



HERMES: HOPSCOTCH ENABLED RAPID MESSAGE EXCHANGE SERVICE

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Las Cumbres Observatory, UCSB & the
SCIMMA collaboration- Scalable
Cyberinfrastructure for Multimessenger
Astrophysics



THE PROBLEM

Imagine you find a bunch of gravitational wave source candidates. The problem today is:

- Our reporting mechanisms (e.g. GCN circulars) are not machine readable, so our Target & Observation Managers (TOMs) or follow-up marshals cannot parse them.
- It is slow for a human to write the text
- There is no standard for how to format tables or even what should be reported.
- Generally only discoveries and the spectroscopic type are reported, whereas we have much more information we want or need (e.g. photometric points, other spectra, limits, available resources).
- Information is reported over several places: GCN Notices and Circulars, Astronomer's Telegrams, the Transient Name Server, and event brokers.

LIGO/Virgo S191205ah: Candidates from the Zwicky Transient Facility Public Survey

Show affiliations

Andreoni, Igor ; Anand, Shreya ; Coughlin, Michael W. ; De, Kishalay ; Kasliwal, Mansi M. ; Duev, Dmitry ; Bellm, Eric  ; Stein, Robert ; Reusch, Simeon  ; Cenko, Brad ; Graham, Matthew ; Zwicky Transient Facility Collaboration ; Global Relay of Transients Watching Observatories Happen Collaboration

The Zwicky Transient Facility (ZTF; Bellm et al. 2019, Graham et al. 2019) public survey serendipitously imaged part of the skymap of the neutron star-black hole merger candidate S191205ah (LVC, GCN #26350) between 2019-12-06 and 2019-12-13 UT. The first 4 nights after the trigger were heavily affected by bad weather at Palomar Observatory. The integrated localization probability observed at least once during the public survey was about 46%, with median limiting magnitudes $r > 19.7$ and $g > 19.6$. The images were processed in real-time through the ZTF reduction and image subtraction pipelines at IPAC (Masci et al., 2019). We queried the ZTF alert stream using the Kowalski infrastructure (Duev et al., 2019). We required at least 2 detections separated by at least 30 minutes to select against moving objects. Furthermore, we cross-matched our candidates with the Minor Planet Center to flag known asteroids. The candidates within the 90% probability contour of S191205ah that passed the automatic selection criteria and human vetting are presented in the table below.

Name	TNS	RA	Dec	JD	filter	mag	z	notes
ZTF19acxpnd	AT2019wkv	11:41:26.84	+08:14:28.3	2458829.0670	r	19.4	0.0899	(a)
ZTF19acxoywk	AT2019wix	09:59:35.08	+13:54:54.2	2458828.0459	g	20.2	0.0511	(b,c)
ZTF19acxoyra	AT2019wid	10:12:22.51	+08:36:33.6	2458828.0459	g	20.2	0.0964	(b)
ZTF19acxowrr	AT2019wib	10:19:29.15	+27:53:01.5	2458828.0477	g	18.7	0.0505	(b)
ZTF19acxpwlh	AT2019wiy	10:22:51.11	+23:36:11.8	2458830.9565	r	19.7	0.123	(a,c)
ZTF19acyiflj	AT2019wmy	10:11:35.97	+23:56:37.8	2458830.9330	r	19.9	-	(d)
ZTF19acyitga	AT2019wmn	10:39:11.24	+05:09:43.0	2458830.9587	r	19.3	0.0708	(b,c)

(a) SDSS photometric redshift (b) SDSS spectroscopic redshift (c) First reported to TNS by ALeRCE (d) Faint host Spectroscopic or photometric redshifts from the Sloan Digital Sky Survey (SDSS) are available for most of the probable host galaxies. The redshift of the candidates are compatible with the distance to S191205ah (385 +/- 164 Mpc, GCN #26350) within the uncertainties. Where host redshifts are available, the absolute magnitude of the reported transients is significantly brighter than expected for

HOPSKOTCH

- ▶ New messaging system being built by SCIMMA (Scalable Cyberinfrastructure for Multimessenger Astrophysics) funded by the NSF - see scimma.org
- ▶ Based on Kafka – will scale to LSST era.
- ▶ Pub-sub model - only subscribe to the information you want.
- ▶ Will carry existing existing astronomical messages, e.g. GCN Circulars and Notices, Transient Name Server messages, Astronomer's Telegrams.
- ▶ Can ultimately support other types of messages, e.g. sending images, spectra, data points, observation plans, instrument availability.



