

Welcome/ Overview / Introduction

Joaquin Vieira

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Director, Center for AstroPhysical Surveys (CAPS)

Senior Astronomy Lead, National Center for Supercomputing Applications (NCSA)

University of Illinois Urbana-Champaign

The Transient and Variable Universe

June 20–22, 2023

National Center for Supercomputing Applications
at the University of Illinois Urbana-Champaign

Event program can be found at publish.illinois.edu/transient-variable-2023



Sponsored by NCSA, Center for AstroPhysical Surveys, and the Illinois Center for Advanced Studies of the Universe.

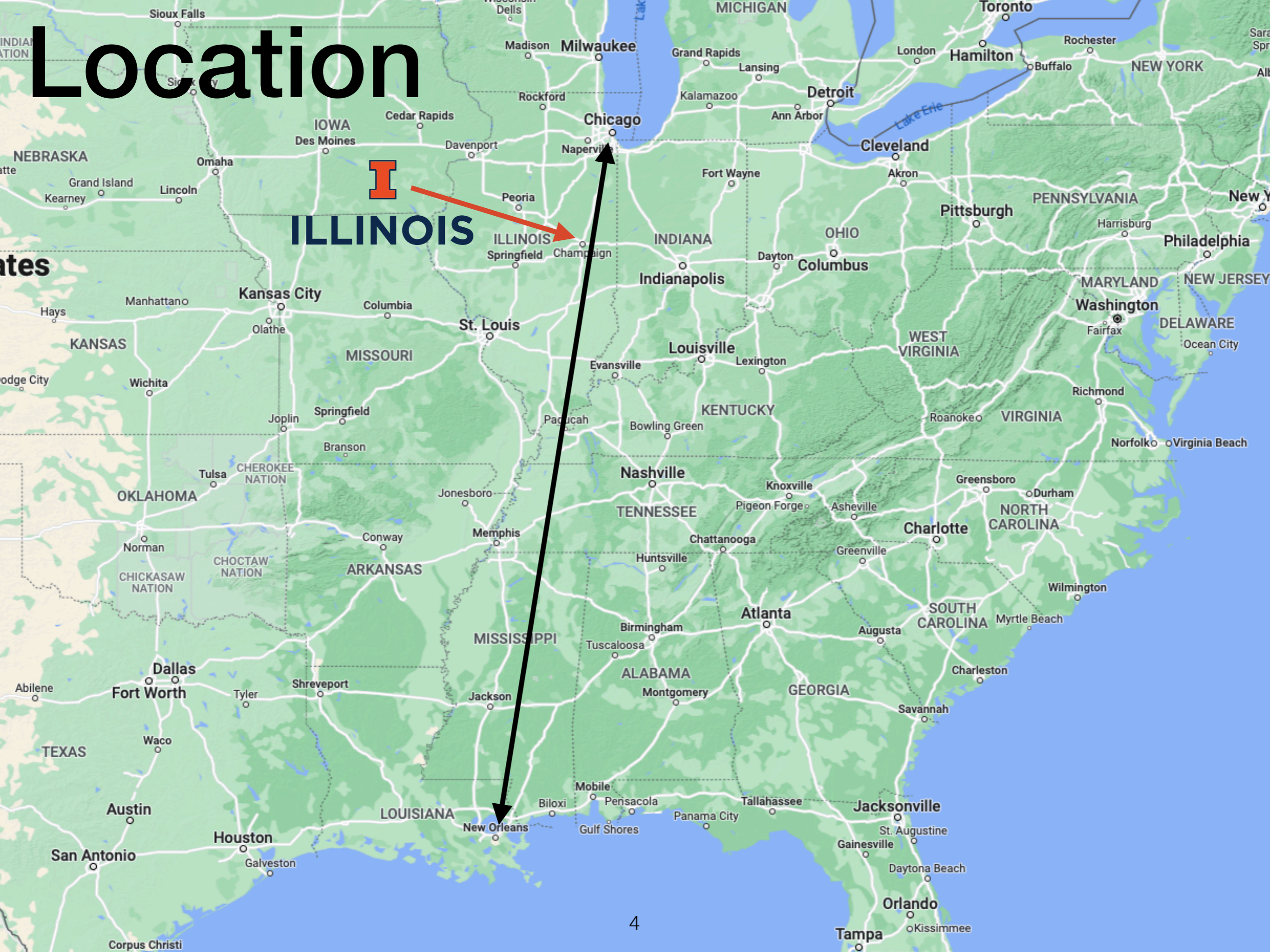
Location



Location



Location



Location

you are here

1 mile radius

Downtown Champaign

Downtown Urbana
Analog Wine Bar
Wed. night

NCSA

Physics

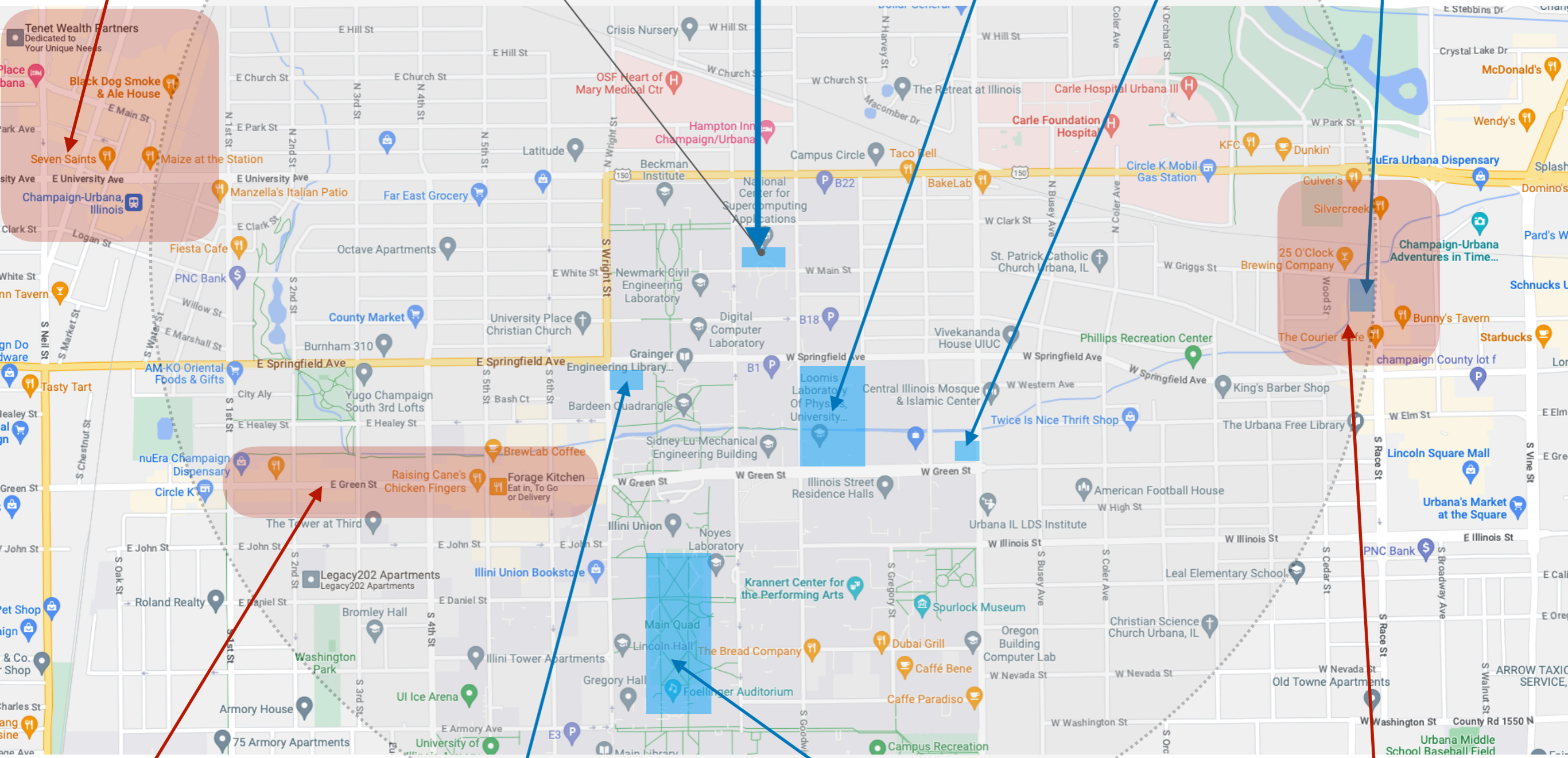
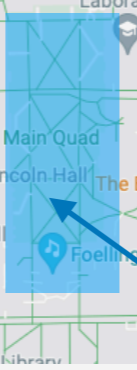
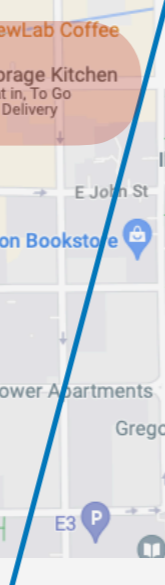
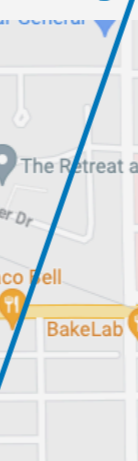
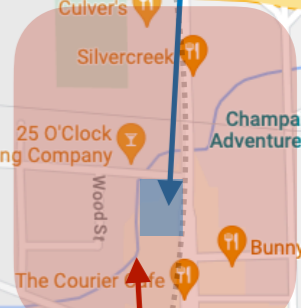
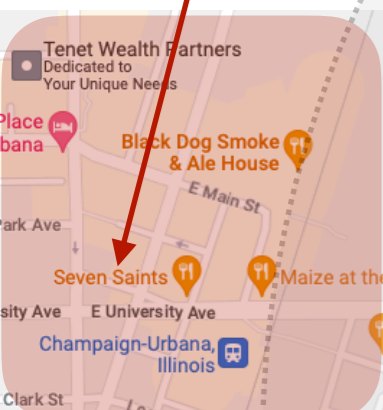
Astronomy

