Gautham Narayan

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RESEARCH INTERESTS

- Observational Cosmology and Cosmography
- Time-domain Astrophysics, particularly Transient Phenomena
- Wide-field Ultraviolet, Optical and Infrared Surveys
- Multi-messenger Astrophysics & Rapid Follow-up Studies
- Statistics, Data Science and Machine Learning

PROFESSIONAL APPOINTMENTS

Current:	Assistant Professor, University of Illinois at Urbana-Champaign Aug 2019–present
Previous:	Lasker Data Science Fellow, Space Telescope Science Institute Jun 2017–Aug 2019
	Postdoctoral Fellow, National Optical Astronomy Observatory (now NOIRLab) Jul 2013–Jun 2017[1]

EDUCATION

Harvard University	Ph.D. Physics, May 2013 Thesis: "Light Curves of Type Ia Supernovae and Cosmological Constraints from the ESSENCE Survey" Adviser: Prof. Christopher W. Stubbs A.M. Physics, May 2007
Illinois Wesleyan University	B.S. (Hons) Physics, Summa Cum Laude, May 2005 Thesis: "Photometry of Outer-belt Objects" Adviser: Prof. Linda M. French

AWARDS AND GRANTS

- List of Instructors rated Excellent, Spring 2020
- NASA ADAP "The Stars Like Dust: Building an All-Sky Photometric Reference", USD 334,711, 2020–present
- LSST Enabling Science Award, USD 27,000, 2020–present
- 2nd ever recipient of the Barry M. Lasker Data Science Fellowship, STScI, 2017–9
- Co-I on several *Hubble Space Telescope* programs with grants totaling over USD 1M, 2012–present
- Co-I, grant for developing ANTARES broker, Heising-Simons Foundation, USD 567,000, 2018
- STScI Director's Discretionary Funding for student research, USD 2500, 2017–9
- LSST Cadence Hackathon, USD 1400, 2018
- Best-in-Show, Art of Planetary Science, Lunar and Planetary Laboratory, U. Arizona, 2015
- Purcell Fellowship, Harvard University, 2005
- Research Honors, Summa Cum Laude, Member of ΦBK, $\Phi K\Phi$, IWU, 2005

[1] Formally employed by The University of Arizona CS Dept. from Dec 2014–Apr 2016, but located at NOAO

RESEARCH HISTORY AND SELECTED PUBLICATIONS

I work at the intersection of cosmology, astrophysics, and data science. Below are brief descriptions of my work on key topics, together with a related publication (full list of publications is at end).

Machine Learning for Time-Domain Discovery

- Lead developer of machine-learning algorithms for time-series classification on state-of-the-art alert broker system: ANTARES
- Presently testing ANTARES on Zwicky Transient Facility (ZTF) alerts as test bed for Legacy Survey of Space and Time (LSST)
- Lead for Photometric LSST Astronomical Time-Series Classification Challenge v2. (v1) remains the largest simulation of of the entire time-domain sky for statistical studies, and the largest Kaggle challenge in Astronomy.

Narayan et al., '18, "Machine-learning-based Brokers for Real-time Classification of the LSST Alert Stream", ApJS Special Issue "Data: Insights and Challenges in a Time of Abundance"

Understanding the Physics of Rare and Unusual Transients

- Led or made major contributions to several projects studying unusual SN, including SN 2020oi, SN 2018oh, SN 2009ku, SN 2008ha, as well as open-source tools to model such events
- Combining work on machine learning with interest in rare & unusual transients by developing novel methods for anomaly detection, incorporating gravitational wave, neutrino and high-energy gamma ray signals into alert-brokers.

