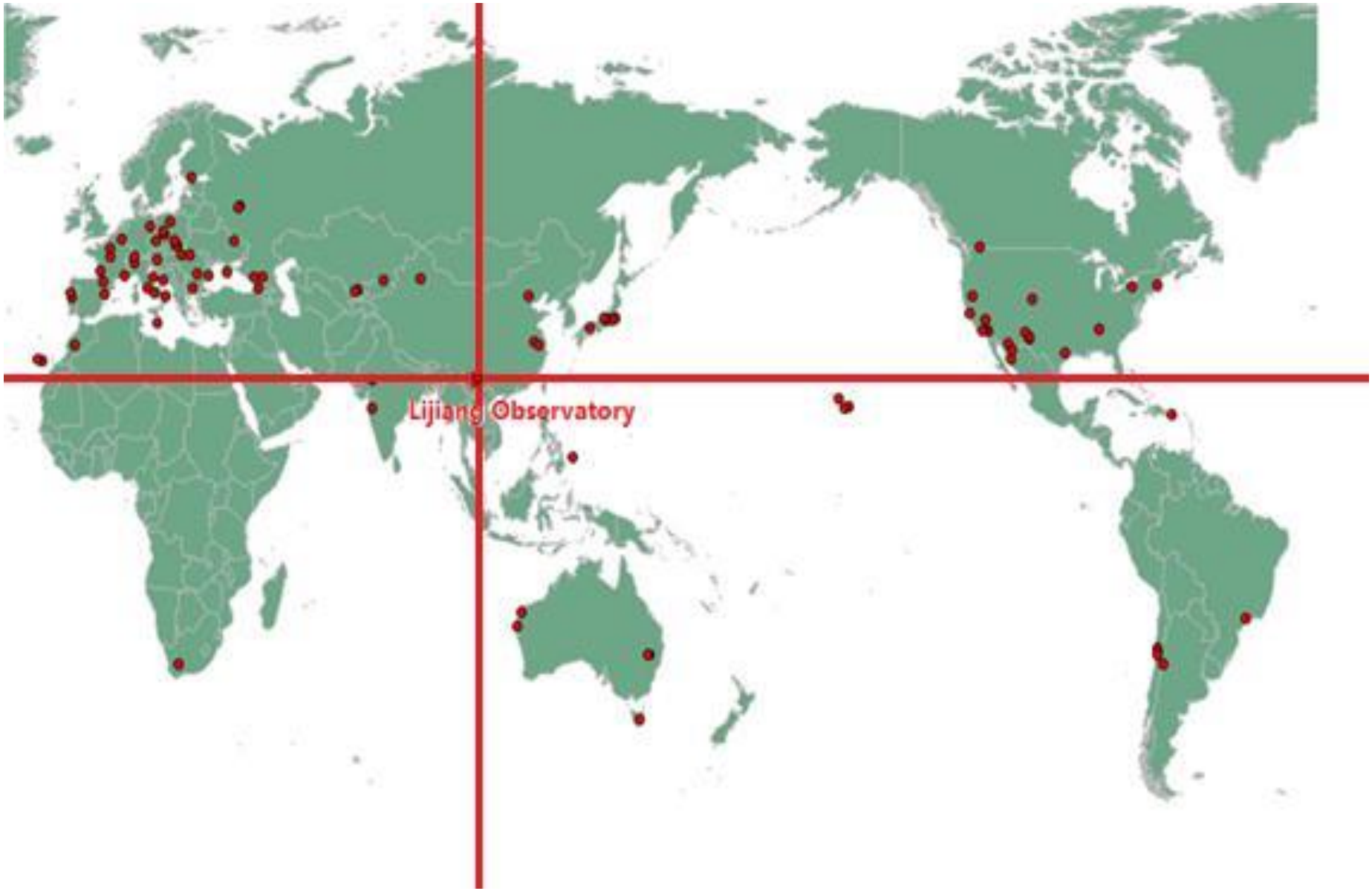
Detection of GW EM Counterparts by 2.4-m telescope @Lijiang

