04:31 2019-06-16 13:13:21:0371 LVC //master/data/ligo/db/S190816/15/J/ 260:17 ± 100.32 NSBH This => Dest => 10710 S190814bv 2019-06-16 12:01:32:73442 LVC //master/data/ligo/db/S190814bv/152/5/ 267:402 ± 51:564 NSBH This => Dest => 1064 S190808ae 2019-06-06 22:25:12. 2019-07-28 (6:45:10 2019-07-28 (6:45:10 2019-07-28 (6:45:10 2019-07-28 (6:45:10 2019-07-28 (6:45:10 2019-07-28 (6:45:10 2019-07-28 (6:45:10 2019-07-24 (5:01:04:040847 LVC //master/data/ligo/db/S190727h/152/ 273.782 ± 170.813 BBH This => Dest => 10550 S19072ba 2019-07-20 (0:08:36 2019-07-24 15:05:19.020467 LVC //master/data/ligo/db/S190728h/151/ 107.98 ± 323.355 BBH This => Dest => 10471 S19072ba 2019-07-07 09:33:6 2019-07-24 15:021404 LVC //master/data/ligo/db/S190728h/151/ 109.827 ± 233.655 BBH This => Dest => 10474 S19070bai 2019-07-07 09:33:6 2019-07-24 15:04:04.8126 LVC //master/data/ligo/db/S190728h/151/ 104.74 ± 233.661 BHT This => Dest =	10728 G	GW190816_FERMI	2019-08-24 21:53:45.784479	2019-08-24 21:53:45.784479	LVC	/master/data/ligo/db/GW190816_FERMI/152/	428.449 ± 142.625		This => Best =>
S1908 Hdw 2019-06-14 21:10:39 2019-06-15 1:10:32.734442 LVC //master/data/ligo/db/5190014b/152/5/ 207.02 ± 51.854 NSBH This => Best => 10674 S19080Bae 2019-06-08 22:21:21 2019-07-28 20:35:28.340329 LVC //master/data/ligo/db/5190728/152/ 288.01 ± 76.6951 Terr This => Best => 10655 S19072Bq 2019-07-20 06:3:3 2019-07-21 00:0:3:6 2019-07-24 15:0:1:0:0:20467 LVC //master/data/ligo/db/5190728/152/ 288.58 ± 655.23 BBH This => Best => 10579 S19072Ba 2019-07-20 00:3:32 2019-07-24 15:0:1:0:0:204671 LVC //master/data/ligo/db/5190728/151/ 107.08 ± 23.333 BBH This => Best => 10578 S19070Gal 2019-07-01 20:33:26 2019-07-24 15:0:0:1:0:0:35.66666 LVC //master/data/ligo/db/519070a/151/ 509.627 ± 23.855 BBH This => Best => 10447 S19070Gal 2019-07-01 20:33:06 2019-07-01 20:33:06 2019-07-01 20:33:06 2019-07-01 20:33:06 2019-07-01 20:33:06 2019-05-21 1:5:05:06666 LVC //master/data/ligo/db/519070a/151/ 105.02 20:821:48 BBH This => Best => 2019-05-20 1	10722	S190822c	2019-08-22 01:29:59	2019-08-22 01:38:05.752008	LVC	/master/data/ligo/db/S190822c/150/1/	34.9392 ± 9.5232	BNS	This => Best =>
10642 \$190000ee 2019-09-08 22:21:21 2019-09-08 22:29:51.567759 LVC /master/data/ligo/db/5190728q/152/ 208.014 7.665051 Terr This =>pest => 10643 \$1907204 2019-07-28 06:45:10 2019-07-28 06:33221 LVC /master/data/ligo/db/5190728/152/ 873.782 170.813 BBH This => pest => 10559 \$1907204 2019-07-20 00:08:36 2019-07-24 170.44.490847 LVC /master/data/ligo/db/5190728/152/ 283.65 ± 65.238 BBH This => pest => 10559 \$1907204 2019-07-24 00:10-07-24 12:100-7244 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 15:100704 12:00-144 13:00-724 13:00-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 12:100-724 <t< th=""><th>10714</th><th>S190816i</th><th>2019-08-16 13:04:31</th><th>2019-08-16 13:13:21.10371</th><th>LVC</th><th>/master/data/ligo/db/S190816i/150/1/</th><th>260.617 ± 100.392</th><th>NSBH</th><th>This => Best =></th></t<>	10714	S190816i	2019-08-16 13:04:31	2019-08-16 13:13:21.10371	LVC	/master/data/ligo/db/S190816i/150/1/	260.617 ± 100.392	NSBH	This => Best =>
1043 5190728q 2019-07-28 06:45:10 2019-07-28 02:35:28:340329 LVC //master/data/ligo/db/5190728q/152/ 673.782 ± 170.812 BHH This => pest => 10650 \$100720a 2019-07-27 06:03:30 2019-06-01 17:07:40.490847 LVC //master/data/ligo/db/5190728q/151/ 1070.89 ± 223.335 BBH This => pest => 10590 \$100720a 2019-07-28 00:08:36 2019-07-24 15:03:100.20467 LVC //master/data/ligo/db/5190728q/151/ 1070.89 ± 223.355 BBH This => pest => 10580 \$100710a 2019-07-06 22:26:41 2019-07-07 10:270.33:06 2019-07-01 20:33:06 2019-07-10 20:33:06 2019-07-10 20:33:06 2019-07-10 20:33:06 2019-07-10 20:33:06 2019-07-10 20:33:06 2019-07-10 20:33:06 <td< th=""><th>10710</th><th>S190814bv</th><th>2019-08-14 21:10:39</th><th>2019-08-15 16:10:32.734442</th><th>LVC</th><th>/master/data/ligo/db/S190814bv/152/5/</th><th>267.402 ± 51.5854</th><th>NSBH</th><th>This => Best =></th></td<>	10710	S190814bv	2019-08-14 21:10:39	2019-08-15 16:10:32.734442	LVC	/master/data/ligo/db/S190814bv/152/5/	267.402 ± 51.5854	NSBH	This => Best =>
10650 \$190727h 2019-07-27 06:03:33 2019-08-01 17:07:40.490847 LVC //master/data/ligo/db/\$190727h/152/ 288.58 ± 655.230 BBH This => best => 10579 \$190720a 2019-07-20 00:08:36 2019-07-24 15:08:19.020467 LVC //master/data/ligo/db/\$190720a/151/ 107.08 ± 22:335 BBH This >> best => 10471 \$1907204 2019-07-07 09:33:26 2019-07-24 15:04:25101 LVC //master/data/ligo/db/\$190706a/150/ 5725.06 ± 144:53.28 BBH This >> best => 10578 \$190706ai 2019-07-06 22:26:41 2019-07-01 12:06:35.566666 LVC //master/data/ligo/db/\$190706ai/150/ 5725.06 ± 144:55.2 BBH This >> best => 10447 \$1906020ag 2019-06-30 18:52:05 2019-06-20 18:56:0686 LVC //master/data/ligo/db/\$190702ai/151/ 104:47.373 23:48:48 BBH This >> best => 10445 \$190620ag 2019-06-30 18:52:05 2019-05-21 06:57:0.566673 LVC //master/data/ligo/db/\$1905214/150/ 105:03.737 23:48:48 BBH This >> best => 10446 \$190521g 2019-05-21 06:57:0.566673 LVC //master/data/ligo/db/\$1905214/150/ <th>10674</th> <th>S190808ae</th> <th>2019-08-08 22:21:21</th> <th>2019-08-08 22:59:51.567759</th> <th>LVC</th> <th>/master/data/ligo/db/S190808ae/151/</th> <th>208.014 ± 76.6051</th> <th>Terr</th> <th>This => Best =></th>	10674	S190808ae	2019-08-08 22:21:21	2019-08-08 22:59:51.567759	LVC	/master/data/ligo/db/S190808ae/151/	208.014 ± 76.6051	Terr	This => Best =>