Narayan et al., '11, "Displaying the Heterogeneity of the SN 2002cx-like Subclass of Type Ia Supernovae with Observations of the Pan-STARRS-1 Discovered SN 2009ku", ApJL

Cosmology and the Nature of Dark Energy

- **Deputy Analysis Coordinator**, LSST Dark Energy Science Collaboration (DESC)
- Led analysis using ESSENCE and literature SNIa to derive cosmological constraints on dark energy equation of state w; co-authored analysis on PS1 SNIa Foundation photometric SNIa
- Co-developed BayeSN with K. Mandel — probabilistic model to infer distance moduli, light curve, and dust properties from UV+Optical+NIR data of low-z SNIa; currently evolving into model for SNIa SED inference at cosmological distances for *NGRST*, future surveys
- Leading analysis apply BayeSN-SED to combined Foundation, Pan-STARRS & literature samples — will be the largest dataset of confirmed cosmological SNIa

Narayan et al., '16, "Light Curves of 213 Type Ia Supernovae from the ESSENCE Survey", ApJS

Operations, Calibration & Optimization of Wide-field Surveys

- Implementing active learning for *TESS* and LSST — targeted observations of least-understood sources to refine machine learning models, and improve survey performance iteratively
- Lead analysis to use *Hubble* imaging and large-aperture spectroscopy to establish faint spectrophotometric standards for LSST and future surveys
- Extensive involvement in transient pipeline development & validation for Pan-STARRS, survey simulations for Foundation, YSE, and analysis of cadence for LSST Wide-Fast-Deep Survey

Narayan et al., '19, "Sub-percent Photometry: Faint DA White Dwarf Spectrophotometric Standards for Astrophysical Observatories", ApJS

PROFESSIONAL AFFILIATIONS

I am an active member of several groups and projects, completed and on-going:

The LSST Dark Energy Science Collaboration (DESC)
The LSST Transient & Variable Stars Collaboration (TVS)
The *Kepler* & *TESS* Extra Galactic Survey
The Foundation Survey
The Pan-STARRS PS1 Science Collaboration
The Mosaic *z*-band Legacy Survey (MzLS)
The PLAsTiCC Team
The ANTARES Project
The DA White Dwarf Calibration Team
The Young Supernova Experiment (YSE)
The ESSENCE Collaboration
The *HST* RAISIN & SIRAH Surveys

Member of the American Astronomical Society (2007–present)

OBSERVING EXPERIENCE

I am an observational cosmologist with extensive experience with different facilities:

- Co-PI on NOIRLab Young Supenova Program on DECam with Long-term Status (LTS) for 2 years (30 nights)
- Co-I on 3 accepted JWST GO Cycle 1 programs for multi-messenger astrophysics
- PI and Co-I on numerous accepted NOIRLab, Las Cumbres Observatory, ESO and *Swift* observing proposals
- Co-I on several major *HST* programs with *WFC3*, *ACS* and *STIS* including:
  GO-12967 (18 orbits), 12999 (8 orbits), 13046 (100 orbits), 13711 (60 orbits), 14216 (100 orbits), 14244 (8 orbits) and 15113 (54 orbits)
- MMT Observatory: 15 nights of Blue Channel spectroscopy on site, 2 nights of remote observing
- Magellan Observatory: 7 nights LDSS3 imaging and long-slit spectroscopy
  1 night of IMACS long-slit spectroscopy
- Gemini Observatory: Analysis of GMOS spectroscopy from ∼5 nights of queue observing
- Kitt Peak National Observatory: several nights of imaging on the 4 m with MOSAIC 1.1 & 3
- Cerro-Tololo Inter-American Observatory: several nights with 0.9 m & 4 m with DECam
  Analysis of 197 nights of MOSAIC-II imaging for ESSENCE/SuperMacho
- WIYN Observatory: 3 nights of imaging on the WIYN 3.5 m with ODI
- F. L. Whipple Observatory: several nights of long-slit spectroscopy on the 1.5 m with FAST and imaging on the 1.2 m with Keplercam, both on-site and remote
- Las Cumbres Observatory: Analysis of 120 hours of 1 m SINISTRO imaging

I've helped design, implement, schedule and optimize numerous surveys. Together with Armin Rest and Mark Huber, I adapted the SMSN `photpipe` pipeline to work on numerous other projects. To date, it has processed ∼7 PB of images, discovering several tens of thousand transient and variable sources.