GECAM Meeting Nov. 1, 2020

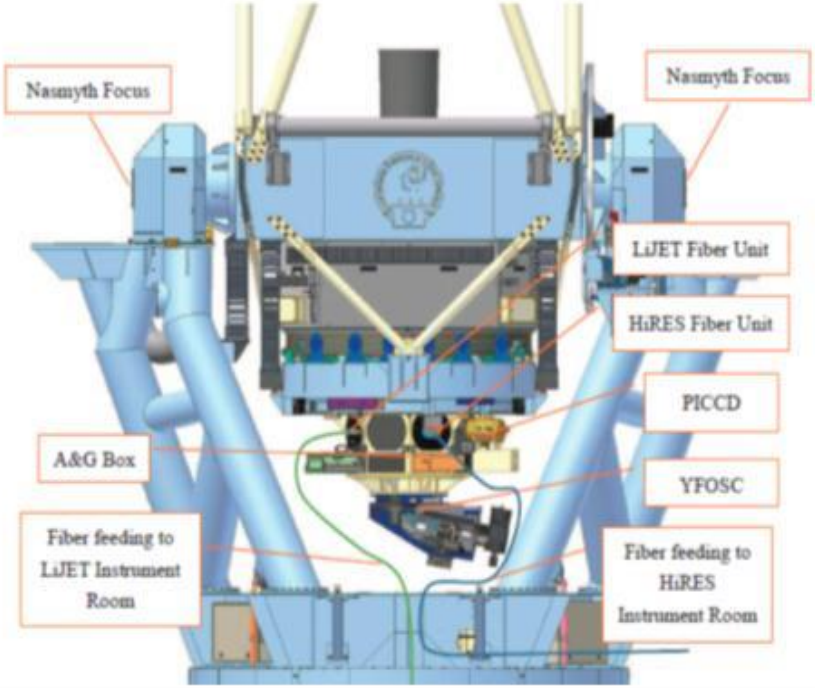
Jirong MAO

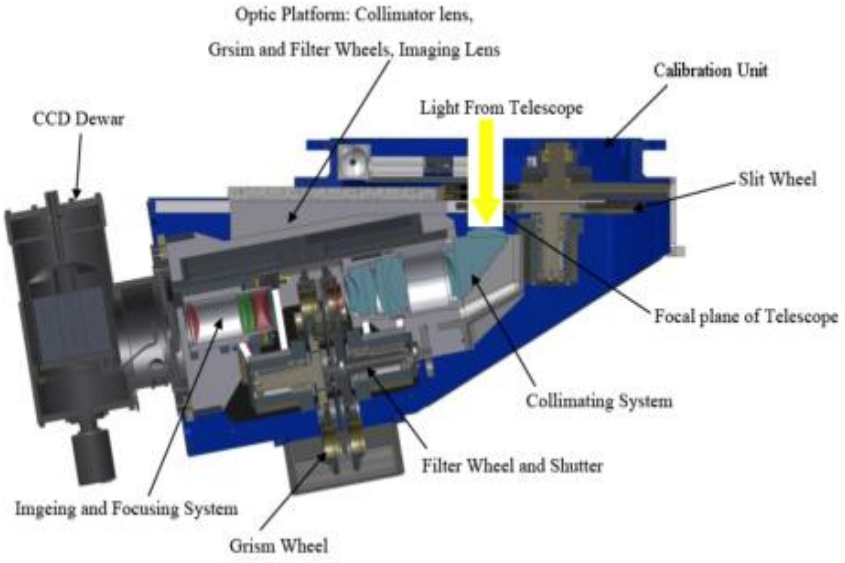
Yunnan Observatories,

Chinese Academy of Sciences


Lijiang Observatory

2.4-meter Telescope


Nasmyth Focus
Nasmyth Focus
LiJET Fiber Unit
HiRES Fiber Unit
PICCD
A&G Box
YFOSC
Fiber feeding to LiJET Instrument Room
Fiber feeding to HiRES Instrument Room