10570 5190720e 2019-07-20 00:08:36 2019-07-24 15:05:19.020467 LVC //master/data/ligo/db/51907204/151/ 1070.89 ± 323.355 BBH This => Best => 10580 \$190718y 2019-07-18 14:35:12 2019-07-24 15:21:04.251101 LVC //master/data/ligo/db/51907074/151/ 800.827 ± 233.655 BBH This => Best => 10578 \$190706ai 2019-07-07 00:33:26 2019-07-07 10:29:30.642918 LVC //master/data/ligo/db/5190706a/150/ 5725.06 ± 1445.52 BBH This => Best => 10449 \$190620ag 2019-07-02 10:30:06 2019-07-02 10:30:05 2019-07-02 10:30:05 2019-07-02 10:30:02 2019-07-02 10:30:02 2019-07-02 10:30:02 2019-05-21 00:57:02 00:02 2019-05-21 00:57:02 00:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02:02 2019-05-21 00:02:02:02 2019-05-21 00:02:02 2019-05-21 00:02:02	10643	S190728q	2019-07-28 06:45:10	2019-07-28 20:35:28.340329	LVC	/master/data/ligo/db/S190728q/152/	873.782 ± 170.813	BBH	This => Best =>
10580 \$1907.18y 2019-07-18 14:35:12 2019-07-24 15:21:04.351101 LVC //master/data/ligo/db/5190774/15// 226.629 164.934 Terr This => Best => 10471 \$190706ai 2019-07-07 09:33:26 2019-07-01 2019-05-20 2019-06-00 18:36:04-96196 LVC //master/data/ligo/db/5190603ag/150/ 1059.02 ± 307.214 BBH This => Best => 10445 \$190621ar 2019-06-20 18:36:04-96196 LVC //master/data/ligo/db/5190524g/150/ 191.693 ± 101 Terr This => Best => 10446 \$190521ar 2019-05-21 05:40:57:30.56667.31 LVC //master/data/ligo/db/5190512g/152/ 191.36:13 ± 72.92.86 BBH This => Best => 10408 \$190521ar 2019-05-12 10:5:40.170498 LVC //mas	10650	S190727h	2019-07-27 06:03:33	2019-08-01 17:07:40.490847	LVC	/master/data/ligo/db/S190727h/152/	2838.58 ± 655.239	BBH	This => Best =>
10471 \$190707q 2019-07-07 09:33:26 2019-07-07 10:23:39.642918 LVC //master/data/ligo/db/S190707q/151/ 909.827 ± 233.565 BBH This => Best => 10578 \$190706ai 2019-07-02 22:36:41 2019-07-24 15:04:50.81308 LVC //master/data/ligo/db/S19070ai/150/ 5725.06 ± 1445.52 BBH This => Best => 10447 \$190602aq 2019-06-02 17:59:27 2019-06-02 17:59:27 2019-06-02 18:36:00.946198 LVC //master/data/ligo/db/S190524/150/ 196.052.41 BBH This => Best => 10449 \$190622aq 2019-05-24 07:43:59 2019-05-24 08:57:60 CVC //master/data/ligo/db/S190524/150/ 196.052.41 BBH This => Best => 10449 \$190521g 2019-05-24 07:43:59 2019-05-21 08:47:30.566673 LVC //master/data/ligo/db/S190521/151/ 1136.13 ± 279.258 BBH This => Best => 10449 \$190521g 2019-05-18 15:35:44 2019-05-18 19:152.41 2019-05-18 19:152.41 2019-05-12 08:77.40 NCC //master/data/ligo/db/S190512b/150/ 275.01 ± 15.67.41 NBH	10579	S190720a	2019-07-20 00:08:36	2019-07-24 15:05:19.020467	LVC	/master/data/ligo/db/S190720a/151/	1070.89 ± 323.335	BBH	This => Best =>
10578 S190706ai 2019-07-06 22:26:41 2019-07-24 15:04:50.81308 LVC /master/data/ligo/db/S190706ai/150/ 5725.06 ± 1445.52 BBH This => Best => 10449 S190701ah 2019-07-01 20:33:06 2019-06-30 10:5712.75608 LVC /master/data/ligo/db/S190502af/150/ 1050:2 a 20.72:14 BBH This => Best => 10445 S19052aq 2019-06-30 10:5712.75608 LVC /master/data/ligo/db/S19052af/151/ 797.337 ± 238.488 BBH This => Best => 10445 S19052aq 2019-05-21 0:67:30.566673 LVC /master/data/ligo/db/S190521f/151/ 113.63.13 ± 279.258 BBH This => Best => 10406 S190521g 2019-05-21 0:67:30.56673 LVC /master/data/ligo/db/S190521f/151/ 113.63.13 ± 279.258 BBH This => Best => 10403 S190521g 2019-05-21 0:67:30.56673 LVC /master/data/ligo/db/S190521f/151/ 113.63.14 ± 90.90.88 BHT This => Best => 10403 S19051Bb 2019-05-17 15:10:17.16:41:50.4080.24 LVC /master/da	10580	S190718y	2019-07-18 14:35:12	2019-07-24 15:21:04.251101	LVC	/master/data/ligo/db/S190718y/150/	226.629 ± 164.934	Terr	This => Best =>
10449 \$190701ah 2019-07-01 20:33:06 2019-07-01 21:06:35.566666 LVC //master/data/ligo/db/S190701ah/151/ 1044.74 ± 233.891 BBH This => Best => 10447 \$190602aq 2019-06-30 18:52:05 2019-06-20 18:36:09.496:198 LVC //master/data/ligo/db/S190602aq/151/ 797.33 ± 238.488 BBH This => Best => 10445 \$190524q 2019-05-24 04:52:06 2019-05-24 06:57:30.566673 LVC //master/data/ligo/db/S190524q/150/ 191.693 ± 101 Terr This => Best => 10408 \$1905211 2019-05-21 03:02:29 2019-05-21 15:43:38.646296 LVC //master/data/ligo/db/S19052152/ 3931.42 ± 953.058 BBH This => Best => 10403 \$190521bj 2019-05-19 15:35:44 2019-05-19 17:05:40.17048 LVC //master/data/ligo/db/S190518b/150/ 27.7601 ± 15.2671 BNS This => Best => 10403 \$190517bj 2019-05-17 05:1510 2019-05-17 16:20:31.76144 LVC //master/data/ligo/db/S190518b/150/ 27.7601 ± 15.2671 BNS This => Best => 10402 \$190517bj 2019-05-13 20:34:08.242118 LVC //master/data/ligo/db/S190512b/150/ <th>10471</th> <th>S190707q</th> <th>2019-07-07 09:33:26</th> <th>2019-07-07 10:29:39.642918</th> <th>LVC</th> <th></th> <th>809.827 ± 233.565</th> <th>BBH</th> <th>This => Best =></th>	10471	S190707q	2019-07-07 09:33:26	2019-07-07 10:29:39.642918	LVC		809.827 ± 233.565	BBH	This => Best =>