SOFTWARE PROFICIENCIES

- Developer on several packages available at `http://github.com/gnarayan`
- Core research strength: inference with bespoke probabilistic and machine learning models
- Extensive experience developing image processing pipelines for ground and space telescopes
- Fluent in Python, C++, IDL and Perl
- Comfortable with C, R, Java, Fortran 95, and IRAF
- Familiarity with Scheme, ML, Haskell, PhP, Ruby and Julia
- Well-versed with several database architectures, provenance, redundancy, and version control
- Proficient with SLURM, HTCondor, PBS, LSF and SGE distributed computing environments
- Some familiarity with Amazon Web Services, Kubernetes and Docker, XSEDE, and Hadoop

MENTORING AND TEACHING

Graduate Students

Alex Gagliano (UIUC), Adviser, 2019–present

- Finalist for American Statistical Association Astrophysics Interest Group Paper of the Year, 2021
- Winner of the NSF GRF (2020) and Illinois Survey Science Fellowship (2019)
- Working on correlations between supernovae and their hosts [4, GHOST], SN 2020oi [1, submitted], LSST PLAsTiCC and other projects.

Patrick Aleo (UIUC), Adviser, 2020–present

- Winner of Illinois Survey Science Fellowship (2019)
- Working on anomaly detection for transients within ZTF and YSE
- Leading 1st data-release of YSE

Daniel Muthukrishna (U. Cambridge), Co-Adviser, 2017–present

- Submitted thesis, preparing for PhD defense, Summer 2021, starting postdoc at MIT, Fall 2021
- Research with Narayan on deep learning for transient classification (RAPID, Muthukrishna et al., 2019)
- Muthukrishna is member of LSST PLAsTiCC team and the ANTARES project

I've authored papers with grad students from the U. Arizona Computer Science Dept. on ANTARES, particularly Zhe Wang and Shuo Yang. I work closely with students Qinan Wang (JHU) and Stephen Thorp (Cambridge). In addition to the committee my own students, I have served on the thesis committee for Alejandro Cardenas-Avendano (UIUC Physics), the prelim committee of Chris Tandoi (as chair), Colin Burke & Sunny Tang (UIUC Astro)

Undergraduate Students

Qifeng Cheng (UIUC Astro), Adviser, Feb. 2021–present

- Developing new dwarf nova model with Narayan and postdocs Soraisam & Malanchev
- Northwestern REU with Wen-fai Fong, Summer 2021, applied to LSST Enabling Science Program
- Earned honors with Narayan for work in ASTR 210 by developing viz. of analema for exoplanetary systems

Sammy Sharief (UIUC CS+Astro), Adviser, Feb. 2021–present

- Working on photometric classification of YSE DR1 with Narayan and Patrick Aleo
- Adapted method to retrieve ZTF forced photometry from IPAC & modeling SNe
- REU on Multi-messenger Astrophysics at RIT, Summer 2021

Ved Shah Gautham (UIUC CS), Adviser, Jan. 2021–present

- Developed M-dwarf flare model with Narayan and postdoc Malanchev; being integrated into PLAsTiCC
- NCSA Summer 2021 Intern; applied to LSST Enabling Science Program
- Will begin examining using ML to distinguish M-dwarf flares from rapid transients, Fall 2021

Andrew Engel (UIUC Physics), Adviser, 2017–2021

- Graduated May 2020 - now data scientist at PNNL
- Working on machine learning for photometric redshifts from galaxies
- Algorithm developed being esed in both ANTARES and YSE - completing paper on research with Narayan in 2021

Daniel Alcantara (Bard College), Research Collaborator, 2016–9

- Intern with R. Street at Las Cumbres Observatory working on microlensing detection
- Worked with Narayan to dramatically improve performance of prototype classifier
- Published Alcantara, Bachelet, Narayan and Street, 2019
- Algorithm being used with MARS broker to find microlensing candidates with ZTF

Tayeb Zaidi (Macalester College), Honors Thesis Adviser, 2016–7

- Worked with Narayan on ANTARES as summer REU student at NOAO in 2015
- Continued work on time-series classification for Senior Honors (earned April 2017)
- Published Narayan, Zaidi, Soraisam et al., 2018, adapted for LSST PLAsTiCC

Previous REU Students

- Marcus Lee (NOAO, 2014) was the first indigenous (Tohono O'odham) student to complete REU program at NOAO
- Linoy Kotler (STScI, 2018) worked on wavelet-based classification of Foundation photometric SNIa sample and is now at Rice University