Optic Platform: Collimator lens,
Grsim and Filter Wheels, Imaging Lens
Calibration Unit
Light From Telescope
CCD Dewar
Slit Wheel
Focal plane of Telescope
Collimating System
Filter Wheel and Shutter
Imgeing and Focusing System
Grism Wheel

Parameter	Value
Pixels	2048×4608
Pixel Size	13.5um×13.5um
Image Area	27.6mm×62.2mm
Field of View	9.60'×9.60'
(Photometry)	(2K×2K)
Image Scale	0.283"/pixel
Cooling Mode	Liquid Nitrogen: -120°C
Gain	0.33e-
Readout Noise	6.3e-(Speed: 400kpixels/s)
	<5.0e-(Speed: 200kpixels/s)

	Size(um)	Sky angle(")
Long Slit	54	0.58
	74	0.8
	93	1.0
	112	1.2
	140	1.5
	168	1.8
	233	2.5
	470	5.0
	940	10.0
Short Slit	54 ×500	0.58 ×5.37
	74 ×500	0.8 ×5.37
	100 ×500	1.07 ×5.37
	140 ×500	1.5 ×5.37
	460 ×500	4.94 ×5.37
	940 ×500	10.0 ×5.37

Grism No.	λc (nm)	λBlaze (nm)	Grooves (nm/mm)	Dispersion (nm/pix)	Resolution (@600nm/pix)	Sp. Range (nm)	Order Range
12	730	700	75	1.1	545	520-980	1
10	380	390	150	0.79	760	340-900	1
3	390	430	400	0.29	2068	340-910	1
15	586	527	300	0.39	1540	410-980	1
5	650	700	300	0.46	1300	496-980	1
14	463	428	600	0.17	3520	360-746	1
8	650	700	600	0.15	4000	510-960	1
13			316	0.06	10000	340-980	3,4,5
9			79	0.06	10000	340-980	7-23

Main Technical Parameters

- Observational modes changing quickly
- Photometry magnitude:

  23-24m good observational condition
- Spectral observation:

  low/middle resolution grisms bright than 18m

  (high resolution not suitable for ToO)