- ▶ Goal is to increase machine readable information.
- ▶ Integrated with Identity and Access Management system (currently COmanage).
- ▶ **Standards problem:** How do we all agree on how to make what we send machine readable?

HERMES: Hopscotch Enabled Rapid Message Exchange Service

Hermes is a prototype of a new messaging service built on HOPSKOTCH allowing users to submit nearly any type of astronomical information, e.g. discoveries, photometric points, spectroscopy, observatory information.

There is a graphical user interface, but it is optional - users may also use the API to submit information.

The message is converted into a machine-readable JSON and published to a particular topic on HOPSKOTCH (Kafka).

HERMES [Submit New Non-localized Event](#) [Submit Candidates](#) [Submit Non-Detections](#) [Submit Search Pointings](#) [Report Photometry](#) [Report Spectroscopy](#) [Report Observatory Availability](#)

Candidate Submission Form

Title:

Topic:

Event ID:

Authors:

ID	RA	Dec	Discovery Date	Telescope	Instrument	Band	Brightness	Brightness Error	Brightness Unit	
AT2020vr	07:34:06.13	+16:46:00.51	58862.15	ztf	ztf	g	20.9	0.209	AB mag	
AT2020vs	07:24:28.50	+16:12:45.85	58862.15	ztf	ztf	g	21.4	0.214	AB mag	
AT2020vu	07:16:47.14	+10:37:18.97	58862.15	ztf	ztf	g	21.6	0.216	AB mag	
AT2020wc	07:03:22.07	+27:22:41.21	58862.16	ztf	ztf	g	20.7	0.207	AB mag	

[Add Row](#)

Upload Data to Main Table

A CSV file with the proper header can be uploaded to automatically fill the above table. Click the button below to copy this header to your clipboard.

[Copy CSV Header](#) test-hermes-candidates.csv

Additional Data Elements:

Key	Value	
email	ajct@iaa.es	

[Add Row](#)

Message:

[Edit](#) [Preview](#)

Following the detection of [AT2020vr/ZTF20aafdtyz](#), [AT2020vt/ZTF20aafemum](#), [AT2020wa/ZTF20aafedbk](#), and [AT2020wc/ZTF20aafeccu](#) (Andreoni et al. GCNC 26741) within the error area of the GW event S200114f (LVC, GCNC 26734), we obtained optical spectra covering the range 3700-7400 A with the 10.4m GTC telescope equipped with OSIRIS in La Palma (Spain) starting on Jan 15, 00:01 UT.

For [AT2020vr/ZTF20aafdtyz](#), we measure $r = 19.80 \pm 0.02$ on Jan 15, 00:08 UT. The GTC spectrum is consistent with a SN Ia at about 6 days before maximum at redshift $z = 0.213 \pm 0.001$, consistent with the redshift of the host galaxy derived from the emission lines ($z = 0.2132 \pm 0.0005$).

[Submit](#)

[Clear Form](#)

HERMES - READING

Topic (can read multiple topics simultaneously).

Message text

Selected message

The screenshot shows the HERMES web interface. At the top, there is a navigation bar with the HERMES logo and several menu items: "Submit New Non-localized Event", "Submit Candidates", "Submit Non-Detections", "Submit Search Pointings", "Report Photometry", "Report Spectroscopy", and "Report Observatory Availability". A user profile "User" is visible on the right.

Below the navigation bar, there is a pagination control showing page 1 of 27, and a "Topics" dropdown menu set to "gcn.circular".

The main content area displays a table of messages:

