# DILLON BROUT PHD

Einstein Fellow @ Harvard-Smithsonian Center for Astrophysics
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*Leading analyses of dark energy, dark matter, and the Hubble constant using Type Ia SNe for the DES, Pantheon+, DEBASS, and SH0ES teams.*

## POSITIONS

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| NASA Einstein Postdoctoral Fellow, Harvard Smithsonian CfA | *June 2020 - Current* |
| NASA Einstein Postdoctoral Fellow, University of Pennsylvania | *June 2019 - June 2020* |

## EDUCATION

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| PhD, Physics and Astronomy, University of Pennsylvania | *2019* |
| MS, Physics and Astronomy, University of Pennsylvania | *2015* |
| BS, Physics, Johns Hopkins University | *2013* |

## AWARDS

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| NASA Einstein Fellowship ($225,000) | *2019* |
| Fermilab Universities Research Fellowship ($10,000) | *2016* |
| PennApps Hackathon 3rd Place Winner | *2016* |
| Provost Undergraduate Research Award | *2012* |
| Double Degree Abrams Scholar (Jazz Saxophone @ Peabody Institute) | *2009-2013* |

## LEADERSHIP

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|---|---|
| Dark Energy Survey Supernova Program 5 Year Cosmology Project Lead | *2021* |
| Pantheon+ SNIa Cosmology Analysis Lead | *2021* |
| SH0ES Hubble Constant Analysis (SNIa rungs) Lead | *2021* |
| PI - Dark Energy Bedrock All Sky Supernovae | *2020* |
| Dark Energy Survey Supernova Program 3 Year Analysis Lead | *2019* |

## PROPOSALS ACCEPTED

**PI**: NOAO Blanco/DECam telescope time - 29 Night Long Term Program (3 year) called Dark Energy Bedrock All Sky Supernovae (DEBASS) *2020-2024*

**co-I**: NOAO Blanco/DECam telescope time - 11.5 night imaging survey called Blanco Images of the Southern Sky (BLISS) *2016-2017*

## DISCOVERIES

**Its Dust:** *Solving the Mysteries of Intrinsic Scatter and Host-galaxy Dependence of Standardized Type Ia Supernova Brightnesses.* I claim to have solved one of the mysteries of SN Ia cosmology that has persisted over the last 15 years. This has spurred an interesting discussion in the field and numerous papers have come out addressing and confirming my claim (e.g. Johansson et al. 2021)!

**Binary Neutron Star Merger**: Co-Discoverer of the very first ever BNS that was alerted by LIGO and Fermi and co-discovered optically by DECam. [*Soares Santos, ..., Brout et al. 2017*]

## TEACHING

**Introduction to Data Science and Machine Learning Bootcamp** *2019*

- Developed and taught intensive 1.5 week course of data mining and machine learning across for graduate students across all fields for a new UPenn MindCORE initiative on data science. [click here]

**Teaching Assistant** *2014-2019*

- Taught classes: Cosmology (for physics majors). TA: Data Science and Machine Learning for Large Datasets, The Big Bang and Beyond, Intro Physics Lab 101.

**Introduction to python for physics research** *2018-2020*

- Taught undergrads and incoming grad students each summer basic python and statistical fundamentals for physics research.

**Machine Learning March Madness** *2017-Current*

- Guest lecturer each year at the Duke University Physics of Sports class where I speak on machine learning prediction of the NCAA College Basketball March Madness bracket.

## ADVISING

- **Sasha Brownsberger** is Christopher Stubbs' grad student at Harvard and we are writing a paper together on H0 determination sensitivity to photometric calibration systems and the data's self calibrating ability to limit the size of systematic uncertainties.

- **Brodie Popovic** is Dan Scolnic's grad student at Duke University and we are in the process of writing a series of papers on my dust model that he is improving upon. Brodie was just awarded an LBL grad fellowship.

- **Alyssa Garcia** is Marcelle Soares Santos' grad student at the University of Michigan. She has been the driving force behind the data processing for my DEBASS program and will ultimately lead our data release and has expressed interest in leading one of our upcoming cosmological analyses.