Campus Town

Campus Instructional Facility
Conference Dinner Wed. night

Main Quad

Downtown Urbana



Daily Schedule

time	thing	what	where
9:00AM–10:30AM	plenary 1	3 talks	main auditorium
10:30AM – 11:00AM	coffee break	mingle	atrium
11:00AM – 12:40PM	parallels 1	5 talks x 3	auditorium, 1030, 1040
12:40PM – 2:00PM	lunch	eat	atrium
2:00PM – 3:30PM	plenary 2	3 talks	main auditorium
3:30PM – 4:00PM	coffee break	mingle	atrium
4:00PM – 5:40PM	parallels 2	5 talks x 3	auditorium, 1030, 1040
6PM–	social activity	mingle	depends

Social Activities

Day	thing	what	where
Tuesday	reception	Hors D'oeuvres & Drinks	NCSA atrium
Wednesday	conference dinner & drinks	dinner and late night mingling	Instructional Facility & Analog Wine Bar
Thursday	free	—	—

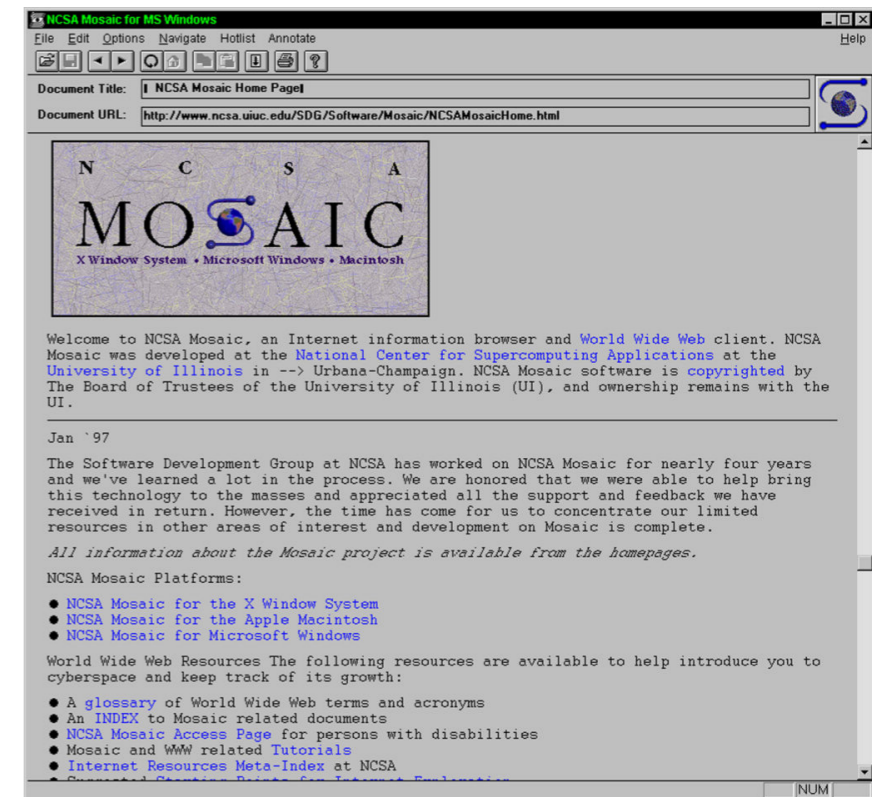
Also:
NCSA Visualization Lab Tours
VR headset demos