	◆	TIMESTAMP	◆	TITLE	◆	SUBMITTER
	1	2022/06/13		GRB 220608B: Detection by VZLUSAT-2		Jakub Ripa at Masaryk University <ripa.jakub@mail.muni.cz>
	2	2022/06/12		Swift GRB 220611A: Global MASTER-Net observations report		Vladimir Lipunov at Moscow State U/Krylov Obs <lipunov@xray.sai.msu.ru>
	3	2022/06/12		GRB 220611A: Swift-XRT refined Analysis		Phil Evans at U of Leicester <pae9@leicester.ac.uk>
	4	2022/06/12		GRB 220610B: AstroSat CZTI detection		Gaurav Waratkar at IIT,Bombay <gauravwaratkar@iitb.ac.in>
⇒	5	2022/06/11		GRB 220611A: Enhanced Swift-XRT position		Phil Evans at U of Leicester <pae9@leicester.ac.uk>
	6	2022/06/11		GRB 220611A: Swift detection of a burst		David Palmer at LANL <palmer@lanl.gov>
	7	2022/06/11		IPN triangulation of GRB 220609B		Anna Ridnaia at Ioffe Institute <ridnaia@mail.ioffe.ru>
	8	2022/06/11		Fermi GRB 220610A: Global MASTER-Net observations report		Vladimir Lipunov at Moscow State U/Krylov Obs <lipunov@xray.sai.msu.ru>
	9	2022/06/10		GRB 220610A: Fermi GBM Final Real-time Localization		Fermi GBM Team at MSFC/Fermi-GBM <do_not_reply@GIOC.nsstc.nasa.gov>
	10	2022/06/10		Fermi trigger No 676537486: Global MASTER-Net observations report		Vladimir Lipunov at Moscow State U/Krylov Obs <lipunov@xray.sai.msu.ru>

The selected message (row 5) is displayed in a detailed view on the right:

GRB 220611A: Enhanced Swift-XRT position

Phil Evans at U of Leicester <pae9@leicester.ac.uk>

M.R. Goad, J.P. Osborne, A.P. Beardmore and P.A. Evans (U. Leicester) report on behalf of the Swift-XRT team.

Using 496 s of XRT Photon Counting mode data and 1 UVOT images for GRB 220611A, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 66.51464, -37.26019 which is equivalent to:

RA (J2000): 04h 26m 3.51s
Dec (J2000): -37d 15' 36.7"

with an uncertainty of 2.4 arcsec (radius, 90% confidence).

This position may be improved as more data are received. The latest position can be viewed at http://www.swift.ac.uk/xrt_positions. Position enhancement is described by Goad et al. (2007, A&A, 476, 1401) and Evans et al. (2009, MNRAS, 397, 1177).

This circular was automatically generated, and is an official product of the Swift-XRT team.

At the bottom of the message view, there is a section for "ADDITIONAL DATA TABLE" with a "Show JSON:" button.

JSON / data



Candidate Submission Form

Add extra variables

Associate a message with a gravitational wave event.

Manually type or upload a data table.

There is built-in error checking.

Compose a text message, and refer to items in the table.

Title: Topic:

Event ID: Authors:

ID	RA	Dec	Discovery Date	Telescope	Instrument	Band	Brightness	Brightness Error	Brightness Unit	
AT2020vr	07:34:06.13	+16:46:00.51	58862.15	ztf	ztf	g	20.9	0.209	AB mag	
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Message:

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[Submit](#) [Clear Form](#)

Candidate Submission Form

Title:

AT2020vr, AT2020vt, AT2020wa and AT2020wc 10.4m GTC spectroscopy

Topic:

hermes.test

Event ID:

S200114f

Authors:

A. F. Valeev (SAO-RAS), Y.-D. Hu, A. J. Castro-Tirado and E. Fernandez-Garcia (IAA-CSIC), V. Sokolov (SAO-RAS), I. Carrasco and A. Castellon (UMA), S. B. Pandey

ID	RA	Dec	Discovery Date	Telescope	Instrument	Band	Brightness	Brightness Error	Brightness Unit	
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Add Row

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Copy CSV Header

Choose File test-hermes-candidates.csv

Additional Data Elements:

Key	Value	
email	ajct@iaa.es	
		

Add Row

HERMES

You can write a text message and refer to items in the table above with curly brackets.

For example: "We found an object at $z=\{\text{redshift}\}$ " would be interpolated as "We found an object at $z=0.213$ "

Message:

Edit

Preview

Following the detection of [AT2020vr/ZTF20aafdtyz](#), [AT2020vt/ZTF20aafemum](#), [AT2020wa/ZTF20aafedbk](#), and [AT2020wc/ZTF20aafeccu](#) (Andreoni et al. GCNC 26741) within the error area of the GW event S200114f (LVC, GCNC 26734), we obtained optical spectra covering the range 3700-7400 A with the 10.4m GTC telescope equipped with OSIRIS in La Palma (Spain) starting on Jan 15, 00:01 UT.

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Submit

Clear Form



Photometry Reporting Form

Title:

Topic:

Event ID:

Authors:

ID	Date-Obs	Telescope	Instrument	Band	Brightness	Brightness Error	Brightness Unit	
							AB mag	

Add Row

Additional Data Elements:

Key	Value

Add Row

Upload Data to Main Table

A CSV file with the proper header can be uploaded to automatically fill the above table. Click the button below to copy this header to your clipboard.