- **Noor Amer** is an undergrad at a university in Turkey and she is an Iraqi refugee. She has been helping me with the planning/observing for my DEBASS program as well as producing a plot for my upcoming paper. She was just accepted to a year long astrophysics study abroad program in Sweden!

- **Cole Meldorf** is an undergrad at the University of Chicago. Together with Dr. Antonella Palmese we have written an in depth analysis on dust in the host galaxies for the DES5YR sample which puts my dust model to the test.

## OUTREACH

- I give twice yearly talks at the Franklin Institute lecture series and "Science After Dark" astronomy program.
- Every year give presentations and do interactive activities on the physics of car racing for underprivelaged youth through the Laboratory for Research on the Structure of Matter Penn Summer Science Initiative (contacts: Andrew McGhie and Mark Licurse).
- Co-founder of UPenn Astronomy outreach group.
- Working closely with an aspiring female astronomer living in Turkey, Noor Amer, who is an Iraqi refugee. Her goal is to go to graduate school for astrophysics and I am dedicated to helping her achieve this.
- Referee of 10+ papers for journals.

## RECENT PROFESSIONAL TALKS

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| **Jan 2021** | Contributed Talk - AAS LSST Special Session *Remote* |
| **Nov 2020** | Contributed Talk - Royal Astronomical Society *Remote* |
| **Sep 2020** | Symposium - NHFP NASA *Remote* |
| **May 2020** | Colloquium - Stockholm University *Remote* |
| **May 2020** | DES Meeting Plenary - *Remote* |
| **Mar 2020** | Invited Speaker - World Summit *Guadeloupe Islands*: "The Hubble Constant Tension Problem: An Overview" |
| **Feb 2020** | Colloquium - Brandeis Univ. *Waltham, MA* |
| **Oct 2019** | Press Event - GOOGLE *New York, NY* |
| **Oct 2019** | Workshop - KICP UChicago *Chicago, IL* |
| **July 2019** | Invited Speaker - *Santa Barbara, CA*: "The Dark Energy Survey Contribution to H0" |
| **Apr 2019** | Colloquium - CMU/Pitt Physics Seminar *Pittsburgh, PA* |
| **Mar 2019** | Workshop - Universites Paris *Paris, France* |
| **Mar 2019** | Colloquium - Service de Physique Thorique @ ULB *Brussels, Belgium* |
| **Feb 2019** | Seminar - American Museum of Natural History *New York, NY* |
| **Feb 2019** | Colloquium - Johns Hopkins/STSCi *Baltimore, MD* |
| **Dec 2018** | Invited Speaker - *Sao Paulo, Brazil*: "SN Cosmology Results from the DES and implications for LSST" at South American Workshop on Cosmology in the LSST Era |
| **May 2018** | Invited Speaker (2 Talks) - *Tucson, AZ*: DECam Community Science Workshop<br>Talk #1: "DES-SN Program, Cosmology Results, and Public Data Release."<br>Talk #2: "DES-GW Program and The Future of GW Cosmology." |
| **May 2018** | DES Meeting Plenary - *College Station, TX*: "Preliminary Cosmology Results from the DES-SN3YR" |
| **Apr 2018** | APS - *Columbus, OH*: "Preliminary Cosmology Results from DES-SN3YR" |
| **Feb 2018** | Invited Speaker - *Fermilab*: "Preliminary Cosmology Results from DES-SN3YR" at FNAL Joint Experimental-Theoretical Physics Seminar ("Wine and Cheese") |
| **Jan 2018** | AAS #231 - *Washington, DC*: "Cosmology Results from DES-SN First 3 Years" |
| **Nov 2017** | DES Meeting Plenary - *Brisbane, AU*: "3YR Cosmology Update" |
| **Dec 2016** | DES Meeting Plenary - *Cambridge, UK*: "The SN Photometric Pipeline" |

## LEAD AUTHOR PUBLICATIONS

1. **Brout, D.**, Hinton, S., & Scolnic, D, *"Binning is Sinning; Supernova Edition"*, 2021