Postdoctoral Scientists Mentored

Monika Soraisam (UIUC), 2019–present

- First recipient of Illinois Survey Science Postdoctoral Fellowship
- Working with Narayan on ANTARES (since 2016), YSE and studies of interesting time-domain phenimena
- Co-advising undergraduate student, Kunal Bhatia, on studies of M31 and development of forced photometry pipeline
- PI of NCSA CDDR grant to deploy ANTARES broker system on Radiant (Co-I Narayan)

Deep Chatterjee (UIUC), 2020–present

- Second recipient of Illinois Survey Science Postdoctoral Fellowship
- Working with Narayan on ANTARES on kilonovae detection and integration with SCiMMA
- Working on using deep-learning for rapid approimation of neutron star EoS and identification of electromagnetic counterpart (El-Cid)

Konstantin Malanchev (UIUC), 2020–present

- Working with Narayan and Patrick Aleo on anomaly detection &
- Developing large cross-matched, cross-calibrated photometric database for LSST

ASTR 310, Computing in Astronomy, UIUC, Fall 2021
ASTR 210, Introduction to Astrophysics, UIUC, Fall 2020
ASTR 596, Fundamentals of Data Science, UIUC, Spring 2020
ZTF Summer School, Pasadena, Aug. 2018
Instructor for: LSST Data Science Fellowship Program, Session 5, Baltimore, Jan. 2018
LSST Data Science Fellowship Program, Session 3, Tucson, Apr. 2017
NOAO Teen Astronomy Cafe, "How Stars Die", Tucson, Nov. 2017
NOAO Big Data Workshop for Tucson High School Students, Tucson, Jan. 2017
Python Workshop for NOAO/NSO REU Students, Tucson, Summer 2014 & 2015

I've additionally served as a Teaching Assistant at Harvard, as Teaching Assistant, Lab Assistant and Tutor at Illinois Wesleyan, and as guest lecturer for Astro 102 (Instructors: C. Salyk and K. Garmany) at the Tohono O'odham Community College.

INVITED COLLOQUIA/SEMINARS/CONFERENCES, 2017–PRESENT

Invited Speaker, Cherenkov Telescope Array Project, scheduled Jun 2021
Invited Speaker, AAS 238, Meeting-in a-meeting (MiM) on Machine Learning, scheduled Jun 2021
LSST Photometric Calibration Working Group Workshop, May 2021
LSST Broker Workshop, Apr 2021
DESI Timedomain Meeting, Apr 2021
Kaler Lecture, Starkel Planetarium - Champaign, IL, Oct 2020
LSST DESC Virtual Meeting - Jul 2020
SciMMA Virtual Meeting, May 2020
Kentucky Area Astronomy Annual Meeting - Louisville, KY, Mar 2020
LSST DESC Annual Meeting - Tucson, AZ, Jan 2020
Kavli Visitor, University of Cambridge, Institute of Astronomy, Dec 2019
LSST TVS and SMWLV workshop - Newark, DE, Oct 2019
SNIa Cosmology Analysis Meeting - KICP Chicago, IL, Oct 2019
Inference for Multi-messenger Astrophysics - Berkeley, CA, May 2019
University of Delaware, Astronomy Seminar - Newark, DE, May 2019
University of Illinois, LSST Seminar - Urbana-Champaign, IL, Apr. 2019
Iowa State University, Dept. of Physics & Astronomy Colloquium - Ames, IA, Apr. 2019
Louisiana State University, Dept. of Physics & Astronomy Colloquium - Baton Rouge, LA, Mar. 2019
University of Wisconsin, Dept. of Physics Colloquium - Milwaukee, WI, Mar. 2019
University of Alabama, Dept. of Physics & Astronomy Colloquium - Tuscaloosa, AL, Mar. 2019
Michigan Technological University, Dept. of Physics Colloquium - Houghton, MI, Feb. 2019
University of Illinois, Dept. of Astronomy Colloquium - Urbana-Champaign, Feb. 2019
University of Minnesota, Dept. of Physics and Astronomy Colloquium - St. Paul, Nov. 2018
LSST Cadence Hackathon - New York, NY, Sep. 2018
Machine Learning for Science and Engineering - Pittsburgh, Jun. 2018
NSF Workshop on Multi Messenger Astrophysics - College Park, May 2018
LSST Photometric Classification Challenge "PLAsTiCC" Sprint Week - New York, NY, May. 2018
Python in Astronomy - New York, NY, Apr. 2018
New Advances in NIR type Ia Supernova Science - Pittsburgh, PA, Apr. 2018
LSST PLAsTiCC Workshop - New York, NY, Jul. 2017
Supernovae: The LSST Revolution - Evanston, IL, Jun. 2017
Building the Infrastructure for Time-Domain Alert Science in the LSST Era - Tucson, AZ, May 2017