I ILLINOIS

NCSA

National Center for Supercomputing Applications

- Illinois has always had a strong connection to computing, with the ILLIAC supercomputers being built and operated here from 1952—1972.
- U. Illinois Astronomy & Physics Prof. Larry Smarr submitted an unsolicited proposal to NSF in 1985. Started in 1986 with \$42M. Smarr was NCSA's founding director.
- Between 1985—1986 NSF founded 5 supercomputing centers:
 - Cornell Theory Center (CTC) at Cornell University
 - National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign
 - Pittsburgh Supercomputing Center (PSC) at Carnegie Mellon University and the University of Pittsburgh
 - San Diego Supercomputer Center (SDSC) at UCSD
 - John von Neumann Center at Princeton University
- Important legacy in the early history of the internet, with the first graphical web interface MOSAIC being built here.
- 2007 NCSA was granted NSF's Blue Waters, a \$208M project, which was NSF's flagship supercomputer and operated from 2012—2021.
- Leadership in computing continues with, e.g. DELTA
- Current NCSA Director is Prof. Bill Gropp. ~250 employees. ~\$70—80M/yr operating budget.
- Historically, Astronomy has been ~10% of NCSA's portfolio.



I ILLINOIS CAPS | The Center for AstroPhysical Surveys

CAPS was started in 2020 and is housed within the National Center for Supercomputing Applications (**NCSA**) at the University of Illinois.

The **strategic goal** for the CAPS is to provide **intellectual** and **scientific leadership** for **astrophysical surveys**.

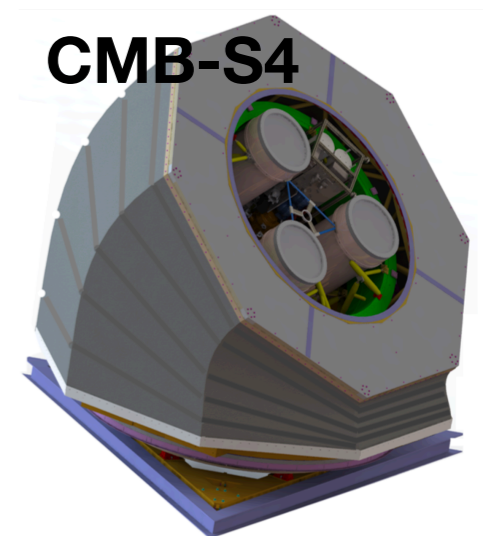
For more information, visit: caps.ncsa.illinois.edu

Projects we are actively engaged in:

- Dark Energy Survey (DES)
- South Pole Telescope (SPT)
- Vera Rubin Observatory (VRO)
- CMB-Stage IV (CMB-S4)
- Scalable CyberInfrastructure to support Multi-Messenger Astrophysics (SCIMMA)

Resources Include:

- 5 graduate student fellowships per year
- 3 postdoctoral fellowships
- computing resources
- visitor program