2. Popovic, B., **Brout, D.,**, *et al., "Improved Treatment of Host-Galaxy Correlations in Cosmological Analyses With Type Ia Supernovae", 2021*
**- Advised Brodie on all aspects of the analysis.**

3. **Brout, D.** & Scolnic, D., *"It's Dust: Solving the Mysteries of Intrinsic Scatter and Host-galaxy Dependence of Standardized Type Ia Supernova Brightnesses", 2020*

4. Hinton, S. & **Brout, D.**, *"Pippin: A pipeline for supernova cosmology", 2020*
**- Developed cosmology analysis portion and current maintainer of the codebase.**

5. Dhawan, S., **Brout, D.**, *et al. "Cosmological Model Insensitivity of Local $H_0$ from the Cepheid Distance Ladder", 2020*
**- Led half of paper regarding first ever concurrent assessment of SNIa covariant systematics for cepheid calibrators and Hubble flow simultaneously.**

6. **Brout, D.**,*et al.*, *"First Cosmology Results using Type Ia Supernovae from the Dark Energy Survey: Analysis, Systematic Uncertainties, and Validation"*, arXiv:1811.02377 , (2018)

7. **Brout, D.**,*et al.*, *"First Cosmology Results using Type Ia Supernovae from the Dark Energy Survey: Photometric Pipeline and Light Curve Data Release"*, arXiv:1811.02378, (2018)

8. DES Collaboration *et al.*, *"First Cosmology Results using Type Ia Supernovae from the Dark Energy Survey: Constraints on Cosmological Parameters"*, arXiv:1811.02374, (2018), FERMILAB-PUB-18-590-AE
**- Alphabetical author list and no corresponding author. I was the single largest contributor to the paper. Produced all results, tables, plots and majority of text.**

9. Guidorzi, G., Marguitti, R., **Brout, D.**, *et al.*, *"Improved Constraints on $H_0$ from a Combined Analysis of Gravitational-wave and Electromagnetic Emission from GW170817 "*, ApJ, **851** (2017) no.2, L36
**- Produced cosmological constraints and analyzed systematic errors. Facilitated discovery of counterpart.**

## SIGNIFICANT CONTRIBUTION PUBLICATIONS

10. Taylor, G., ..., **Brout, D.** *et al.*, *"A Revised SALT2 Surface for Fitting Type Ia Supernova Light Curves"*, arXiv:1811.02375, (2018)
**- Provided and advised on cosmology analsis pipeline portion of the analysis.**

11. Herner, K., Annis, J., **Brout, D.** *et al.*, *"Optical follow-up of gravitational wave triggers with DECam during the first two LIGO/VIRGO observing runs"*, Astron. Comput. **33**, 100425 doi:10.1016/j.ascom.2020.100425 (2020)
**- Developed alerts pipeline and optimized observing strategy.**

12. DES Collaboration *et al.*, *"Cosmological Constraints from Multiple Probes in the The Dark Energy Survey"*, arXiv:1811.02375, (2018)

**- Provided SN distances and likelihood. Alphabetical paper.**

13. Kessler, R., **Brout, D.**, *et al.*, *"First Cosmology Results using Type Ia Supernovae from the Dark Energy Survey: Simulations to Correct Supernova Distance Biases"*, arXiv:1811.02379, (2018)

**- Ran photometry on 10,000 fakes to compute corrections applied to the DES simulated fluxes. Made Figures 2 & 3.**

14. Scolnic, D., Kessler, R., **Brout, D.**, *et al.*, *"How Many Kilonovae Can Be Found in Past, Present, and Future Survey Data Sets?"*, ApJ, **852** (2017) no.1, L3

**- Implemented the kilonova model and ran extensive simulations.**

15. Soares-Santos, M., Holz, D., ..., **Brout, D.**, *et al.*, *"The electromagnetic counterpart of the binary neutron star merger LIGO/VIRGO GW170817. I. Discovery of the optical counterpart using the dark energy camera"*, ApJ, **848** (2017) no.2, L16

**- Wrote the DES-GW follow-up strategy pipeline. Designed the database, webpage, and alert system for real-time monitoring of LIGO events. Integrated the strategy/analysis with the data reduction pipeline.**

16. Doctor, Z., Kessler, R., ..., **Brout, D.**, *et al.*, *"A Search for Optical Emission from Binary-Black-Hole Merger GW170814 with the Dark Energy Camera"*, in prep (2018), DES-2018-0335, PUB-18-601-PPD.