Copy CSV Header

Choose File no file selected

Message:

Edit

Preview

Enter Message. Use '{key}' to reference values in Additional Data Table.

Submit

Clear Form

TOM TRIGGERING AND COMMUNICATION

- ▶ TOM: Target & Observation Manager. For example, the Supernova Exchange.
- ▶ Organize information about a target
- ▶ Automated data reduction
- ▶ Tools for visualization
- ▶ Tools for communication, organizing follow-up data, coordinating papers.
- ▶ Directly request new data from telescopes
- ▶ HERMES will facilitate TOM-to-TOM communication

SN 2017cbv SN Ia $z = 0.003999$

14:32:34.38 -44:08:03.1
218.143250 -44.134194

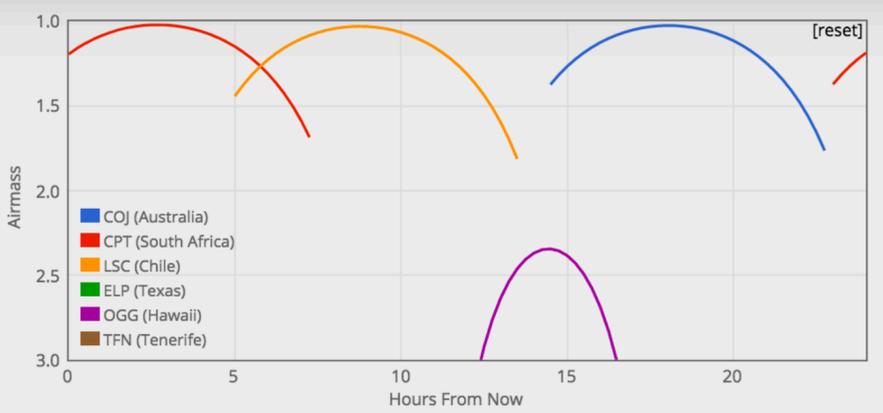


- Known as:**
AT 2017cbv
DLT17u
SN 2017cbv
- Known to:**
AMNH
ANU
ASASSN
Boulder
CfA
Chase
China
CSP
DLT40
ETH
ex-LCOGT
Gaia
iPTF
KMTNet
LBNL
LCOGT
LIGO
LSQ
OGLE
OKC
Padova
PESSTO
PS1
PTF
Public
QUB
SAAO
SDSU
Skymapper
TAU
UCB
UCB-Kasen
UPenn
UT
- Grant to all sharing groups

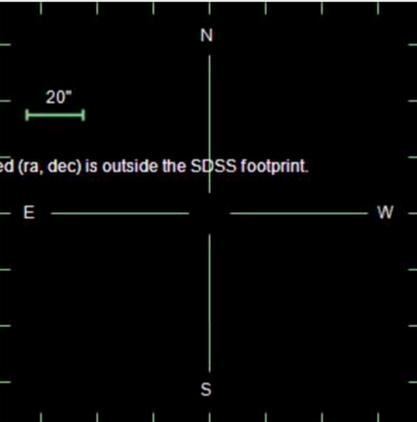
Object Comments

- Griffin** NGC 5643, D = 16.9 Mpc, $\mu = 31.14$ mag
2017-03-10 18:37:19
 - Dave** Put in for a Gemini JH spectrum
2017-03-10 19:12:30
 - Dave** Got a JH spectrum last night. Put in another one. Will try to reduce while at meeting
2017-03-12 04:03:39
 - Stefano** I modified the coordinate from 14:32:34.42 -44:08:02.8 to 14:32:34.38 -44:08:03.1
2017-03-12 05:08:27
 - Stefano** decreasing acposure time
2017-03-14 00:44:34
 - Griffin** Final photometry through 2017-04-15 sent to Dave
2017-04-16 07:20:24
- Add a comment...