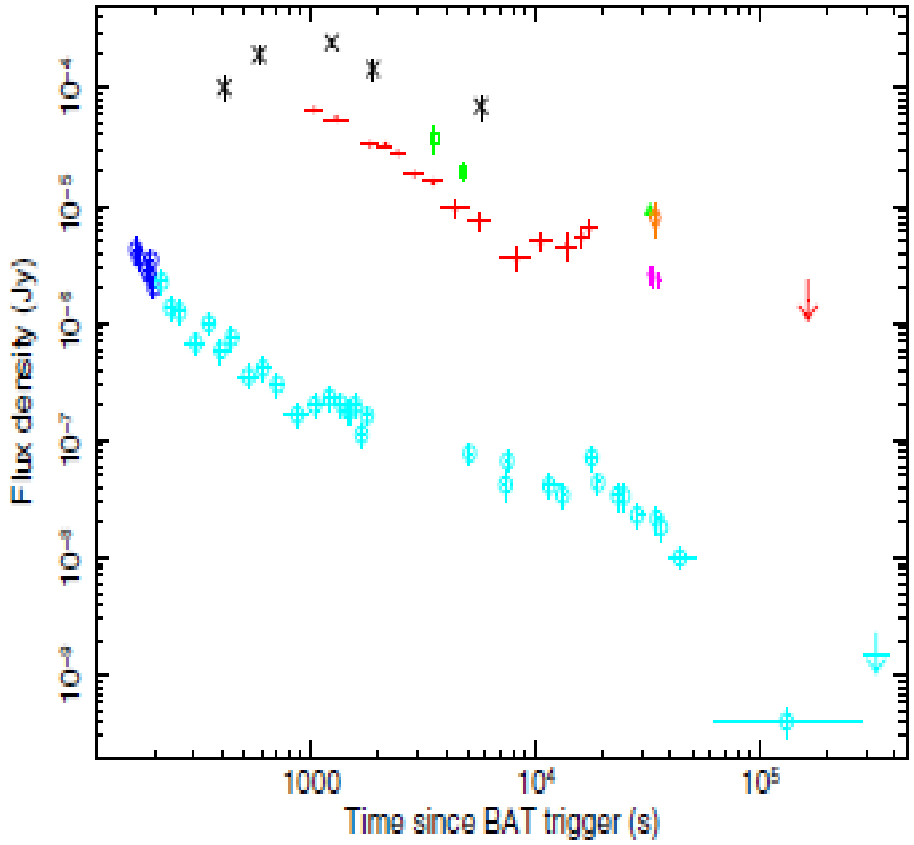
GRB(Transient) Observation

A&A 538, A1 (2012)
DOI: 10.1051/0004-6361/201117770

Astronomy & Astrophysics

Diversity of multiwavelength emission bumps in the GRB 100219A afterglow

J. Mao[1,2,3,4], D. Malesani[5], P. D'Avanzo[4], S. Covino[4], S. Li[2,3], P. Jakobsson[6], and J. M. Bai[2,3]



Achievements

- 192 Gamma-ray coordinates network(GCN)
- 9 papers on GRBs and other transients
- Full experience on transient observation

Before GW 170817

The Astrophysical Journal, 845:152 (10pp), 2017 August 20 https://doi.org/10.3847/1538-4357/aa81d2

CrossMark

A Tale of Two Transients: GW 170104 and GRB 170105A

V. Bhalerao[1], M. M. Kasliwal[2], D. Bhattacharya[3], A. Corsi[4], E. Aarthy[5], S. M. Adams[2], N. Blagorodnova[2], T. Cantwell[6], S. B. Cenko[7,8], R. Fender[9], D. Frail[10], R. Itoh[11], J. Jencson[2], N. Kawai[11], A. K. H. Kong[12,13], T. Kupfer[2], A. Kutyrev[14], J. Mao[15,16,17], S. Mate[1], N. P. S. Mithun[5], K. Mooley[9,23], D. A. Perley[18,19], Y. C. Perrott[20], R. M. Quimby[21], A. R. Rao[22], L. P. Singer[7], V. Sharma[3], D. J. Titterington[20], E. Troja[7,14], S. V. Vadawale[5], A. Vibhute[3], H. Vedantham[2], and S. Veilleux[14]

GW170817 optical spectra (SALT)

Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS 474, L71–L75 (2018)
Advance Access publication 2017 December 4

doi:10.1093/mnrasl/slx196

A comparison between SALT/SAAO observations and kilonova models for AT 2017gfo: the first electromagnetic counterpart of a gravitational wave transient – GW170817

