Shivan Khullar

Curriculum Vitae

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shivankhullar.github.io

Education

2019-Present **University of Toronto**, *Toronto, Canada*
Ph.D. (Direct-Entry) Astronomy and Astrophysics
Advisors: Prof. Norman Murray and Prof. Chris Matzner
GPA: 3.99/4.0

2014-2019 **Birla Institute of Technology & Science (BITS) Pilani University**, *Goa, India*
M.Sc. (Hons.) Physics & **B.E. (Hons.) Electronics and Instrumentation**
GPA (Physics degree): 9.38/10

Research Interests

I'm interested in simulating various physical processes in our universe. My research focuses on questions related to star formation, giant molecular cloud formation and evolution, stellar feedback, turbulence, magnetohydrodynamics, and numerical methods in fluid dynamics. I use numerical simulations as a tool to understand systems that are hard to study analytically. I use some of the world's largest supercomputers to run and analyze these simulations.
Keywords: Star formation, ISM, stellar feedback, molecular clouds, simulations

Publications

Summary: 4 first author publications, 1 n-th author publication

- **Shivan Khullar**, Christopher D. Matzner, Norman Murray, Michael Y. Grudić, Dávid Guszejnov, Andrew Wetzel, Philip F. Hopkins, 2024, ApJ, *'Playing with FIRE: A Galactic Feedback-Halting Experiment Challenges Star Formation Rate Theories'*
- **Shivan Khullar**, Christoph Federrath, Mark R. Krumholz, Christopher D. Matzner, 2021, MNRAS *'The density structure of supersonic self-gravitating turbulence'*
- **Shivan Khullar**, Qingbo Ma, Philipp Busch, Benedetta Ciardi, Marius B. Eide and Koki Kakiichi, 2020, MNRAS *'Probing the high-z IGM with the hyperfine transition of ^{3}He+'*
- **Shivan Khullar**, Mark R. Krumholz, Christoph Federrath, Andrew J. Cunningham, 2019, MNRAS *'Determining star formation thresholds from observations'*
- Riwaj Pokhrel, Robert A. Gutermuth, Mark R. Krumholz, Christoph Federrath, Mark Heyer, **Shivan Khullar**, S. Thomas Megeath, Philip C. Myers, Stella S. R. Offner, Judith L. Pipher, William J. Fischer, Thomas Henning, Joseph L. Hora, 2021, ApJ Letters *'The Single-Cloud Star Formation Relation'*

Honors & Awards

2024 **Jui Lin Yen Award 2024**, *Department of Astronomy and Astrophysics, University of Toronto, for the most notable published work by a graduate student in the department in a given year.*
Award amount: $1,000

2020 **International Graduate Student Fellowship for Excellence in Doctoral Studies**, *Department of Astronomy and Astrophysics, University of Toronto*
Award amount: $3,000

2022 **Mary and Ron Martin International Graduate Fellowship**, *University of Toronto*
Award amount: ∼$9,000

2022 **International Graduate Student Fellowship for Excellence in Doctoral Studies**, *Department of Astronomy and Astrophysics, University of Toronto*
Award amount: $3,000

2021 **International Graduate Student Fellowship for Excellence in Doctoral Studies**, *Department of Astronomy and Astrophysics, University of Toronto*
Award amount: $3,000

2021 **Mary and Ron Martin International Graduate Fellowship**, *University of Toronto*
Award amount: ∼$9,000

2019 - 2021 **Department of Astronomy and Astrophysics International Entrance Award**, *Department of Astronomy and Astrophysics, University of Toronto*
Award amount: $10,000

2021,2023 **Compute time**, *Digital Research Alliance of Canada*
Award amount: 3 million+ CPU hrs (∼2,000)

Talks and Conferences

Invited Talks

October 2024 **RMS Seminar, Harvard University**, *Boston, USA*
Title: From kpc to AU: Star formation across the scales

September 2024 **Seminar, American Museum of Natural History**, *New York, USA*
Title: From kpc to AU: Star formation across the scales

September 2024 **SIM Meeting, Center for Computational Astrophysics, Flatiron Institute**, *New York, USA*
Title: From kpc to AU: Star formation across the scales

May 2024 **AstroTours public talk, University of Toronto**, *Toronto, Canada*
Title: And then there was more light: the violent births of stars

March 2024 **TASTY talk, University of Toronto**, *Toronto, Canada*
Title: From kpc to pc: Trying to capture chaos in a single number

November 2022 **Journal club seminar, McMaster University**, *Virtual*
Title: Playing with FIRE: Molecular clouds and star formation in a galactic feedback-halting experiment

October 2021 **Star Formation/ISM Rendezvous, Princeton University**, *Virtual*
Title: Star formation thresholds and the density PDF

October 2020 **Mini-astro workshop**, *Virtual*
Title: The physics of star formation and its simulations

February 2019 **International Max Planck Research School on Astrophysics at the Ludwig Maximilians University, Munich**, *Garching, Germany*, Star Formation Thresholds: Real and Illusory

Contributed Talks

August 2024 **Star Formation Workshop**, *Hamilton, Canada*
Title: The role of stellar feedback in GMC evolution

May 2024 **Globular Clusters and their Tidal Tails**, *Toronto, Canada*
Title: The role of stellar feedback in GMC evolution

July 2023 **The Physics of Star Formation: From Stellar Cores to Galactic Scales**, *Lyon, France*
Title: Playing with FIRE: Molecular clouds and star formation in a galactic feedback-halting experiment