10447 S190630ag 2019-06-30 18:57:12.765088 LVC //master/data/ligo/db/5190630ag/150/ 1059.02 ± 307.214 BBH This => Best => 10445 S190602aq 2019-06-02 17:59:27 2019-06-02 18:50:949619 LVC //master/data/ligo/db/5190502a/150/ 191.693 ± 101 Terr This => Best => 10408 S190521q 2019-05-21 07:43:59 2019-05-21 08:730.566673 LVC //master/data/ligo/db/5190521/151/ 1136.13 ± 279.258 BBH This => Best => 10408 S190521g 2019-05-21 09:730.540.170498 LVC //master/data/ligo/db/51905121/151/ 135.354 ± 790.989 BBH This => Best => 10404 S190513bb 2019-05-18 99:125:48 LVC //master/data/ligo/db/5190517b/150/ 229.50 ± 103.7.85 BBH This => Best => 10402 S190517h 2019-05-13 2019-05-17 16:41:50.40214 LVC //master/data/ligo/db/5190513b/151/ 1987.05 ± 501.212 BBH This => Best => 10403 S190512b	10578	S190706ai	2019-07-06 22:26:41	2019-07-24 15:04:50.81308	LVC	/master/data/ligo/db/S190706ai/150/	5725.06 ± 1445.52	BBH	This => Best =>
10445 S190602aq 2019-06-02 17:59:27 2019-06-02 18:36:09.496198 LVC /master/data/ligo/db/S19062aq/151/ 797.337 ± 238.488 BBH This => Best => 10440 S190524q 2019-05-24 04:52:06 2019-05-24 05:04:58.088204 LVC /master/data/ligo/db/S190524q/150/ 191.693 ± 101 Terr This => Best => 10408 S190521g 2019-05-21 03:02:29 2019-05-21 15:43:38.646296 LVC /master/data/ligo/db/S190521g/152/ 3931.42 ± 953.035 BBH This => Best => 10404 S190519bj 2019-05-19 15:35:44 2019-05-18 19:25:48 LVC /master/data/ligo/db/S190519b/151/ 3153.54 ± 790.989 BBH This => Best => 10404 S190518bb 2019-05-18 19:21 2019-05-18 19:25:48 LVC /master/data/ligo/db/S190517b/150/ 227.7601 ± 15.2671 BNS This => Best => 10405 S190513bm 2019-05-13 20:54:28 2019-05-13 21:34:08.234118 LVC /master/data/ligo/db/S190513b/151/ 1987.05 ± 501.212 BBH This => Best => 10365 S190513bm 2019-05-10 20:59:39 2019-05-10 10:47:10.047701 LVC /master/data/ligo/db	10449	S190701ah	2019-07-01 20:33:06	2019-07-01 21:06:35.566666	LVC	/master/data/ligo/db/S190701ah/151/	1044.74 ± 233.891	BBH	This => Best =>
10440 \$190524q 2019-05-24 04:52:06 2019-05-24 05:04:58.088204 LVC /master/data/ligo/db/5190524q/150/ 191.693 ± 101 Terr This => Best => 10408 \$190521r 2019-05-21 07:43:59 2019-05-21 08:57:30.566673 LVC /master/data/ligo/db/5190521g/151/ 3931.42 ± 953.035 BBH This => Best => 10404 \$190521g 2019-05-21 05:3:44 2019-05-19 17:05:40.170498 LVC /master/data/ligo/db/5190518b/151/ 3153.54 ± 790.98 BBH This => Best => 10403 \$190518bb 2019-05-18 19:25:48 LVC /master/data/ligo/db/5190518b/150/ 27.7601 ± 15.2671 BBH This => Best => 10403 \$190517h 2019-05-17 05:101 2019-05-13 21:34:08.024118 LVC /master/data/ligo/db/5190518b/150/ 27.7601 ± 15.2671 BBH This => Best => 10401 \$190517h 2019-05-17 16:41:50.480126 LVC /master/data/ligo/db/5190518b/151/ 1987.05 ± 501.212 BBH This => Best => 10401 \$190512at 2019-05-10 10:47:19.047701 LVC /master/data/ligo/db/5190512at/152/ 1387.68 ± 322.114 BBH This => Best =>	10447	S190630ag	2019-06-30 18:52:05	2019-06-30 18:57:12.765088	LVC	/master/data/ligo/db/S190630ag/150/	1059.02 ± 307.214	BBH	This => Best =>
10408 \$190521r 2019-05-21 07:43:59 2019-05-21 08:57:30.566673 LVC /master/data/ligo/db/S190521/151/ 1136.13 ± 279.258 BBH This => Best => 10439 \$190521g 2019-05-21 03:02:29 2019-05-21 15:43:38.646296 LVC /master/data/ligo/db/S1905219/152/ 3931.42 ± 953.035 BBH This => Best => 10404 \$190519bj 2019-05-19 15:35:44 2019-05-19 17:05:40.170498 LVC /master/data/ligo/db/S190519bj/151/ 3153.54 ± 790.389 BBH This => Best => 10402 \$190517h 2019-05-17 05:51:01 2019-05-17 16:41:50.480126 LVC /master/data/ligo/db/S190517h/150/ 2950 ± 1037.85 BBH This => Best => 10402 \$190512at 2019-05-17 06:21:37.61949 LVC /master/data/ligo/db/S190512012/152/ 1387.68 ± 322.114 BBH This => Best => 10363 \$1905102 2019-05-10 20:593 2019-05-10 10:67:31.761949 LVC /master/data/ligo/db/S190512012/152/ 1387.68 ± 322.114 BBH This => Best => 10363 \$190503bf 2019-05-20 318:54:04 2019-07-30 15:03:36.592837 LVC /master/data/ligo/db/S1905030f/150/	10445	S190602aq	2019-06-02 17:59:27	2019-06-02 18:36:09.496198	LVC	/master/data/ligo/db/S190602aq/151/	797.337 ± 238.488	BBH	This => Best =>
10439 S190521g 2019-05-21 03:02:29 2019-05-21 15:43:38.646296 LVC //master/data/ligo/db/S190519j/152/ 3931.42 ± 953.035 BBH This => Best => 10404 S190519bj 2019-05-19 15:35:44 2019-05-19 17:05:40.170498 LVC //master/data/ligo/db/S190519b/151/ 3153.54 ± 790.889 BBH This => Best => 10403 S190518bb 2019-05-18 19:12:14 2019-05-18 19:25:48 LVC //master/data/ligo/db/S190518b/150/ 27.7601 ± 15.2671 BNS This => Best => 10402 S190517h 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-13 20:54:28 2019-05-10 10:47:19.047701 LVC //master/data/ligo/db/S190512a/152/ 1387.68 ± 322.114 BBH This => Best => 10201 S190426c 2019-05-03 18:54:04 2019-07-30 15:03:36.592837 LVC //master/data/ligo/db/S190503bf150/ 421.108 ± 104.533 BBH This => Best => 10201 S	10440	S190524q	2019-05-24 04:52:06	2019-05-24 05:04:58.088204	LVC	/master/data/ligo/db/S190524q/150/	191.693 ± 101	Terr	This => Best =>