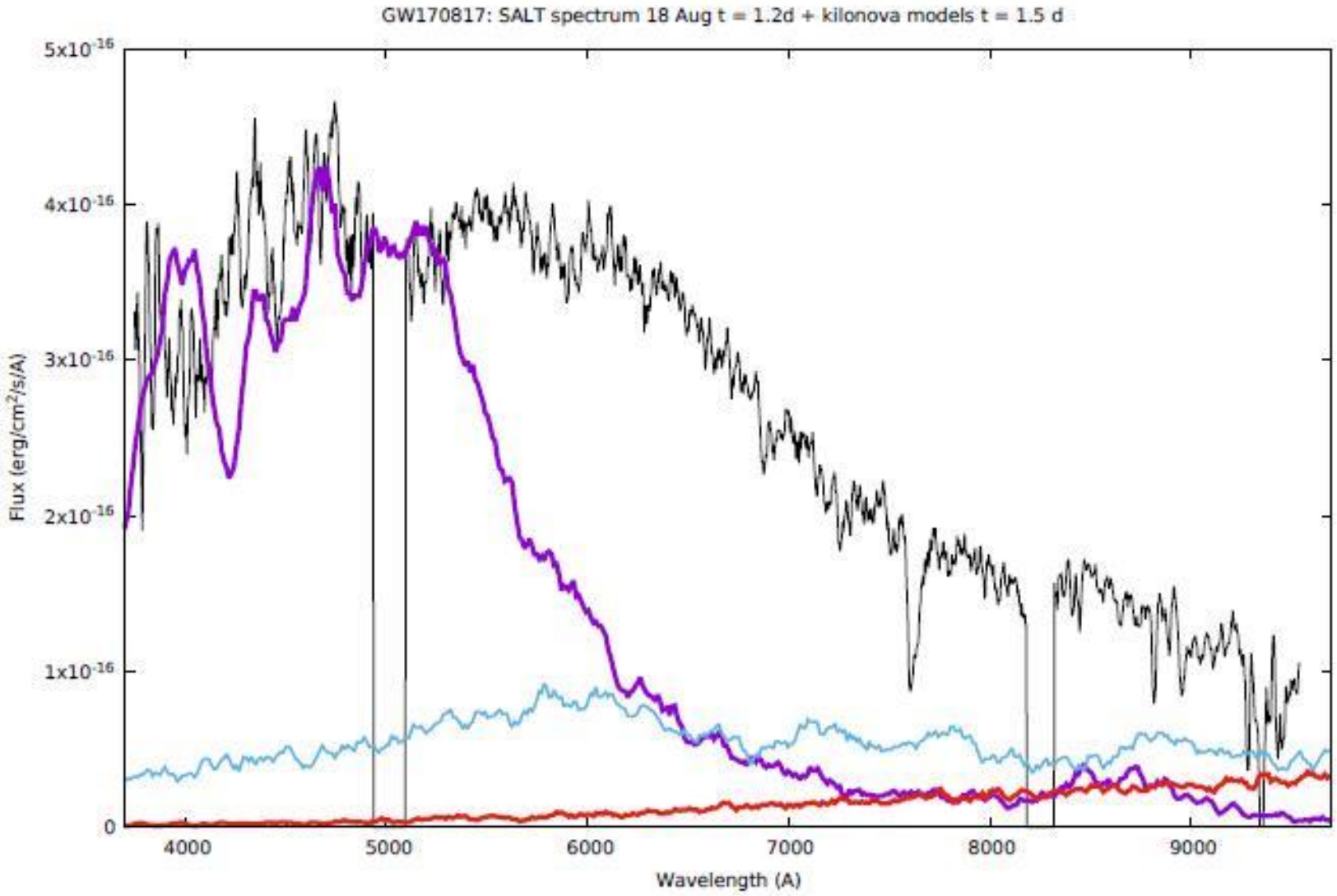
David A. H. Buckley,[1,2]★ Igor Andreoni,[3,4,5] Sudhanshu Barway,[1] Jeff Cooke,[3,4,6] Steven M. Crawford,[1,2] Evgeny Gorbovskoy,[7] Mariusz Gromadzki,[8] Vladimir Lipunov,[9,7] Jirong Mao,[10,11,12] Stephen B. Potter,[1] Magaretha L. Pretorius,[13,1] Tyler A. Pritchard,[3] Encarni Romero-Colmenero,[1,2] Michael M. Shara,[14,15] Petri Väisänen[1,2] and Ted B. Williams[1]

