

GOURAV KHULLAR

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RESEARCH INTERESTS

Formation and evolution of galaxies in massive **galaxy clusters**.
Physics of galaxies in the **high-redshift universe** using strong gravitational lensing.
Spectrophotometric characterization of galaxy cluster environments via **multi-wavelength observations**: X-ray, UV, optical and infrared data from Chandra X-ray Observatory, Hubble Space Telescope, and Magellan Telescopes.
Statistics of strong and weak gravitational lensing fields and arcs around galaxy clusters.

EDUCATION

PhD Candidate, Dept. of Astronomy and Astrophysics, Kavli Institute for Cosmological Physics (KICP), University of Chicago, Chicago, IL, USA (2015-present)
Thesis Advisor: Prof. Michael D. Gladders; Galaxy Clusters and Gravitational Lensing.

Masters of Advanced Study (MASt.) in Astrophysics, Institute of Astronomy (IoA), University of Cambridge, Cambridge, UK (2014-15) Grade: 2:1
INLAKS Foundation Fellow at Fitzwilliam College, University of Cambridge
Thesis: **AGN and Galaxy properties in the Dark Energy Survey** (Prof. Richard McMahon, IoA)
Analysis of multi-frequency data to characterise spectral energy properties of active galaxies. Visual classification of galaxy merger scenarios in deep field survey data from DES, with comparison from CANDELS (Hubble) and WISE data in the COSMOS field.

Erasmus Mundus Undergraduate Exchange Semester, Aalto University, Helsinki, Finland (2014)
Erasmus Fellow, Dept. of Physics, Aalto University

Bachelor of Technology (B.Tech.), Engineering Physics, Indian Institute of Technology Delhi (IITD), New Delhi, India (2010-14) GPA:8.7/10
Thesis: **Stellar Speckle Interferometry and Adaptive Optics** (Prof. Kedar Khare, Dept. of Physics)
Experimental analysis of Fourier speckle patterns to attain diffraction-limited resolutions and development of a Shack-Hartmann Wavefront reconstruction system. Simulation of turbulent atmospheres through algorithmic development of wavefront profiles.

PROFESSIONAL EMPLOYMENT

Teacher and Instructor, Physics of Stars, The College, University of Chicago 2018
Researcher, Aalto University Metsahovi Radio Observatory, Helsinki, Finland 2014
Advisor: Dr. Joni Tammi (Director, Metsahovi Observatory)
Summer Researcher, University of Victoria, and Canadian Computational Cosmology Collaboration (C4), Victoria, Canada 2013
Advisors: Prof. Arif Babul (Director,C4) and Dr. Fabrice Durier
Researcher Indian Institute of Astrophysics (IIA), Bangalore, India 2012
Advisor: Prof. G.C. Anupama (Lead Scientist, Thirty Meter Telescope)
Summer Researcher, University of Oxford, Oxford, UK, 2012
Advisor: Prof. Philipp Podsiadlowski

AWARDS

Graduate Student Leadership Award, University of Chicago 2018
Inclusive Pedagogy Grant, Chicago Center for Teaching, University of Chicago 2018

-Diversity, Equity and Inclusion Journal Club (DEIJC), Astronomy & Astrophysics
 Inclusive Pedagogy Grant, Chicago Center for Teaching, University of Chicago 2018
 -Physics of Stars, The College, University of Chicago
 AAS Education and Professional Development Grant, Astrobiters Education 2017,2018
 Brinson Fellowship for Summer Graduate Research, University of Chicago 2016,2017
 Jerry Rao Fellowship for Graduate School, University of Chicago 2015-16
 Finalist, Graduate Teaching Assistant Award, University of Chicago 2015-16
 INLAKS Foundation Scholarship, University of Cambridge, UK 2014-15
 Erasmus Mundus Scholarship, Aalto University, Finland 2013-14
 Outstanding Contribution Award, Co-Curricular and Academic Activities 2013
 Indian Institute of Technology Delhi, India
 Research Student Scholarship, Indian Institute of Astrophysics, India 2012
 Semester Excellence Awards for Three Semesters, IIT Delhi 2011-13
 KVPY Scholarship for undergraduates, Government of India (declined) 2010

