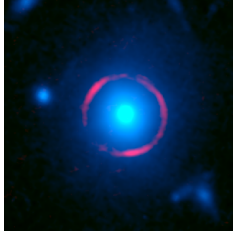
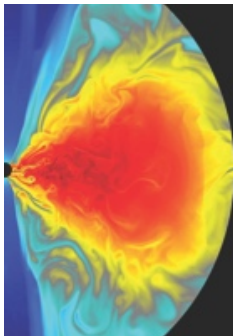




Astronomy, Astrophysics, & Cosmology Research



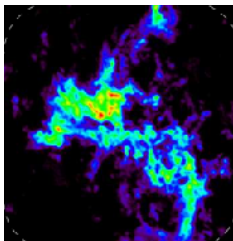
Observational Cosmology: Observational cosmology is the study of the composition, origin, evolution, and eventual fate of the Universe. Research topics include the cosmic microwave background, gravitational lensing, large scale structure, dark energy, dark matter, and instrumentation. **Faculty:** Carrasco Kind, Filippini, Holder, Kembell, Menanteau, Vieira.



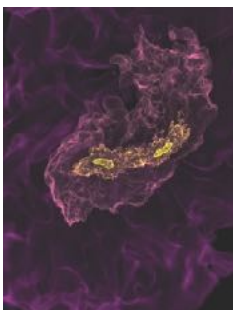
Theoretical Cosmology: The dominant constituents of the Universe—dark matter and dark energy—are as yet poorly understood. Illinois cosmologists develop models to understand how the Universe has evolved to its present state. Research areas include dark matter, inflation, structure formation, galaxy cluster energetics and merging, and big bang nucleosynthesis. **Faculty:** Adshead, Barrow, Draper, Fields, Holder, Ricker, Shapiro, Shelton.



Black Holes and Compact Objects: The densest forms of matter in the Universe power its most energetic phenomena. Research topics include accretion onto supermassive black holes, variability of galactic nuclei, searches for black hole binaries, merging binaries, gravitational wave signals and sources, supernovae, gamma-ray bursts, and explosive nucleosynthesis. **Faculty:** Barrow, Fields, French, Gammie, Liu, Narayan, Ricker, Shapiro, Shen, Witek, Yunes.



Galaxy Formation and Evolution: The early Universe was lit up by the formation of the first stars and galaxies, with the overall cosmic star formation rate reaching a peak about 10 billion years ago and gradually fading ever since. We use observations and models to trace how galaxies form and evolve over cosmic time, from the epoch of reionization to the present day. **Faculty:** Barrow, French, Menanteau, Shen, Turk, Vieira, Wong.



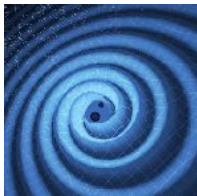
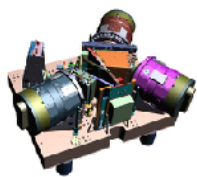
Circumstellar and Interstellar Matter: Interstellar gas is the raw material from which stars form, and stars end their lives returning much of that gas into space, allowing the cycle to begin again. Infrared and radio mapping, coupled with high-resolution spectroscopy, enable us to characterize the physical and chemical conditions of this gas. **Faculty:** Kembell, Looney, Mouschovias, Wong.

Star and Planet Formation: Collapsing molecular cloud cores generate disks from which stars and planets eventually accrete. The properties of these disks are governed by the interplay of gravity, magnetic fields, angular momentum, and turbulent and thermal processes, which we study both observationally and theoretically. **Faculty:** Gammie, Looney, Mouschovias.

Computational Astrophysics: Research in all of the above areas is being transformed by high-performance computing and machine-learning algorithms — areas in which there is long-standing collaboration between Astronomy and the National Center for Supercomputing Applications (NCSA). Topics include magnetohydrodynamic (MHD) and N-body simulations, numerical relativity, cyberinfrastructure, real-time processing of astronomical survey data, and data visualization. **Faculty:** Barrow, Gammie, Narayan, Ricker, Shapiro, Turk.