SERVICE & PUBLIC OUTREACH WORK

Deputy Analysis Coordination, LSST Dark Energy Science Collaboration, 2021–present
Co-convener, LSST DESC Supernova Working Group, 2019–2021
Member, SN Science Investigation Team, Nancy Grace Roman Space Telescope, 2020–present
Member, Faculty Search Committee, UIUC, 2020 & 2021
Chair, SNe Across LSST, Originally Apr. 28-30, 2020, rescehduled due to COVID-19
Panelist, NSF Review Panel, Mar 2020
Speaker, Astronomy on Tap - Urbana-Champaign, "The Myth and Mythology of the Planets", Feb 2020
Organizer, Astronomy on Tap - Urbana-Champaign, Nov 2019–present
SOC, Managing Follow-up Observations in the Era of ZTF and LSST, Sep. 30–Oct. 4, 2019
Speaker, Astronomy on Tap - Urbana-Champaign, "Making a Movie of the Night Sky", Sep. 2019
Chair, Enabling Multi Messenger Astrophysics in the Big Data Era, Apr. 25–26, 2019
SOC, Deep Learning for Multimessenger Astrophysics: Real-time Discovery at Scale, Oct. 2018
LOC, Building the Infrastructure for Time-Domain Alert Science in the LSST Era, May 2017
Organizer, Astronomy on Tap - Tucson/Space Drafts, 2015-2017
Organizer, NOAO FLASH Talk Series, 2015–2017
Organizer, NOAO Coffee Hour Series, 2014–5
Reviewer for the AAS Journals, ongoing
Speaker, Space Telescope Public Lecture Series, Chasing Supernovae with Kepler, Sep. 2018
Guest, Three Body Problems Podcast, Bringing Data Science Into Astronomy, Sept. 2018
Scientist, TED-Ed Original Videos (Pt. 1) (Pt. 2)
Speaker, 365 Days of Astronomy Podcast (Pt. 1) (Pt. 2)
Speaker, Youth for Astronomy and Engineering, Nov. 2018
Speaker, NerdNite Baltimore, Mar. 2018
Panelist, Tucson Comic Con and TUSCon, Nov. 2015 and 2016
"Robots in Space" and "The Physics of Space Battles"
Speaker, Astronomy on Tap - Tucson with the Tucson Symphony Orchestra, Oct. 2016
"A Trip through Gustav Holst's Planets"
Speaker, Astronomy on Tap - Tucson, Jan. 2015
"If You Only Knew The Power of The Dark Side"
Speaker, Green Valley Astronomy Club, Sahuarita, AZ, May 2016
Volunteer, Science Night, Elvira Elementary School, Tucson, AZ, Mar. 2015 and Mar. 2017
Volunteer, Astronomy Night, Arizona Sonoran Desert Museum, Jul. 2015
Volunteer, Kitt Peak National Observatory Open Night for the Tohono O'odham Nation, May 2015
Volunteer, Tucson Festival of Books, Mar. 2015

I've led public stargazing at the Museum of Science in Boston (2011–2), the Table Mountain star party, WA (2006) and throughout my time as an undergraduate at Illinois Wesleyan's Mark Evans Observatory (2001–5).

REFERENCES

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LIST OF PUBLICATIONS

h-index: 33, 4806 citations. (Scopus/Google Scholar)
Publications are listed with 1st author or major contributor first.

Primary Publications

[1] **An Early-Time Optical and Ultraviolet Excess in the type-Ic SN 2020oi**. A. Gagliano, L. Izzo, C. D. Kilpatrick, B. Mockler, W. Vincente Jacobson-Galán, G. Terreran, G. Dimitriadis, Y. Zenati, K. Auchettl, M. R. Drout, **G. Narayan**, R. J. Foley, R. Margutti, A. Rest, D. O. Jones, C. Aganze, P. D. Aleo, A. J. Burgasser, D. A. Coulter, R. Gerasimov, C. Gall, J. Hjorth, C.-C. Hsu, E. A. Magnier, K. S. Mandel, A. L. Piro, C. Rojas-Bravo, M. R. Siebert, H. Stacey, M. Cullen Stroh, J. J. Swift, K. Taggart, and S. Tinyanont. *arXiv e-prints*, May 2021. arXiv:2105.09963.