PUBLICATIONS

"Spectroscopic Confirmation of Five Galaxy Clusters at $z \gtrsim 1.25$ in the 2500 deg² SPT-SZ Survey", Khullar et al., The Astrophysical Journal, Volume 870, Issue 1, article id. 7, 16 pp. (2019)
 "Galaxy populations in the most distant SPT-SZ clusters - I. Environmental quenching in massive clusters at $1.4 - 1.7$ ", arXiv:1807.09768 (2018)
 "Origin of a massive hyper-runaway subgiant star LAMOST-HVS1 – Implication from Gaia and follow-up spectroscopy", ApJ 873, 116 (2019)
 "A Detailed Study of the Most Relaxed SPT-selected Galaxy Clusters: Properties of the Cool Core and Central Galaxy", The Astrophysical Journal, Volume 870, Issue 2, article id. 85, 13 pp. (2019)
 "The Dark Energy Survey: Data Release 1", The Astrophysical Journal Supplement Series, Volume 239, Issue 2, article id. 18, 25 pp. (2018)
 "Cluster Cosmology Constraints from the 2500 deg² SPT-SZ Survey: Inclusion of Weak Gravitational Lensing Data from Magellan and the Hubble Space Telescope", arXiv:1812.01679 (2018)
 "2016 QU89", Minor Planet Electronic Circ., No. 2018-V144 (2018) (2018)
 "2016 QV89", Minor Planet Electronic Circ., No. 2018-V143 (2018) (2018)
 "X-ray Properties of SPT Selected Galaxy Clusters at $0.2 \leq z \leq 1.5$ Observed with XMM-Newton", arXiv:1807.02556 (2018)

OBSERVING EXPERIENCE AND PROPOSALS

Magellan/Clay: LDSS3 Spectroscopic observations of Strong Lenses observed via SPT (2 night) June 2019
 Magellan/Clay: LDSS3 Spectroscopic observations of high-redshift galaxy clusters observed via SPT (2 night) June 2019
 Magellan/Clay: LDSS3 Spectroscopic observations of Strong Lenses observed via SPT (2 nights) Dec 2018
 Magellan/Clay: LDSS3 Spectroscopic observations of Strong Lenses observed via SPT (3 nights) Jan 2018
 Magellan/Clay: MIKE Spectroscopic observations of Hyper-velocity stars Jan 2018
 Magellan/Clay: LDSS3 Spectroscopic observations of high-redshift galaxy clusters observed via Dark Energy Survey and Spitzer archival data (2 nights) Nov 2017
 CTIO/Blanco: Dark Energy Survey Year 5 Operations and Observations (7 nights) Oct 2017
 Magellan/Clay: LDSS3 Spectroscopic observations of SPT-discovered strong lenses (2 nights) June 2016
 Magellan/Clay: LDSS3 Spectroscopic observations of high-redshift galaxy clusters discovered via SPT (2 nights) Jan 2016
 Himalayan Chandra Telescope, Indian Insitute of Astrophysics: Photometric observa-

tions of Type Ib supernovae (1 night)

Dec 2012

Proposal I: Magellan/Clay: PI, PISCO *griz* photometric observations of high-redshift SPT galaxy clusters (observed Nov 2016)

Proposal II: Magellan/Clay: Co-PI, LDSS3 spectroscopic observations of high-redshift DES galaxy clusters (observed Nov 2017)

Proposal III: Co-I, HST Proposal 15307, "Building the SPT-HST Legacy: Imaging Massive Clusters to $z=1.5$ " (observed August 2018-present)

HST Cycle 27 Proposals

Observational design, data reduction and analysis:

Space Based Observatories: Hubble Space Telescope (ACS, WFC3), Spitzer Space Telescope (IRAC), Chandra X-ray Observatory (ACIS)

Ground Based Observatories: Magellan Telescopes (LDSS3, MIKE, PISCO)

JWST Early Release Science Proposal (PI: J. Rigby, NASA Goddard)

INVITED AND CONTRIBUTED TALKS AND POSTERS

"Spectroscopic Confirmation of Five Galaxy Clusters at $z > 1.25$ in the 2500 deg² SPT-SZ Survey", American Astronomical Society, 232nd AAS Meeting, id. 324.05 (Jun 2018)

"Astrobites as a Pedagogical Tool in Classrooms", American Astronomical Society, 232nd AAS Meeting, id. 209.01 (Jun 2018)