**- Made Figure 1 and optimized image search strategy.**

17. Macaulay, E., Nichol, R. C., Bacon, D., **Brout, D.**, *et al.*, *"First Cosmology Results using Type Ia Supernovae from the Dark Energy Survey: Measurement of the Hubble Constant"*, arXiv:1811.02376.

**- Did full derivation of SN distances and systematic uncertainties for $H_0$ measurement.**

18. Bernardinelli, P., Bernstein, G., ... , **Brout, D.**, *et al.*, *"Trans-Neptunian objects found in the first four years of the Dark Energy Survey"*, arXiv:1909.01478.

**- Built forced photometric pipeline.**

## OTHER PUBLICATIONS

C. D. Kilpatrick *et al.* [Gravity Collective], [arXiv:2106.06897 [astro-ph.HE]].

B. M. Rose, G. Aldering, M. Dai, S. Deustua, R. J. Foley, E. Gangler, P. Gris, I. M. Hook, R. Kessler and G. Narayan, *et al.* [arXiv:2104.01199 [astro-ph.CO]].

G. T. 1, C. Lidman, B. E. Tucker, D. Brout, S. R. Hinton and R. Kessler, Mon. Not. Roy. Astron. Soc. **504** (2021) no.3, 4111-4122 doi:10.1093/mnras/stab962 [arXiv:2104.00172 [astro-ph.CO]].

M. Vincenzi *et al.* [DES], Mon. Not. Roy. Astron. Soc. **505** (2021) no.2, 2819-2839 doi:10.1093/mnras/stab1353 [arXiv:2012.07180 [astro-ph.CO]].

I. Sevilla-Noarbe *et al.* [DES], Astrophys. J. Suppl. **254** (2021) no.2, 24 doi:10.3847/1538-4365/abeb66 [arXiv:2011.03407 [astro-ph.CO]].

J. Muir *et al.* [DES], Phys. Rev. D **103** (2021) no.2, 023528 doi:10.1103/PhysRevD.103.023528 [arXiv:2010.05924 [astro-ph.CO]].

L. Kelsey *et al.* [DES], Mon. Not. Roy. Astron. Soc. **501** (2021) no.4, 4861-4876 doi:10.1093/mnras/staa3924 [arXiv:2008.12101 [astro-ph.CO]].

A. Garcia *et al.* [DES], Astrophys. J. **903** (2020) no.1, 75 doi:10.3847/1538-4357/abb823 [arXiv:2007.00050 [astro-ph.HE]].

R. Morgan *et al.* [DES], Astrophys. J. **901** (2020) no.1, 83 doi:10.3847/1538-4357/abafaa [arXiv:2006.07385 [astro-ph.HE]].

C. Lidman *et al.* [DES], Mon. Not. Roy. Astron. Soc. **496** (2020) no.1, 19-35 doi:10.1093/mnras/staa1341 [arXiv:2006.00449 [astro-ph.CO]].

T. de Jaeger *et al.* [DES], doi:10.1093/mnras/staa1402 [arXiv:2005.09757 [astro-ph.HE]].

C. Inserra *et al.* [DES], Mon. Not. Roy. Astron. Soc. **504** (2021) no.2, 2535-2549 doi:10.1093/mnras/stab978 [arXiv:2004.12218 [astro-ph.CO]].

E. Macaulay *et al.* [DES], Mon. Not. Roy. Astron. Soc. **496** (2020) no.3, 4051-4059 doi:10.1093/mnras/staa1852 [arXiv:2007.07956 [astro-ph.CO]].

T. M. C. Abbott *et al.* [DES], Phys. Rev. D **102** (2020) no.2, 023509 doi:10.1103/PhysRevD.102.023509 [arXiv:2002.11124 [astro-ph.CO]].