10404 S190519bj 2019-05-19 15:35:44 2019-05-19 17:05:40.170498 LVC //master/data/ligo/db/S190519bj/151/ 3153.54 ± 790.989 BBH This => Best => 10403 S190518bb 2019-05-18 19:19:21 2019-05-18 19:25:48 LVC /master/data/ligo/db/S190517b) 27.7601 ± 15.2671 BNS This => Best => 10402 S190513bm 2019-05-13 2019-05-17 16:41:50.480126 LVC /master/data/ligo/db/S190517b/150/ 2950 ± 1037.85 BBH This => Best => 10401 S190513bm 2019-05-12 16:07:14 2019-05-17 16:20:31.761949 LVC /master/data/ligo/db/S190513bm/151/ 1987.06 ± 322.114 BBH This => Best => 10363 S190510g 2019-05-10 02:59:39 2019-05-10 10:47:19.047701 LVC /master/data/ligo/db/S190510g/152/ 227.221 ± 92.413 BNS This => Best => 10:64 S1905252 2019-04-26 15:39:31.835087 LVC /master/data/ligo/db/S190425c/152/ 375.432 ± 108.174 BNS This => Best => 10:198 S190425c 2019-04-22 15:16:13.849222 LVC<	10408	S190521r	2019-05-21 07:43:59	2019-05-21 08:57:30.566673	LVC	/master/data/ligo/db/S190521r/151/	1136.13 ± 279.258	BBH	This => Best =>
10403 S190518bb 2019-05-18 19:19:21 2019-05-18 19:25:48 LVC //master/data/ligo/db/S190518bb/150/ 27.7601 ± 15.2671 BNS This => Best => 10402 S190517h 2019-05-17 05:51:01 2019-05-17 16:41:50.480126 LVC //master/data/ligo/db/S190517h/150/ 2950 ± 1037.85 BBH This => Best => 10401 S190513bm 2019-05-13 20:54:28 2019-05-17 16:20:31.761949 LVC //master/data/ligo/db/S190512at/152/ 1387.68 ± 322.114 BBH This => Best => 10363 S190510g 2019-05-10 02:59:39 2019-05-10 10:47:19.047701 LVC //master/data/ligo/db/S190510g/152/ 227.221 ± 92.413 BNS This => Best => 10201 S190426c 2019-04-26 15:21:55 2019-04-26 16:39:31.835087 LVC //master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10198 S190425z 2019-04-26 15:21:55 2019-04-26 15:16:33.849222 LVC /master/data/ligo/db/S190425c/152/ 156.144 ± 41.3734 BNS This => Best => 10198 S190421ar 2019-04-12 05:60:5	10439	S190521g	2019-05-21 03:02:29	2019-05-21 15:43:38.646296	LVC	/master/data/ligo/db/S190521g/152/	3931.42 ± 953.035	BBH	This => Best =>
10402 S190517h 2019-05-17 05:51:01 2019-05-17 16:41:50.480126 LVC //master/data/ligo/db/S190517h/150/ 2950 ± 1037.85 BBH This => Best => 10366 S190513bm 2019-05-13 20:54:28 2019-05-13 21:34:08.234118 LVC //master/data/ligo/db/S190513bm/151/ 1987.05 ± 501.212 BBH This => Best => 10401 S190512at 2019-05-12 18:07:14 2019-05-17 16:20:31.761949 LVC //master/data/ligo/db/S190512at/152/ 1387.68 ± 322.114 BBH This => Best => 10363 S190510g 2019-05-10 02:59:39 2019-05-10 10:47:19.047701 LVC //master/data/ligo/db/S190510g/152/ 227.21 ± 92.413 BNS This => Best => 10544 S19050506 2019-05-20 15:03:36.592837 LVC //master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 1056 S190426c 2019-04-25 08:18:05 2019-04-26 15:16:33.849222 LVC //master/data/ligo/db/S190421ar/151/ 228.132 ± 696.623 Terr This => Best => 10196 S190421ar 2019-04-12 05:30:44 2019-04-20 15:10:303866 LVC //master/data/ligo/db/S190412m/150/ 812.179 ± 194.141 This => Best =	10404	S190519bj	2019-05-19 15:35:44	2019-05-19 17:05:40.170498	LVC	/master/data/ligo/db/S190519bj/151/	3153.54 ± 790.989	BBH	This => Best =>
10366 S190513bm 2019-05-13 20:54:28 2019-05-13 21:34:08.234118 LVC //master/data/ligo/db/S190513bm/151/ 1987.05 ± 501.212 BBH This => Best => 10401 S190512at 2019-05-12 18:07:14 2019-05-17 16:20:31.761949 LVC //master/data/ligo/db/S190512at/152/ 1387.68 ± 322.114 BBH This => Best => 10363 S190510g 2019-05-10 02:59:39 2019-05-10 10:47:19.047701 LVC //master/data/ligo/db/S190510g/152/ 227.221 ± 92.413 BNS This => Best => 10644 S190503bf 2019-05-03 18:54:04 2019-07-30 15:03:36.592837 LVC //master/data/ligo/db/S190503bf/150/ 421.108 ± 104.533 BBH This => Best => 10196 S190426c 2019-04-26 15:16:33.849222 LVC //master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10196 S190421ar 2019-04-21 21:38:56 2019-04-22 17:06:12.033586 LVC //master/data/ligo/db/S1904252/152/ 126.144 ± 10.3734 BNS This => Best => 10185 S190412m 2019-04-21 21:38:56 2019-04-22 17:06:12.033586 LVC //master/data/ligo/db/S190412m/151/ 228.1279 ± 194.141 This => Best =>	10403	S190518bb	2019-05-18 19:19:21	2019-05-18 19:25:48	LVC	/master/data/ligo/db/S190518bb/150/	27.7601 ± 15.2671	BNS	This => Best =>
10401 \$190512at 2019-05-12 18:07:14 2019-05-17 16:20:31.761949 LVC /master/data/ligo/db/S190512at/152/ 1387.68 ± 322.114 BBH This => Best => 10363 \$190510g 2019-05-10 02:59:39 2019-05-10 10:47:19.047701 LVC /master/data/ligo/db/S190510g/152/ 227.221 ± 92.413 BNS This => Best => 10644 \$190503bf 2019-05-03 18:54:04 2019-07-30 15:03:36.592837 LVC /master/data/ligo/db/S190503bf/150/ 421.108 ± 104.533 BBH This => Best => 10201 \$190426c 2019-04-26 15:21:55 2019-04-26 16:39:31.835087 LVC /master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10196 \$190421ar 2019-04-26 05:31:65 2019-04-26 15:16:33.849222 LVC /master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10196 \$190421ar 2019-04-12 05:30:44 2019-04-12 06:40:50.026518 LVC /master/data/ligo/db/S190421ar/151/ 2281.32 ± 696.623 Terr This => Best => 10185 \$190412m 2019-04-08 18:18:02 2019-04-12 0 0:40:50.026518 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best =>	10402	S190517h	2019-05-17 05:51:01	2019-05-17 16:41:50.480126	LVC	/master/data/ligo/db/S190517h/150/	2950 ± 1037.85	BBH	This => Best =>