Graduate & Research Faculty

- **Peter Adshead**, *Associate Professor* — theoretical cosmology
- **Kirk Barrow**, *Assistant Professor* — cosmological simulations, galaxy formation
- **Matias Carrasco Kind**, *Research Assistant Professor* — galaxy surveys, machine learning
- **Patrick Draper**, *Assistant Professor* — early universe, high-energy physics
- **Brian Fields**, *Professor* — cosmology, nuclear and particle astrophysics
- **Jeffrey Filippini**, *Assistant Professor* — observational cosmology, instrumentation, dark matter
- **K. Decker French**, *Assistant Professor* — extragalactic astronomy, transients
- **Charles Gammie**, *Professor* — theory of black holes, disks, & turbulence
- **Robert Gruendl**, *Research Associate Professor* — imaging, survey science
- **Gilbert Holder**, *Professor* — theoretical cosmology, gravitational lensing
- **Athol Kembell**, *Professor* — interferometry, masers, gravitational lensing
- **Xin Liu**, *Associate Professor* — survey science, active galactic nuclei
- **Leslie Looney**, *Professor, Department Chair* — star and planet formation
- **Felipe Menanteau**, *Research Associate Professor* — survey science, cosmology, galaxy clusters
- **Telemachos Mouschovias**, *Professor* — theory of star formation
- **Gautham Narayan**, *Assistant Professor* — time domain astronomy, data science
- **Paul Ricker**, *Professor* — computational astrophysics, cosmology, binary stars
- **Stuart Shapiro**, *Professor* — compact objects, general relativity, gravitational waves
- **Jessie Shelton**, *Associate Professor* — particle physics, dark matter
- **Yue Shen**, *Associate Professor* — quasars, variability, survey science
- **Matthew Turk**, *Assistant Professor* — primordial star formation, visualization
- **Joaquin Vieira**, *Professor* — observational cosmology, galaxy evolution, instrumentation
- **Helvi Witek**, *Assistant Professor* — black holes, gravitational waves
- **Tony Wong**, *Professor* — interstellar medium, nearby galaxies
- **Nico Yunes**, *Professor* — neutron stars, black holes, gravitational waves



Departmental Research Facilities

Center for AstroPhysical Surveys (CAPS) (caps.ncsa.illinois.edu): CAPS unites the astrophysical survey science efforts across the Physics and Astronomy departments and NCSA. Initiatives include the Dark Energy Survey, a 5000 deg² optical imaging survey of the southern sky conducted with the Blanco 4m telescope, the Vera Rubin Observatory, which will conduct a high-cadence survey of the sky using a dedicated 8.4m telescope and state-of-the-art 3.2-gigapixel camera, and CMB-S4, the next-generation ground-based cosmic microwave background experiment. CAPS also provides its members with cluster computing resources and offers a number of graduate student and postdoctoral fellowships. Faculty contact: *Vieira*

South Pole Telescope (SPT) (pole.uchicago.edu): Located at the geographic south pole, the 10-m SPT is the largest telescope dedicated to studies of the cosmic microwave background (CMB), the oldest light in the Universe. Faculty contact: *Vieira*

Subaru Prime Focus Spectrograph (PFS) (pfs.ipmu.jp): The PFS is wide-field optical and near-IR spectrograph that will be mounted on the 8.2-m Subaru telescope. It aims to investigate the nature of dark matter and its role in galaxy formation through a combination of Galactic and extragalactic surveys. Faculty contact: *Liu*

Sloan Digital Sky Survey V (SDSS-V) (www.sdss5.org): SDSS-V builds on the hardware and expertise accumulated by previous SDSS generations to perform wide-field, multi-epoch spectroscopy in both hemispheres. It consists of three key programs, respectively mapping the Milky Way, nearby galaxies, and accreting black holes. Faculty contact: *Shen*