D. Scolnic *et al.* [DES], Astrophys. J. Lett. **896** (2020) no.1, L13 doi:10.3847/2041-8213/ab8735 [arXiv:2002.00974 [astro-ph.GA]].

M. Smith *et al.* [DES], Mon. Not. Roy. Astron. Soc. **494** (2020) no.3, 4426-4447 doi:10.1093/mnras/staa946 [arXiv:2001.11294 [astro-ph.CO]].

P. Wiseman *et al.* [DES], Mon. Not. Roy. Astron. Soc. **495** (2020) no.4, 4040-4060 doi:10.1093/mnras/staa1302 [arXiv:2001.02640 [astro-ph.GA]].

K. R. Herner *et al.* [DUNE], EPJ Web Conf. **245** (2020), 01008 doi:10.1051/epjconf/202024501008

D. Brout,

M. Pursiainen *et al.* [DES], Mon. Not. Roy. Astron. Soc. **494** (2020) no.4, 5576-5589 doi:10.1093/mnras/staa995 [arXiv:1911.12083 [astro-ph.HE]].

A. J. Shajib *et al.* [DES], Mon. Not. Roy. Astron. Soc. **494** (2020) no.4, 6072-6102 doi:10.1093/mnras/staa828 [arXiv:1910.06306 [astro-ph.CO]].

P. H. Bernardinelli *et al.* [DES], Astrophys. J. Suppl. **247** (2020) no.1, 32 doi:10.3847/1538-4365/ab6bd8 [arXiv:1909.01478 [astro-ph.EP]].

R. Morgan *et al.* [DES], Astrophys. J. **883** (2019), 125 doi:10.3847/1538-4357/ab3a45 [arXiv:1907.07193 [astro-ph.HE]].

D. Scolnic, S. Perlmutter, G. Aldering, D. Brout, T. Davis, A. Filippenko, R. Foley, R. Hložek, R. Hounsell and S. Jha, *et al.* [arXiv:1903.05128 [astro-ph.CO]].

M. Soares-Santos *et al.* [DES, LIGO Scientific and Virgo], Astrophys. J. Lett. **876** (2019) no.1, L7 doi:10.3847/2041-8213/ab14f1 [arXiv:1901.01540 [astro-ph.CO]].

Z. Doctor *et al.* [DES], Astrophys. J. Lett. **873** (2019) no.2, L24 doi:10.3847/2041-8213/ab08a3 [arXiv:1812.01579 [astro-ph.HE]].

C. B. D'Andrea *et al.* [DES], Astron. J. **160** (2020) no.6, 267 doi:10.3847/1538-3881/abc01b [arXiv:1811.09565 [astro-ph.CO]].

D. Brout *et al.* [DES], Astrophys. J. **874** (2019), 150 doi:10.3847/1538-4357/ab08a0 [arXiv:1811.02377 [astro-ph.CO]].

E. Macaulay *et al.* [DES], Mon. Not. Roy. Astron. Soc. **486** (2019) no.2, 2184-2196 doi:10.1093/mnras/stz978 [arXiv:1811.02376 [astro-ph.CO]].

S. R. Hinton *et al.* [DES], Astrophys. J. **876** (2019) no.1, 15 doi:10.3847/1538-4357/ab13a3 [arXiv:1811.02381 [astro-ph.CO]].

J. Lasker *et al.* [DES], Mon. Not. Roy. Astron. Soc. **485** (2019) no.4, 5329-5344 doi:10.1093/mnras/stz619 [arXiv:1811.02380 [astro-ph.CO]].

D. Brout *et al.* [DES], Astrophys. J. **874** (2019) no.1, 106 doi:10.3847/1538-4357/ab06c1 [arXiv:1811.02378 [astro-ph.IM]].

R. Kessler *et al.* [DES], Mon. Not. Roy. Astron. Soc. **485** (2019), 1171 doi:10.1093/mnras/stz463 [arXiv:1811.02379 [astro-ph.CO]].

T. M. C. Abbott *et al.* [DES], Phys. Rev. Lett. **122** (2019) no.17, 171301 doi:10.1103/PhysRevLett.122.171301 [arXiv:1811.02375 [astro-ph.CO]].