10363 S190510g 2019-05-10 02:59:39 2019-05-10 10:47:19.047701 LVC /master/data/ligo/db/S190510g/152/ 227.221 ± 92.413 BNS This => Best => 10644 S190503bf 2019-05-03 18:54:04 2019-07-30 15:03:36.592837 LVC /master/data/ligo/db/S190503bf/150/ 421.108 ± 104.533 BBH This => Best => 10201 S190426c 2019-04-26 15:21:55 2019-04-26 16:39:31.835087 LVC /master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10198 S190425z 2019-04-25 08:18:05 2019-04-26 15:16:33.849222 LVC /master/data/ligo/db/S190425c/152/ 156.144 ± 41.3734 BNS This => Best => 10196 S190421ar 2019-04-12 019-04-22 17:06:12.033886 LVC /master/data/ligo/db/S190421ar/151/ 2281.32 ± 696.623 Terr This => Best => 10185 S190408an 2019-04-09 13:48:07.07137 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10186 S190408an 2019-04-05 16:01:30 2019-04-12 15:17:49.139	10366	S190513bm	2019-05-13 20:54:28	2019-05-13 21:34:08.234118	LVC	/master/data/ligo/db/S190513bm/151/	1987.05 ± 501.212	BBH	This => Best =>
10644 S190503bf 2019-05-03 18:54:04 2019-07-30 15:03:36.592837 LVC /master/data/ligo/db/S190503bf/150/ 421.108 ± 104.533 BBH This => Best => 10201 S190426c 2019-04-26 15:21:55 2019-04-26 16:39:31.835087 LVC /master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10198 S190425z 2019-04-26 15:21:55 2019-04-26 15:16:33.849222 LVC /master/data/ligo/db/S190425z/152/ 156.144 ± 41.3734 BNS This => Best => 10196 S190421ar 2019-04-21 21:38:56 2019-04-22 17:06:12.033586 LVC /master/data/ligo/db/S190421ar/151/ 2281.32 ± 696.623 Terr This => Best => 10185 S190412m 2019-04-12 05:30:44 2019-04-12 06:40:50.026518 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10183 S190408an 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066	10401	S190512at	2019-05-12 18:07:14	2019-05-17 16:20:31.761949	LVC	/master/data/ligo/db/S190512at/152/	1387.68 ± 322.114	BBH	This => Best =>
10201 S190426c 2019-04-26 15:21:55 2019-04-26 16:39:31.835087 LVC //master/data/ligo/db/S190426c/152/ 375.432 ± 108.174 BNS This => Best => 10198 S190425z 2019-04-25 08:18:05 2019-04-26 15:16:33.849222 LVC //master/data/ligo/db/S190425z/152/ 156.144 ± 41.3734 BNS This => Best => 10196 S190421ar 2019-04-21 21:38:56 2019-04-22 17:06:12.033586 LVC //master/data/ligo/db/S190421ar/151/ 2281.32 ± 696.623 Terr This => Best => 10185 S190412m 2019-04-12 05:30:44 2019-04-12 06:40:50.026518 LVC //master/data/ligo/db/S190412m/150/ 812.179 ± 194.141 This => Best => 10183 S190408an 2019-04-08 18:18:02 2019-04-09 13:48:07.07137 LVC //master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC //master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066 G299232 2017-08-25 13:13:37 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G298936/152/ 1541 ± 415.434	10363	S190510g	2019-05-10 02:59:39	2019-05-10 10:47:19.047701	LVC	/master/data/ligo/db/S190510g/152/	227.221 ± 92.413	BNS	This => Best =>
10198 S190425z 2019-04-25 08:18:05 2019-04-26 15:16:33.849222 LVC /master/data/ligo/db/S190425z/152/ 156.144 ± 41.3734 BNS This => Best => 10196 S190421ar 2019-04-21 21:38:56 2019-04-22 17:06:12.033586 LVC /master/data/ligo/db/S190421ar/151/ 2281.32 ± 696.623 Terr This => Best => 10185 S190412m 2019-04-21 20:30:44 2019-04-12 06:40:50.026518 LVC /master/data/ligo/db/S190412m/150/ 812.179 ± 194.141 This => Best => 10183 S190408an 2019-04-08 18:18:02 2019-04-09 13:48:07.07137 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066 G299232 2017-08-25 13:13:37 2017-08-29 16:08:46.552308 LVC /master/data/ligo/db/G299232/151/ 254.502 ± 86.5358 This => Best => 10070 G298936 2017-08-23 13:13:58 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G298936/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:	10644	S190503bf	2019-05-03 18:54:04	2019-07-30 15:03:36.592837	LVC	/master/data/ligo/db/S190503bf/150/	421.108 ± 104.533	BBH	This => Best =>
10196 S190421ar 2019-04-21 21:38:56 2019-04-22 17:06:12.033586 LVC /master/data/ligo/db/S190421ar/151/ 2281.32 ± 696.623 Terr This => Best => 10185 S190412m 2019-04-12 05:30:44 2019-04-12 06:40:50.026518 LVC /master/data/ligo/db/S190412m/150/ 812.179 ± 194.141 This => Best => 10183 S190408an 2019-04-08 18:18:02 2019-04-09 13:48:07.07137 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066 G299232 2017-08-25 13:13:37 2017-08-29 16:08:46.552308 LVC /master/data/ligo/db/G299232/151/ 254.502 ± 86.5358 This => Best => 10070 G298936 2017-08-19 15:50:46 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G29836/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:46 2017-08-19 Vaddia019/24/94 inov/v Central Enginet From Hadd/vab/G298389/151/ ± This => Best => 10074 GW170818 2017-08-18 02:25:09.1 2019-03-14 Madatanig/adaganger UGRB	10201	S190426c	2019-04-26 15:21:55	2019-04-26 16:39:31.835087	LVC	/master/data/ligo/db/S190426c/152/	375.432 ± 108.174	BNS	This => Best =>