CrossMark

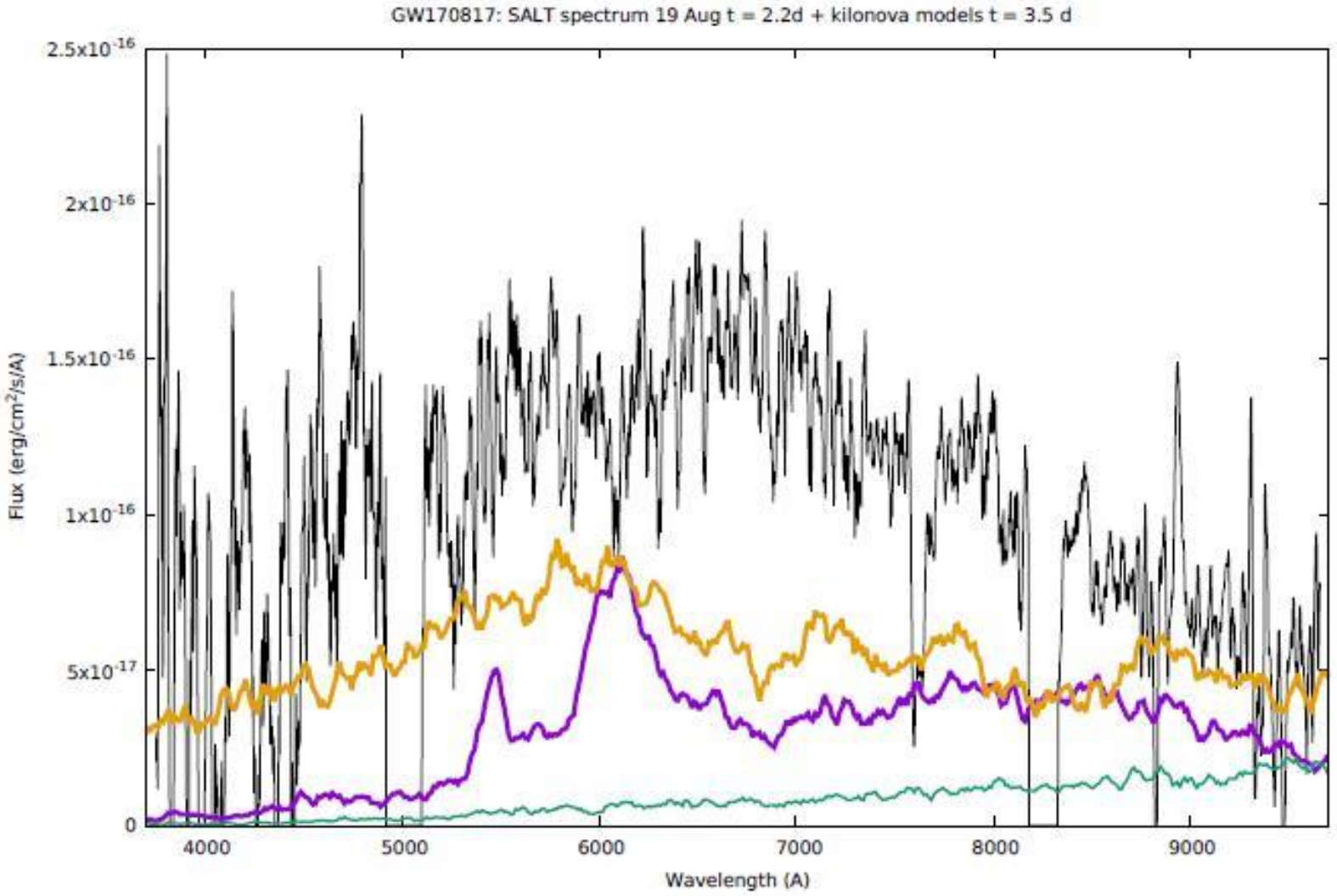
The Rapid Reddening and Featureless Optical Spectra of the Optical Counterpart of GW170817, AT 2017gfo, during the First Four Days