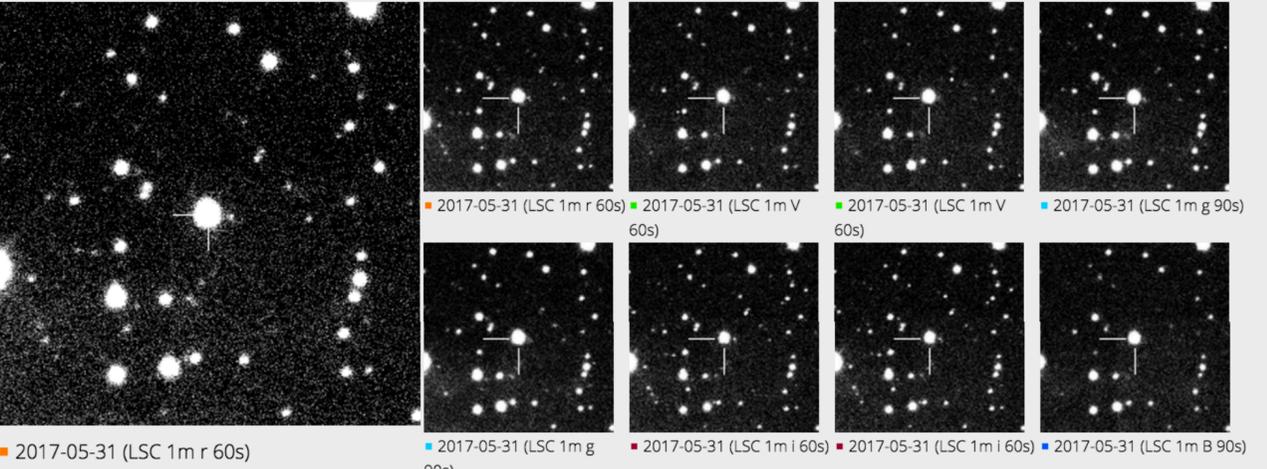
Current Visibility at LCOGT



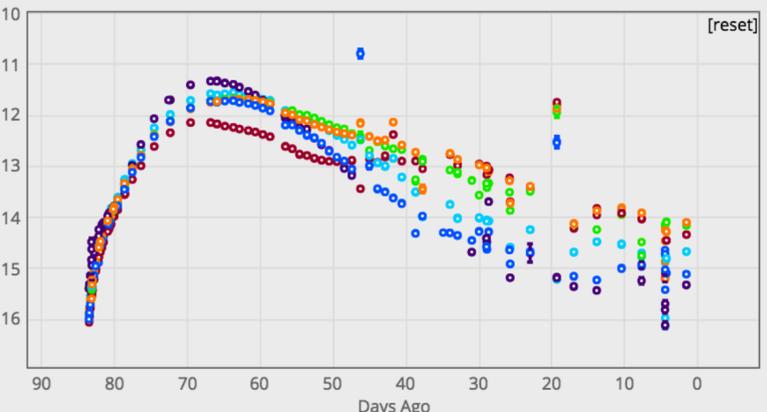
SDSS



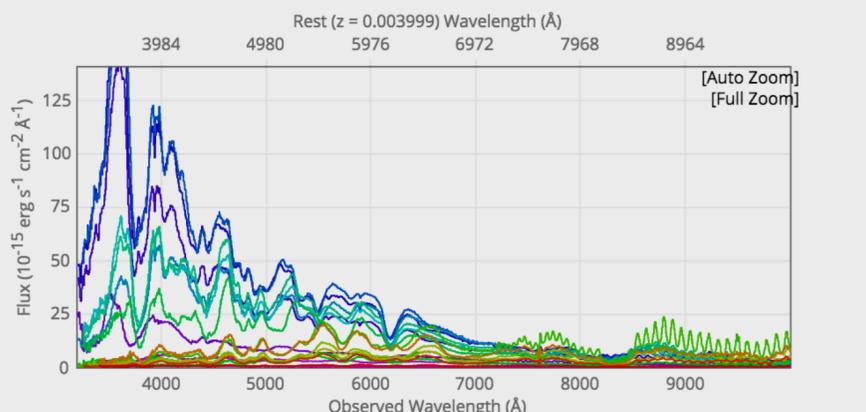
Latest LCOGT Images



Photometry



Spectroscopy (binned)



Interested Persons:

I'm interested in this object

Difference Imaging Off
 Calibration On

Science Interests:

- Classification
- Early Photometry SN
- SN Ia Nebular Sample
- Nearby SNe

PATH FORWARD

- ▶ Proof of concept is public at hermes.lco.global
- ▶ Present to the community, get community engagement and feedback
- ▶ Create working groups (open to the community), which deliver specifications
- ▶ Refine and iterate concept to have a minimum viable product by the beginning of LIGO/Virgo/Kagra O4 (December?)
- ▶ Send comments or ideas to hermes@lco.global