10185 S190412m 2019-04-12 05:30:44 2019-04-12 06:40:50.026518 LVC /master/data/ligo/db/S190412m/150/ 812.179 ± 194.141 This => Best => 10183 S190408an 2019-04-08 18:18:02 2019-04-09 13:48:07.07137 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066 G299232 2017-08-25 13:13:37 2017-08-29 16:08:46.552308 LVC /master/data/ligo/db/G299232/151/ 254.502 ± 86.5358 This => Best => 10070 G298936 2017-08-19 15:50:46 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G298936/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:46 2017-08-19 Valadianis/adapt novy. Central Engineter and add/ligo/db/G298389/151/ ± This => Best => 10174 GW170818 2017-08-18 02:25:09.1 2019-03-14 Multimessan ger L@RB observations/dKW25/db/GW170818/150/ 567.547 ± 112.025 This => Best => 10071 G017-08-12 12:41:00 G017-08-12 12:41:00 G012-21 St.Petersburg. Russia. 12/sept/	10198	S190425z	2019-04-25 08:18:05	2019-04-26 15:16:33.849222	LVC	/master/data/ligo/db/S190425z/152/	156.144 ± 41.3734	BNS	This => Best =>
10183 S190408an 2019-04-08 18:18:02 2019-04-09 13:48:07.07137 LVC /master/data/ligo/db/S190408an/151/ 1472.9 ± 357.875 This => Best => 10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066 G299232 2017-08-25 13:13:37 2017-08-29 16:08:46.552308 LVC /master/data/ligo/db/G299232/151/ 254.502 ± 86.5358 This => Best => 10070 G298936 2017-08-23 13:13:58 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G298936/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:46 2017-08-19 Valadianis/Lapst novy. Central Enginetional Data Mathemediata/ligo/db/G298389/151/ ± This => Best => 10174 GW170818 2017-08-18 02:25:09.1 2019-03-14 Mathemediatan gene LGRB observations/dXW25/db/GW170818/150/ 567.547 ± 112.025 This => Best => 10071 G017-08-17 12:41:10 G017-08-17 12:41:10 G017-08-17 12:41:10 G017-08-17 12:41:10 G017-08-17 12:41:10 16:10 16:10 16:10 16:10 16:10 16:10 16:10<	10196	S190421ar	2019-04-21 21:38:56	2019-04-22 17:06:12.033586	LVC	/master/data/ligo/db/S190421ar/151/	2281.32 ± 696.623	Terr	This => Best =>
10186 S190405ar 2019-04-05 16:01:30 2019-04-12 15:17:49.139004 LVC /master/data/ligo/db/S190405ar/152/ 268.106 ± 128.788 This => Best => 10066 G299232 2017-08-25 13:13:37 2017-08-29 16:08:46.552308 LVC /master/data/ligo/db/G299232/151/ 254.502 ± 86.5358 This => Best => 10070 G298936 2017-08-23 13:13:58 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G29836/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:46 2017-08-19 Vadianis/Japa novy/Central Engine trom trady/bb/G298389/151/ ± This => Best => 10174 GW170818 2017-08-18 02:25:09.1 2019-03-14 Mantimessan ger LGRB observations/dKW25/db/GW170818/150/ 567.547 ± 112.025 This => Best => 10071 master/data/ligo/db/G298048/152/ 39.77 ± 8.30844 This => Best =>		S190412m	2019-04-12 05:30:44		LVC		812.179 ± 194.141		This => Best =>
10066 G299232 2017-08-25 13:13:37 2017-08-29 16:08:46.552308 LVC /master/data/ligo/db/G299232/151/ 254.502 ± 86.5358 This => Best => 10070 G298936 2017-08-23 13:13:58 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G299336/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:46 2017-08-19 Vadimins/Lipu novy/Central Engine trom Lipud/bb/G298389/151/ ± This => Best => 10174 GW170818 2017-08-18 02:25:09.1 2019-03-14 Maintimessan ger LGRB observations/dKW25db/GW170818/150/ 567.547 ± 112.025 This => Best => 10071 C017-08-17 12:41:00 C017-08-18 02:22	10183	S190408an	2019-04-08 18:18:02	2019-04-09 13:48:07.07137	LVC	/master/data/ligo/db/S190408an/151/	1472.9 ± 357.875		This => Best =>
10070 G298936 2017-08-23 13:13:58 2017-08-29 17:21:36.838523 LVC /master/data/ligo/db/G298936/152/ 1541 ± 415.434 This => Best => 10047 G298389 2017-08-19 15:50:46 2017-08-19 Vacinity Liput novy Central Enginetional Ligd/bb/G298389/151/ ± This => Best => 10174 GW170818 2017-08-18 02:25:09.1 2019-03-14 Multimessan get CRB observations/dKW25/db/GW170818/150/ 567.547 ± 112.025 This => Best => 10071 GW170818 2017-08-12:12:41:00 Gu12-22 St.Petersburg. Russia. 12/sept2019a/ligo/db/G298048/152/ 39.77 ± 8.30844 This => Best =>	10186	S190405ar	2019-04-05 16:01:30	2019-04-12 15:17:49.139004	LVC		268.106 ± 128.788		This => Best =>
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10174 GW170818 2017-08-18 02:25:09.1 2019-03-14 Mathinessan ger LGRB observationsd KW25db/GW170818/150/ 567.547 ± 112.025 This => Best => 10071 Control of the second secon	10070	G298936	2017-08-23 13:13:58				1541 ± 415.434		This => Best =>
10071 2017-08-17 12:41:0 121-30-12:21: St. Petersburg: Russia, 12/Sept 2019a/ligo/db/G298048/152/ 39.77 ± 8.30844 This => Best =>	10047	G298389	2017-08-19 15:50:46				±		This => Best =>
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101 V™7595 V N 7-08- 10:30 V 1-14 55:1 41 01 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		C208048	2017-08-17 12:41:0	2-00-30-12:21 St.Peters	burg, Ru	sia, 12/sept2019a/ligo/db/G298048/152/	39.77 ± 8.30844		This => Best =>
	109	VNC7595	7-08- 10:30	200-1602:55:0 41		/master/data/ligo/db/G297595/152/	534.286 ± 131.305		This => Best =>