Curtis McCully[1,2], Daichi Hiramatsu[1,2], D. Andrew Howell[1,2], Griffin Hosseinzadeh[1,2], Iair Arcavi[1,2,19], Daniel Kasen[3,4,5], Jennifer Barnes[6,19], Michael M. Shara[7,8], Ted B. Williams[9], Petri Väisänen[9,10], Stephen B. Potter[9], Encarni Romero-Colmenero[9,10], Steven M. Crawford[9,10], David A. H. Buckley[9,10], Jeffery Cooke[11,12,13], Igor Andreoni[11,13,14], Tyler A. Pritchard[11], Jirong Mao[15,16,17], Mariusz Gromadzki[18], and Jamison Burke[1,2]

GW 170817A (blue)



GW 170817A (red)

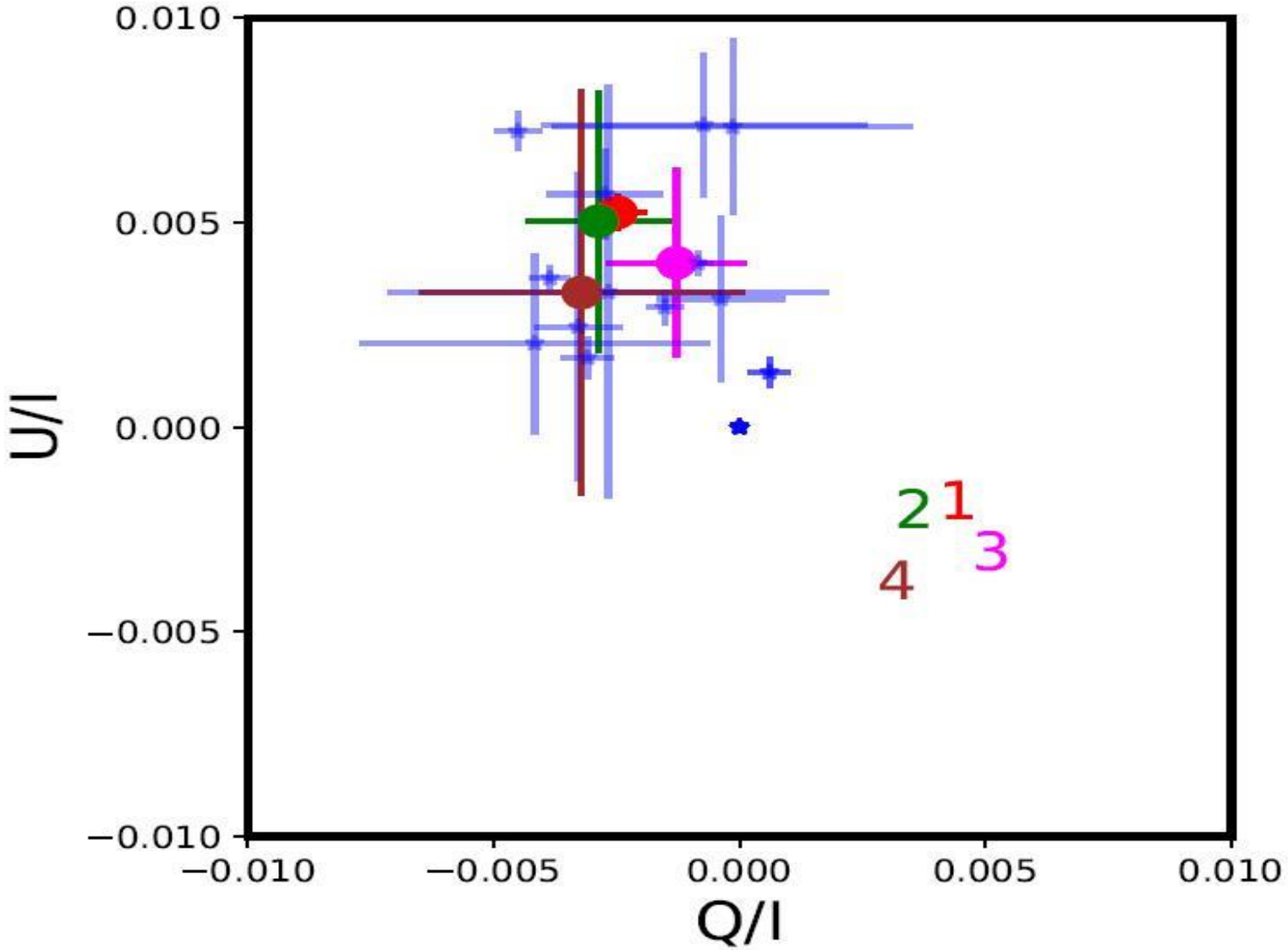


GW170817 [kilonova] optical polarization(VLT)