"Diversity Equity and Inclusion Journal Club", SACNAS MidWest Meeting, University of Chicago (May 2018)

"Stellar Population Synthesis analysis of member galaxies in SPT-discovered high-redshift Clusters", SPT Clusters Collaboration Meeting (April 2018)

"Spectroscopic follow-up of high-redshift galaxy clusters", Dark Energy Survey Collaboration Meeting, Chicago (June 2017)

"2pt correlation function distortions and mass reconstruction of galaxy clusters", Dark Energy Survey Collaboration Meeting, Chicago (June 2017)

"Still Red and Dead? Measuring feedback and star-formation in clusters at $z > 1$ ", American Astronomical Society, 228th AAS Meeting, (June 2016)

'AGN and Host Galaxies in the Dark Energy Survey', Fitzwilliam Graduate Conference, University of Cambridge (May 2015)

'Spectroscopic Analysis of Type Ib Supernova SN2004ao', Tryst, IIT Delhi, India (March 2013)

'H1 21cm analysis of nebular clouds', Radio Astronomy Winter School, Inter-University Centre for Astronomy and Astrophysics (IUCAA), India (December 2011)

WORKSHOPS AND MEETINGS

.AstroX Conference, STScI, Baltimore, September 2018

Data Visualization and Exploration in the LSST Era Workshop, NCSA, Urbana-Champaign, August 2018

SACNAS Midwest Meeting, University of Chicago, May 2018

Using Python to Search NASA's Astrophysics Archives (Remote), IPAC, June 2018

ALMA Proposal Workshop, Northwestern University and NRAO, March 2018

ComSciCon Chicago Science Outreach Workshop, August 2017

SPT Cluster Collaboration Meetings, Argonne, Chicago, 2017,2018

Future Cosmic Surveys Workshop, University of Chicago, Oct 2016

CMB-S4 Meeting, University of Chicago, Oct 2016

Cosmology Using Low Resolution Spectroscopy in 2020s, University of Chicago, 2016

Dark Energy Survey Chicagoland Collaboration Meetings, 2015,2016,2017

World Wide Telescope Developer Workshop, Nov 2015

AstroStatistics Workshop, Royal Statistical Society, London, Dec 2014

Workshop on Cosmology, Inter-University Centre for Astronomy and Astrophysics,
India Nov 2012

**OUTREACH
AND
PROFESSIONAL
SERVICE**

Founder, Diversity, Equity and Inclusion Journal Club (DEIJC), Astronomy and Astrophysics - KICP, University of Chicago 2017-present
Media Intern, 232nd AAS Meeting, American Astronomical Society Jun 2018
Graduate Mentor, Dept of Astronomy and Astrophysics, University of Chicago 2018-19
IMPACT Mentor, International Student Mentorship Program, University of Chicago 2016-18
Instructor and Course planner, Space Explorers Summer Institutes for underprivileged high school students near University of Chicago 2016,2017,2018
University of Chicago Committees: Dean's Student Advisory Committee (2015-17), Equity and Inclusion Council(2018-present)
Astrobites, the astro-ph reader's digest: Author (2016-2018), Education Researcher (2018-present), Co-Administrator (2018-present)
Teaching Committee and Student Representative, Part III and MAST Astrophysics, Institute of Astronomy, University of Cambridge 2014-15
Academic Affairs Officer, Fitzwilliam College, University of Cambridge 2014-15
President, Astronomy Club, Indian Institute of Technology Delhi 2012-13
Physics Representative, Academic Committee, Indian Institute of Technology Delhi 2012-13

Mentoring Undergraduate students in Gladders Research Group, University of Chicago:
1. Katya Gozman, Sophomore, University of Chicago (SED fitting and Stellar Population Synthesis for high-redshift galaxies)
2. Sebastian Fernandez-Mulligan, Senior Undergraduate, University of Chicago (MCMC algorithms and statistical methods for astrophysical simulations)

Conflict Resolution Training, November 2018
Bystander Intervention and Support Training, February 2019

PRESS

Massive Hyper-Runaway Star Ejected from Milky Way's Disk 2019
The Physics of Toys, Yerkes Summer Institute, KICP, University of Chicago 2017
Spy vs. Spy, Yerkes Summer Institute, KICP, University of Chicago 2016