Very Bright GRB160625B

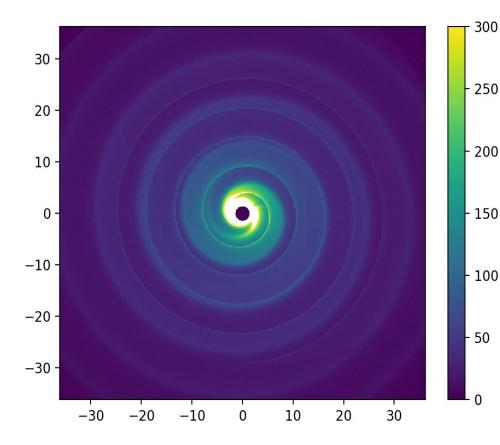


The black curve is the MASTER optical curve, red - Fermi LAT observations (> 1 MeV)

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019



The black curve is the MASTER optical curve, red - Fermi LAT observations (> 1 MeV)



The x, y axes show the distance in solar radii, the relative density of particles is shown in color (above)

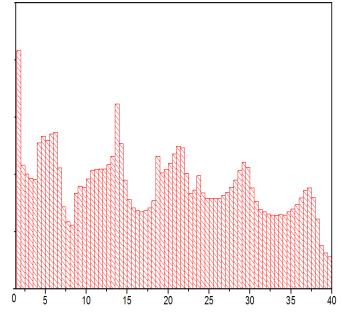
Density distribution on the line of sight, x - distance in the radii of the Sun, y - relative density (right)

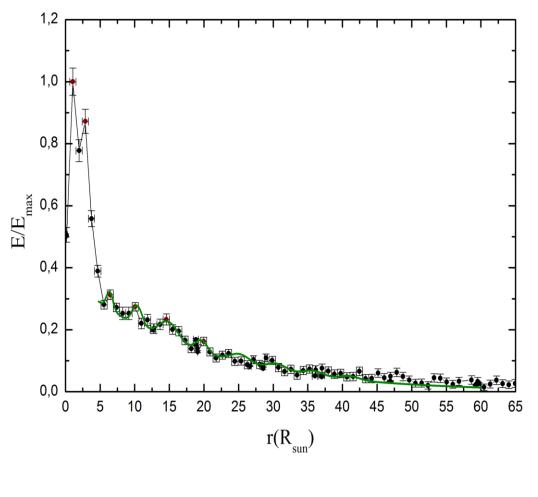
Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019 Model A: The gravitational impact of a companion star (NS) directly on the stellar wind. (Topolev et al.,2019)

Параметры моделируемой системы:

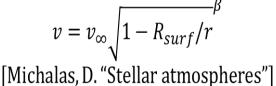
1.	$M_1 = 1.5 M_{\odot}$
2.	$M_2 = 20 M_{\odot}$
З.	$R_2 \approx 1.4 R_{\odot}$
4.	<i>v</i> ∞ ≈ 1300 км/с

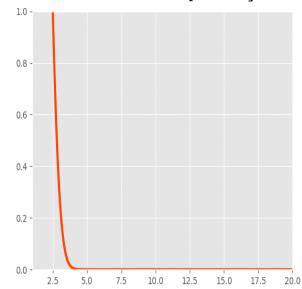
5. $T \approx 5800 c$





Зеленый - модельная кривая для параметров: радиус поверхности испускания – 1,4 R☉; Tsystem ≈ 7200 с; v∞ ≈ 500км/с (Сверху) Движение волн плотности в радиальном направлении (Справа) Vladimir Lipunov, Central Engine from Early Multimessanger GF Model B: a companion star (NS) is drawn in an ellipse relative to a collapsing star; passage through the pericenter of the orbit perturbs the main star. The stellar wind flux density increases, creating a density wave that is already accelerating according to the stellar wind acceleration law (Topolev et al.,2019):





Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019



LVT151012 ~~~~~~

GW170104

0

GW170817

time observable (seconds)

LIGO/University of Oregon/Ben Farr

2

SPINAR COMEBACK!

• Lunan Sun, Milton Ruiz, Stuart L. Shapiro, Phys. Rev. D 99, 064057 (2019) - Magnetic Braking and Damping of Differential Rotation in Massive Stars

 Milton Ruiz, Antonios Tsokaros, Vasileios Paschalidis, and Stuart L. Shapiro, Physical Review D, Volume 99, Issue 8 - Effects of spin on magnetized binary neutron star mergers and jet launching

 Maurice H.P.M. van Putten and Massimo Della Valle, Mon. Not. R. Astron. Soc.000, 1–9, 4 September 2018 Observational evidence for Extended Emission to GW170817

Vladimir Lipunov, Central Engine from Early Multimessanger GRB observations, KW25, St.Petersburg, Russia, 12 sep 2019

MODERN CALCULATIONS and observations

Lunan Sun, Milton Ruiz, Stuart L. Shapiro, Phys. Rev. D 99, 064057 (2019) –
 Magnetic Braking and Damping of Differential Rotation in Massive Stars

 Milton Ruiz, Antonios Tsokaros, Vasileios Paschalidis, and Stuart L. Shapiro, Physical Review D, Volume 99, Issue 8 – Effects of spin on magnetized binary neutron star mergers and jet launching

 Maurice H.P.M. van Putten and Massimo Della Valle, Mon. Not. R. Astron. Soc.000, 1–9, 4 September 2018 Observational evidence for Extended Emission to GW170817

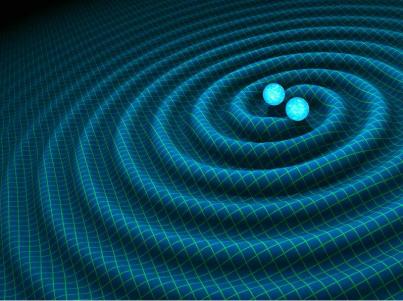
New Spinar consideration

(Posdnyakov et al. 2019, in preparation) -

- Nuclear pressure
- · Lense-Thirring effect
- Disappearance of the magnetic field during collapse
- Angular momentum losses
- New: Dynamo-mechanism

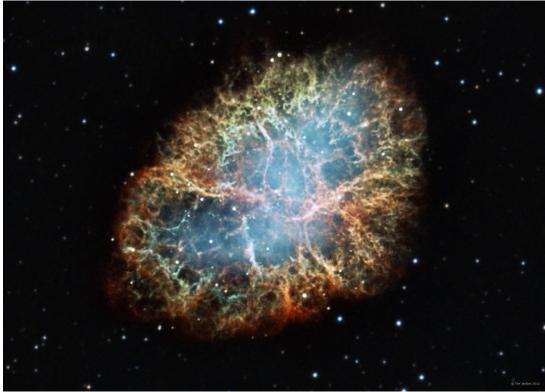
Before merger:

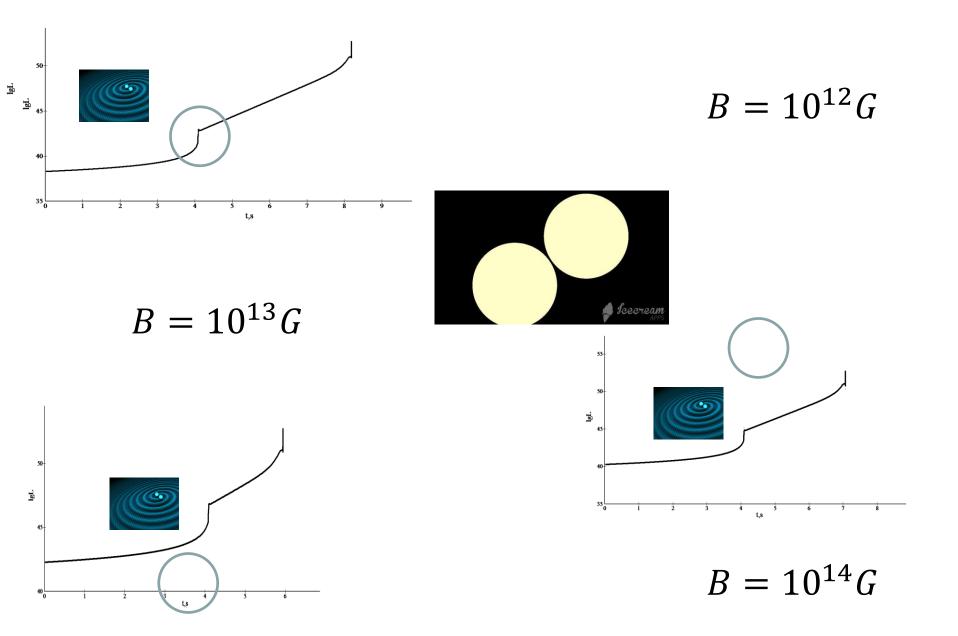
 $\frac{32G^4M_1^2M_2^2(M_1+M_2)}{5c^5A^5}$ $L_g =$ $L = \frac{\ddot{D}^2}{180c^5}$

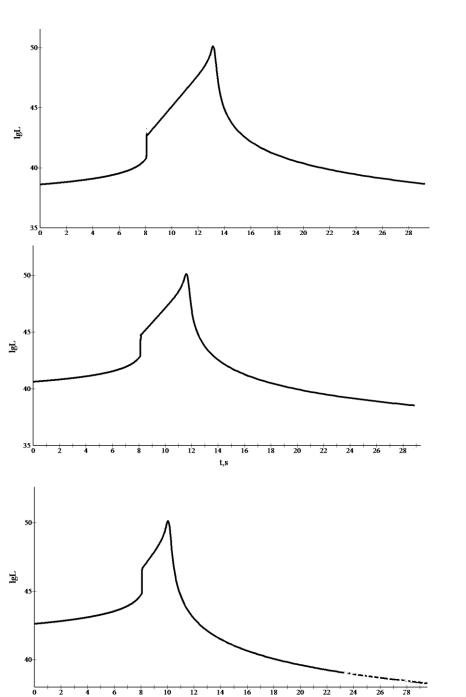


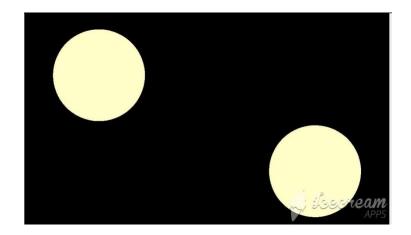
optical radiation

 We assume that the spinar spectrum corresponds to the Crab pulsar (B0531+21) spectrum.

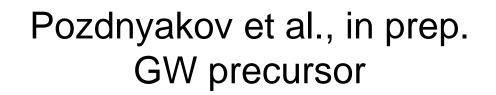


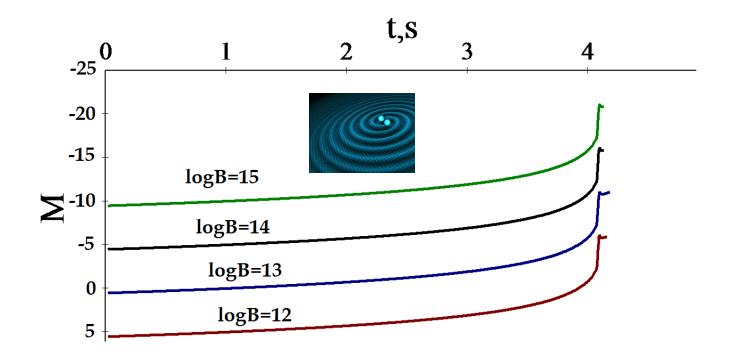






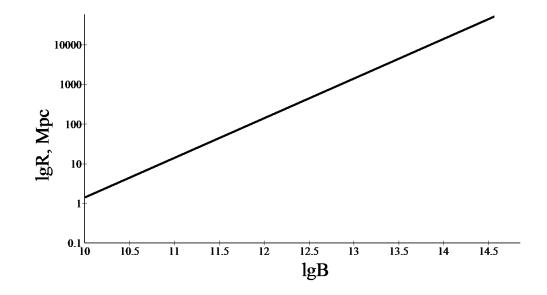






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MASTER can see the optical transient:



Summary

- The magnetic field strongly affects the electromagnetic luminosity
- For usual electromagnetic fields we can see the optical transient at a distance about 200-300 Mpc
- At these distances in the radio band can radiate about 20 Ya at a frequency of 178 MHz

Perspectives

- More detailed account of differential rotation
- Accounting of statistical data on magnetic fields of neutron stars
- More detailed account of the jet

5 UNSOLVED OBSERVATIONAL GRB PROBLEMS

- I. The discovery of the most distant objects in the Universe.
- II. Prompt optical Short GRB emission detection.
- III. Optical emission Precursor detection for GRB. -
- IV. High time resolution observations of the prompt optical/UV/IR emission.

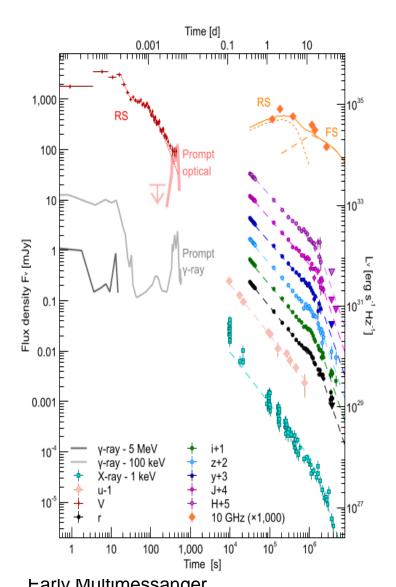
V. NS+BH localization

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Thank you for attention



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Extended Data Figure 1 | Multiwavelength light curves for GRB 160625B and its afterglow. Different emission components shape the temporal evolution of GRB 160625B. On timescales of seconds to minutes after the explosion, we observe bright prompt (solid lines) and reverse-shock (dotted lines) components. On timescales of hours to weeks after the burst, emission from the forward shock (dashed lines) becomes the dominant component from X-rays down to radio energies. After about 14 days, the afterglow emission falls off at all wavelengths. This phenomenon, known as jet-break, is caused by the beamed geometry of the outflow. Error bars denote 1σ limits; upper limits are 3σ . Times are given with reference to the LAT trigger time T_0 . FS, forward shock; RS, reverse shock; a subscript 'v' refers to frequency; u, V, r, i, z, y, J and H denote specific optical filters.