T. M. C. Abbott *et al.* [DES], Astrophys. J. Lett. **872** (2019) no.2, L30 doi:10.3847/2041-8213/ab04fa [arXiv:1811.02374 [astro-ph.CO]].

T. M. C. Abbott *et al.* [DES], Phys. Rev. D **99** (2019) no.12, 123505 doi:10.1103/PhysRevD.99.123505 [arXiv:1810.02499 [astro-ph.CO]].

H. T. Diehl *et al.* [DES], Proc. SPIE Int. Soc. Opt. Eng. **10704** (2018), 107040D doi:10.1117/12.2312113

M. C. March, R. C. Wolf, m. Sako, C. D'Andrea and D. Brout, [arXiv:1804.02474 [astro-ph.CO]].

T. M. C. Abbott *et al.* [DES and NOAO Data Lab], Astrophys. J. Suppl. **239** (2018) no.2, 18 doi:10.3847/1538-4365/aae9f0 [arXiv:1801.03181 [astro-ph.IM]].

K. Herner, J. Annis, E. Berger, D. Brout, R. Butler, H. Chen, P. Cowperthwaite, H. Diehl, Z. Doctor and A. Drlica-Wagner, *et al.* J. Phys. Conf. Ser. **898** (2017) no.3, 032050 doi:10.1088/1742-6596/898/3/032050

A. Palmese, W. Hartley, F. Tarsitano, C. Conselice, O. Lahav, S. Allam, J. Annis, H. Lin, M. Soares-Santos and D. Tucker, *et al.* Astrophys. J. Lett. **849** (2017) no.2, L34 doi:10.3847/2041-8213/aa9660 [arXiv:1710.06748 [astro-ph.HE]].

C. Guidorzi, R. Margutti, D. Brout, D. Scolnic, W. Fong, K. D. Alexander, P. S. Cowperthwaite, J. Annis, E. Berger and P. K. Blanchard, *et al.* Astrophys. J. Lett. **851** (2017) no.2, L36 doi:10.3847/2041-8213/aaa009 [arXiv:1710.06426 [astro-ph.CO]].

M. Nicholl, E. Berger, D. Kasen, B. D. Metzger, J. Elias, C. Briceño, K. D. Alexander, P. K. Blanchard, R. Chornock and P. S. Cowperthwaite, *et al.* Astrophys. J. Lett. **848** (2017) no.2, L18 doi:10.3847/2041-8213/aa9029 [arXiv:1710.05456 [astro-ph.HE]].

R. Chornock, E. Berger, D. Kasen, P. S. Cowperthwaite, M. Nicholl, V. A. Villar, K. D. Alexander, P. K. Blanchard, T. Eftekhari and W. Fong, *et al.* Astrophys. J. Lett. **848** (2017) no.2, L19 doi:10.3847/2041-8213/aa905c [arXiv:1710.05454 [astro-ph.HE]].

M. Soares-Santos *et al.* [DES and Dark Energy Camera GW-EM], Astrophys. J. Lett. **848** (2017) no.2, L16 doi:10.3847/2041-8213/aa9059 [arXiv:1710.05459 [astro-ph.HE]].

P. K. Blanchard, E. Berger, W. Fong, M. Nicholl, J. Leja, C. Conroy, K. D. Alexander, R. Margutti, P. K. G. Williams and Z. Doctor, *et al.* Astrophys. J. Lett. **848** (2017) no.2, L22 doi:10.3847/2041-8213/aa9055 [arXiv:1710.05458 [astro-ph.HE]].

B. P. Abbott *et al.* [LIGO Scientific, Virgo, 1M2H, Dark Energy Camera GW-E, DES, DLT40, Las Cumbres Observatory, VINROUGE and MASTER], Nature **551** (2017) no.7678, 85-88 doi:10.1038/nature24471 [arXiv:1710.05835 [astro-ph.CO]].

W. Fong, E. Berger, P. K. Blanchard, R. Margutti, P. S. Cowperthwaite, R. Chornock, K. D. Alexander, B. D. Metzger, V. A. Villar and M. Nicholl, *et al.* Astrophys. J. Lett. **848** (2017) no.2, L23 doi:10.3847/2041-8213/aa9018 [arXiv:1710.05438 [astro-ph.HE]].