[2] **The ANTARES Astronomical Time-domain Event Broker**. T. Matheson, C. Stubens, N. Wolf, C.-H. Lee, **G. Narayan**, A. Saha, A. Scott, M. Soraisam, A. S. Bolton, B. Hauger, D. R. Silva, J. Kececioglu, C. Scheidegger, R. Snodgrass, P. D. Aleo, E. Evans-Jacquez, N. Singh, Z. Wang, S. Yang, and Z. Zhao. AJ, Mar. 2021. 161(3):107.

[3] **Testing the Consistency of Dust Laws in SN Ia Host Galaxies: A BayeSN Examination of Foundation DR1**. S. Thorp, K. S. Mandel, D. O. Jones, S. M. Ward, and **G. Narayan**. *arXiv e-prints*, Feb. 2021. arXiv:2102.05678.

[4] **GHOST: Using Only Host Galaxy Information to Accurately Associate and Distinguish Supernovae**. A. Gagliano, **G. Narayan**, A. Engel, M. Carrasco Kind, and LSST Dark Energy Science Collaboration. ApJ, Feb. 2021. 908(2):170.

[5] **The Young Supernova Experiment: Survey Goals, Overview, and Operations**. D. O. Jones, R. J. Foley, **G. Narayan**, J. Hjorth, M. E. Huber, P. D. Aleo, K. D. Alexander, C. R. Angus, K. Auchettl, V. F. Baldassare, S. H. Bruun, K. C. Chambers, D. Chatterjee, D. L. Coppejans, D. A. Coulter, L. DeMarchi, G. Dimitriadis, M. R. Drout, A. Engel, K. D. French, A. Gagliano, C. Gall, T. Hung, L. Izzo, W. V. Jacobson-Galán, C. D. Kilpatrick, H. Korhonen, R. Margutti, S. I. Raimundo, E. Ramirez-Ruiz, A. Rest, C. Rojas-Bravo, M. R. Siebert, S. J. Smartt, K. W. Smith, G. Terreran, Q. Wang, R. Wojtak, A. Agnello, Z. Ansari, N. Arendse, A. Baldeschi, P. K. Blanchard, D. Brethauer, J. S. Bright, J. S. Brown, T. J. L. de Boer, S. A. Dodd, J. R. Fairlamb, C. Grillo, A. Hajela, C. Hede, A. N. Kolborg, J. A. P. Law-Smith, C. C. Lin, E. A. Magnier, K. Malanchev, D. Matthews, B. Mockler, D. Muthukrishna, Y. C. Pan, H. Pfister, D. K. Ramanah, S. Rest, A. Sarangi, S. L. Schrøder, C. Stauffer, M. C. Stroh, K. L. Taggart, S. Tinyanont, R. J. Wainscoat, and Young Supernova Experiment. ApJ, Feb. 2021. 908(2):143.

[6] **Results of the Photometric LSST Astronomical Time-series Classification Challenge (PLAsTiCC)**. R. Hložek, K. A. Ponder, A. I. Malz, M. Dai, **G. Narayan**, E. E. O. Ishida, J. Allam, T., A. Bahmanyar, R. Biswas, L. Galbany, S. W. Jha, D. O. Jones, R. Kessler, M. Lochner, A. A. Mahabal, K. S. Mandel, J. R. Martínez-Galarza, J. D. McEwen, D. Muthukrishna, H. V. Peiris, C. M. Peters, and C. N. Setzer. *arXiv e-prints*, Dec. 2020. arXiv:2012.12392.

[7] **A Hierarchical Bayesian SED Model for Type Ia Supernovae in the Optical to Near-Infrared**. K. S. Mandel, S. Thorp, **G. Narayan**, A. S. Friedman, and A. Avelino. *arXiv e-prints*, Aug. 2020. arXiv:2008.07538.