The unpolarized macronova associated with the gravitational wave event GW 170817

S. Covino, K. Wiersema, Y. Z. Fan, K. Toma, A. B. Higgins, A. Melandri, P. D'Avanzo, C. G. Mundell, E. Palazzi, N. R. Tanvir, M. G. Bernardini, M. Branchesi, E. Brocato, S. Campana, S. di Serego Alighieri, D. Götz, J. P. U. Fynbo, W. Gao, A. Gomboc, B. Gompertz, J. Greiner, J. Hjorth, Z. P. Jin, L. Kaper, S. Klose, S. Kobayashi, D. Kopac, C. Kouveliotou, A. J. Levan, J. Mao, D. Malesani, E. Pian, A. Rossi, R. Salvaterra, R. L. C. Starling, I. Steele, G. Tagliaferri, E. Troja, A. J. van der Horst & R. A. M. J. Wijers

Nature Astronomy **volume 1**, pages791–794 (2017)
doi:10.1038/s41550-017-0285-z


0.010
0.005
0.000
−0.005
−0.010
U/I
−0.010
−0.005
0.000
0.005
0.010
Q/I
2
1
3
4

Explanation of Low-level Linear Polarization Degree of GW170817/GRB170817A

- Thermal+nonthermal electron energy distribution
- Polarization radiative transfer

The Astrophysical Journal, 860:153 (7pp), 2018 June 20

https://doi.org/10.3847/1538-4357/aac5d9

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Synchrotron Polarization Radiative Transfer: Relativistic Thermal Electron Contribution

Jirong Mao[1,2,3], Stefano Covino[4], and Jiancheng Wang[1,2,3]

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Non-detection of GW EM counterpart in Last Run

- GW alert: GW is in huge banana regions
  distance is a few hundred Mpc to Gpc
- Many optical candidates for one GW event:
  supernova, nova, other optical transients…
- Take much observational times & manpower

Main Difficulties

- Optical surveys:

  still relatively small field-of-view

- Candidate selection criteria:

  -- host galaxies in local universe

  -- different algorithms/codes in different groups have different ranks

Domestic Cooperation

- 2-meter telescopes:

  small field-of-view follow-up of follow-up
- Some small telescopes:

  remote & quick response & large field of view
- Wide cooperation is necessary

International Cooperation

- GECAM with Fermi/AGILE/Swift-BAT/ … :

  position error in a few degree
- GECAM with Swift-XRT:

  position error in a few arcmin/arcsecond
- International optical telescopes

Theoretical Prediction Helps?

- Physical properties of NS-NS, NS-BH, & BH-BH
- GW events from BH-BH have no EM counterparts?
- And more…?

Bi-Trigger

- GECAM first alert

  Then other space/ground-based telescopes follow-up
- First alert from others

  Then GECAM can be refined (subthreshold)

Other High-energy Transients

- Gamma-ray binary, X-ray binary, AGN flaring fast radio burst, unknown of unknown
- GRB physics still not understood:

  -- some Fermi-LAT GRBs are soft

The Astrophysical Journal, 898:14 (15pp), 2020 July 20 https://doi.org/10.3847/1538-4357/ab9805

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Spectral Diversities of Gamma-Ray Bursts in High-energy Bands: Hints from Turbulent Cascade

Jirong Mao[1,2,3], Liande Li[1,2,4], and Jiancheng Wang[1,2,3]

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