July 2022 **A Holistic View of Stellar Feedback and Galaxy Evolution**, *Ascona, Switzerland*
Title: Playing with FIRE: Molecular clouds and star formation in a galactic feedback-halting experiment

Posters/Lightning Talks

June 2024 **Canadian Astronomical Society (CASCA), Annual Meeting**, *Toronto, Canada*
Title: Playing with FIRE: Molecular clouds and star formation in a galactic feedback-halting experiment

Feb 2024 **Turbulence in the Universe**, *KITP, Santa Barbara, USA*
Title: Playing with FIRE: Molecular clouds and star formation in a galactic feedback-halting experiment

June 2022 **International High Performance Computing Summer School**, *Athens, Greece*
Title: Combining multiple scales in star formation simulations

May 2022 **Canadian Astronomical Society (CASCA), Annual Meeting**, *Virtual*
Title: GMCs on FIRE: The impact of feedback on star formation rates, efficiencies, and laws

May 2021 **Canadian Astronomical Society (CASCA), Annual Meeting**, *Virtual*
Title: The density structure of supersonic self-gravitating turbulence

May 2020 **Canadian Astronomical Society (CASCA), Annual Meeting**, *Virtual*
Title: Star Formation Thresholds: Real or Illusory?

Teaching Experience

Teaching Assistant

Winter 2024 **AST 222: Galaxies and Cosmology**, *University of Toronto*

Fall 2023 **AST 221: Stars and Planets**, *University of Toronto*

Summer 2023	**AST 201: Stars and Galaxies**, *University of Toronto*
Summer 2023	**CTA 200H**, *University of Toronto*
Fall 2022	**AST 101: The Sun and Its Neighbours**, *University of Toronto*
Summer 2022	**AST 201: Stars and Galaxies**, *University of Toronto*
Winter 2022	**AST 320: Intro to Astrophysics**, *University of Toronto*
Fall 2021	**AST 325/326: Intro to Practical Astronomy**, *University of Toronto*
Summer 2021	**AST 201: Stars and Galaxies**, *University of Toronto*
Winter 2021	**AST 201: Stars and Galaxies**, *University of Toronto*
Fall 2020	**AST 101: The Sun and Its Neighbours**, *University of Toronto*
Winter 2020	**AST 201: Stars and Galaxies**, *University of Toronto*
Fall 2019	**AST 101: The Sun and Its Neighbours**, *University of Toronto*
Spring 2018	**Mathematical Methods for Physics**, *BITS Pilani, Goa*
Fall 2017	**Electro-Magnetic Theory I**, *BITS Pilani, Goa*

Duties include:

- Leading tutorials, planetarium shows, observing nights, marking projects and exams (AST 101/201, University of Toronto)
- Designing and leading tutorials, grading assignments (AST 221, University of Toronto)
- Designing and leading tutorials, grading lab reports (AST 325/326, University of Toronto)
- Making assignment solutions, holding office hours and grading assignments (AST 320, University of Toronto)
- Designing lecture slides, marking quizzes (BITS Pilani, Goa)

Service

Mentorship

Research mentorship

- Nan Jiang, incoming graduate student at University of Toronto
- Aryan Jain, undergraduate student at University of Toronto
- Daniel Zhou, undergraduate student at University of Toronto

Peer mentorship

- Phil Van-Lane, graduate student at University of Toronto
- Kanah Smith, undergraduate student at University of Toronto, now PhD student at IST Austria
- Ethen Sun, graduate student at University of Toronto
- Isaac Rosenberg, undergraduate student at University of Toronto

Outreach

- Public talk at UofT GASA's AstroTours, May 2024
- Planetarium shows at UofT GASA's AstroTours
- Various exhibits and refreshments coordination at UofT GASA's AstroTours

Organizational

- Formed and organized a star-formation/ISM focus group at University of Toronto.
- Student representative, CITA visitor committee.
- President, SEDS Celestia (2016-17), astronomy club at BITS-Pilani Goa.
- Member of the Student Faculty Council at the Department of Physics, BITS-Pilani Goa.

Technical Skills

- High Performance Computing - MPI/OpenMP. Used Gadi/Raijin supercomputer at NCI Australia; Niagara supercomputer at SciNet, Compute Canada; Frontera supercomputer at TACC, USA.
- Languages - Python, C, C++, R, Mathematica, Matlab; English, Hindi, Punjabi, Bengali

Undergraduate Research Experience

August 2018 - Dec 2018 **Determining Star Formation Thresholds from Observations**, *RSAA, Australian National University, Canberra, Australia*
Supervisors - Prof. Mark Krumholz and Prof. Christoph Federrath

Jan 2019 - June 2019 **Gravitational Decoherence**, *Raman Research Institute, Bangalore, India*
Supervisor - Prof. Joseph Samuel

June 2018 - July 2018 **The ^{3}He+ hyperfine transition line signal at high redshifts**, *Max Planck Institute for Astrophysics, Garching, Germany*
Supervisor - Prof. Benedetta Ciardi

May - June 2017 **Determining the size distribution of H II regions during Reionization using granulometry**, *NCRA-TIFR, Pune, India*
Supervisor - Prof. Tirthankar Roy Choudhury

May - July 2016 **Mass Modelling of galaxies using HI 21-cm line observations**, *IUCAA, Pune, India*
Supervisor - Dr. Neeraj Gupta