[8] **Models and Simulations for the Photometric LSST Astronomical Time Series Classification Challenge (PLAsTiCC)**. R. Kessler, **G. Narayan**, A. Avelino, E. Bachelet, R. Biswas, P. J. Brown, D. F. Chernoff, A. J. Connolly, M. Dai, S. Daniel, R. Di Stefano, M. R. Drout, L. Galbany, S. González-Gaitán, M. L. Graham, R. Hložek, E. E. O. Ishida, J. Guillochon, S. W. Jha, D. O. Jones, K. S. Mand el, D. Muthukrishna, A. O'Grady, C. M. Peters, J. R. Pierel, K. A. Ponder, A. Prša, S. Rodney, V. A. Villar, LSST Dark Energy Science Collaboration, and Transient and Variable Stars Science Collaboration. *Publ. Astron. Soc. Pac.*, Sep 2019. 131(1003):p. 094501.

[9] **A machine learning classifier for microlensing in wide-field surveys**. D. Godines, E. Bachelet, **G. Narayan**, and R. A. Street. *Astronomy and Computing*, Jul 2019. 28:100298.

[10] **Subpercent Photometry: Faint DA White Dwarf Spectrophotometric Standards for Astrophysical Observatories**. **G. Narayan**, T. Matheson, A. Saha, T. Axelrod, A. Calamida, E. Olszewski, J. Claver, K. S. Mandel, R. C. Bohlin, and J. B. Holberg. *Astrophys. J. Suppl. Ser.*, Apr 2019. 241(2):20.

[11] **RAPID: Early Classification of Explosive Transients Using Deep Learning**. D. Muthukrishna, **G. Narayan**, K. S. Mandel, R. Biswas, and R. Hložek. *Publ. Astron. Soc. Pac.*, Nov. 2019. 131(1005):p. 118002.

[12] **Machine-learning-based Brokers for Real-time Classification of the LSST Alert Stream**. **G. Narayan**, T. Zaidi, M. D. Soraisam, Z. Wang, M. Lochner, T. Matheson, A. Saha, S. Yang, Z. Zhao, J. Kececioglu, C. Scheidegger, R. T. Snodgrass, T. Axelrod, T. Jenness, R. S. Maier, S. T. Ridgway, R. L. Seaman, E. M. Evans, N. Singh, C. Taylor, J. Toeniskoetter, E. Welch, S. Zhu, and ANTARES Collaboration. *Astrophys. J. Suppl. Ser.*, May 2018. 236:9.

[13] **Photometry and Spectroscopy of Faint Candidate Spectrophotometric Standard DA White Dwarfs**. A. Calamida, T. Matheson, A. Saha, E. Olszewski, **G. Narayan**, J. Claver, C. Shanahan, J. Holberg, T. Axelrod, and R. Bohlin. *Astrophys. J.*, Feb 2019. 872(2):199.

[14] **Light Curves of 213 Type Ia Supernovae from the ESSENCE Survey**. **G. Narayan**, A. Rest, B. E. Tucker, R. J. Foley, W. M. Wood-Vasey, P. Challis, C. Stubbs, R. P. Kirshner, C. Aguilera, A. C. Becker, S. Blondin, A. Clocchiatti, R. Covarrubias, G. Damke, T. M. Davis, A. V. Filippenko, M. Ganeshalingam, A. Garg, P. M. Garnavich, M. Hicken, S. W. Jha, K. Krisciunas, B. Leibundgut, W. Li, T. Matheson, G. Miknaitis, G. Pignata, J. L. Prieto, A. G. Riess, B. P. Schmidt, J. M. Silverman, R. C. Smith, J. Sollerman, J. Spyromilio, N. B. Suntzeff, J. L. Tonry, and A. Zenteno. *Astrophys. J. Suppl. Ser.*, May 2016. 224:3.

[15] **Toward a Network of Faint DA White Dwarfs as High-precision Spectrophotometric Standards**. **G. Narayan**, T. Axelrod, J. B. Holberg, T. Matheson, A. Saha, E. Olszewski, J. Claver, C. W. Stubbs, R. C. Bohlin, S. Deustua, and A. Rest. *Astrophys. J.*, May 2016. 822:67.

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and several other TNS alerts, ATELs, and CBATs.

Other Publications

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