B. P. Abbott *et al.* [LIGO Scientific, Virgo, Fermi GBM, INTEGRAL, IceCube, AstroSat Cadmium Zinc Telluride Imager Team, IPN, Insight-Hxmt, ANTARES, Swift, AGILE Team, 1M2H Team, Dark Energy Camera GW-EM, DES, DLT40, GRAWITA, Fermi-LAT, ATCA, ASKAP, Las Cumbres Observatory Group, OzGrav, DWF (Deeper Wider Faster Program), AST3, CAASTRO, VINROUGE, MASTER, J-GEM, GROWTH, JAGWAR, CaltechNRAO, TTU-NRAO, NuSTAR, Pan-STARRS, MAXI Team, TZAC Consortium, KU, Nordic Optical Telescope, ePESSTO, GROND, Texas Tech University, SALT Group, TOROS, BOOTES, MWA, CALET, IKI-GW Follow-up, H.E.S.S., LOFAR, LWA, HAWC, Pierre Auger, ALMA, Euro VLBI Team, Pi of Sky, Chandra Team at McGill University, DFN, ATLAS Telescopes, High Time Resolution Universe Survey, RIMAS, RATIR and SKA South Africa/MeerKAT], Astrophys. J. Lett. **848** (2017) no.2, L12 doi:10.3847/2041-8213/aa91c9 [arXiv:1710.05833 [astro-ph.HE]].

P. S. Cowperthwaite, E. Berger, V. A. Villar, B. D. Metzger, M. Nicholl, R. Chornock, P. K. Blanchard, W. Fong, R. Margutti and M. Soares-Santos, *et al.* Astrophys. J. Lett. **848** (2017) no.2, L17 doi:10.3847/2041-8213/aa8fc7 [arXiv:1710.05840 [astro-ph.HE]].

K. D. Alexander, E. Berger, W. Fong, P. K. G. Williams, C. Guidorzi, R. Margutti, B. D. Metzger, J. Annis, P. K. Blanchard and D. Brout, *et al.* Astrophys. J. Lett. **848** (2017) no.2, L21 doi:10.3847/2041-8213/aa905d [arXiv:1710.05457 [astro-ph.HE]].

D. Scolnic *et al.* [DES], Astrophys. J. Lett. **852** (2018) no.1, L3 doi:10.3847/2041-8213/aa9d82 [arXiv:1710.05845 [astro-ph.IM]].

D. M. Scolnic, D. O. Jones, A. Rest, Y. C. Pan, R. Chornock, R. J. Foley, M. E. Huber, R. Kessler, G. Narayan and A. G. Riess, *et al.* Astrophys. J. **859** (2018) no.2, 101 doi:10.3847/1538-4357/aab9bb [arXiv:1710.00845 [astro-ph.CO]].

T. M. C. Abbott *et al.* [DES], Phys. Rev. D **98** (2018) no.4, 043526 doi:10.1103/PhysRevD.98.043526 [arXiv:1708.01530 [astro-ph.CO]].

P. S. Cowperthwaite *et al.* [DES], Astrophys. J. Lett. **826** (2016), L29 doi:10.3847/2041-8205/826/2/L29 [arXiv:1606.04538 [astro-ph.HE]].

B. P. Abbott *et al.* [LIGO Scientific, Virgo, ASKAP, BOOTES, DES, Fermi-GBM, Fermi-LAT, GRAWITA, INTEGRAL, iPTF, InterPlanetary Network, J-GEM, La Silla-QUEST Survey, Liverpool Telescope, LOFAR, MASTER, MAXI, MWA, Pan-STARRS, PESSTO, Pi of the Sky, SkyMapper, Swift, TAROT, Zadko, Algerian National Observatory, C2PU, TOROS and VISTA], Astrophys. J. Suppl. **225** (2016) no.1, 8 doi:10.3847/0067-0049/225/1/8 [arXiv:1604.07864 [astro-ph.HE]].

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