Astronomy Group & CAPS@ NCSA

Oct 2022

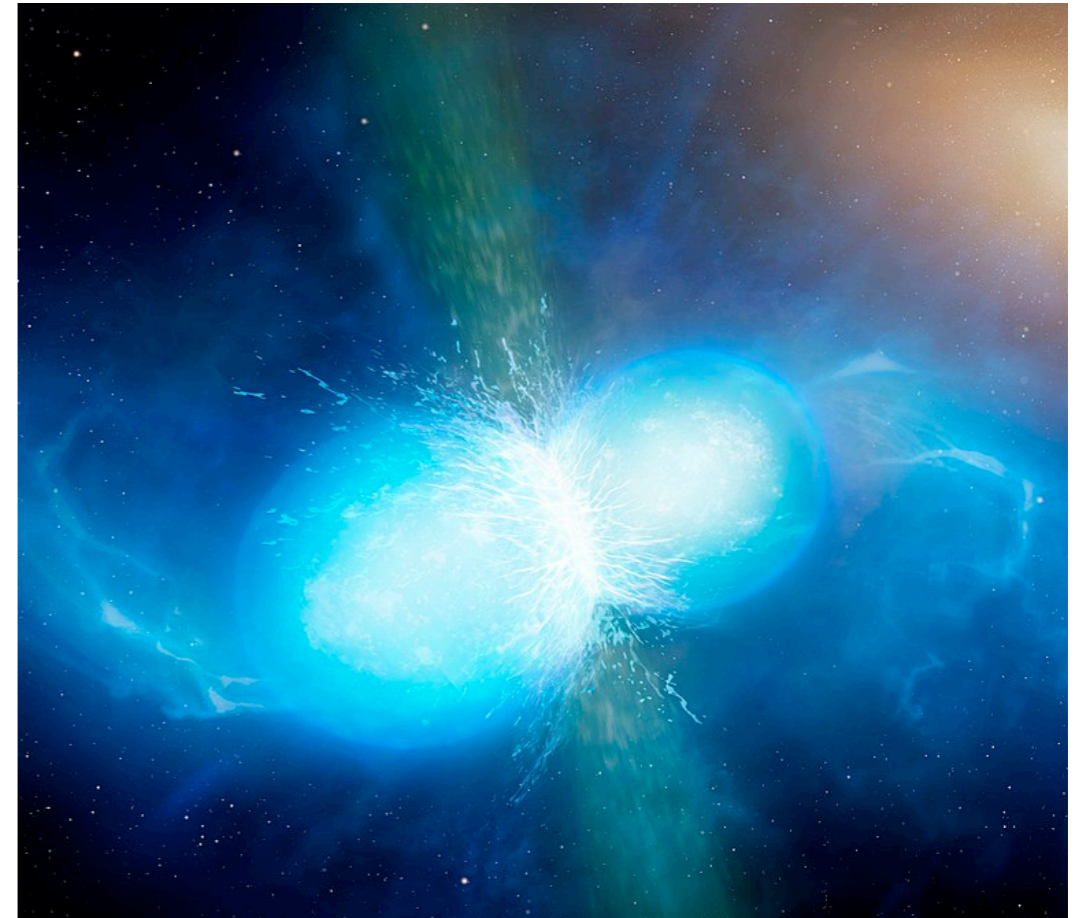


NCSA | National Center for Supercomputing Applications
CAPS | Center for AstroPhysical Surveys

I ILLINOIS CAPS | The Center for AstroPhysical Surveys

Scalable CyberInfrastructure to support Multi-Messenger Astrophysics (SCIMMA)

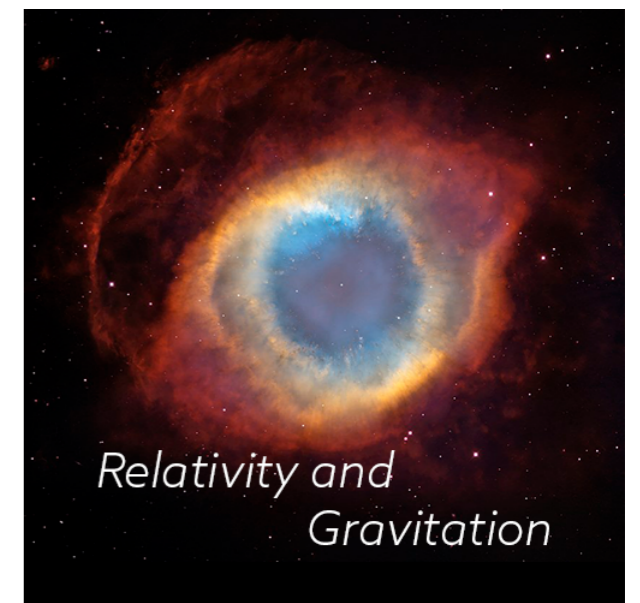
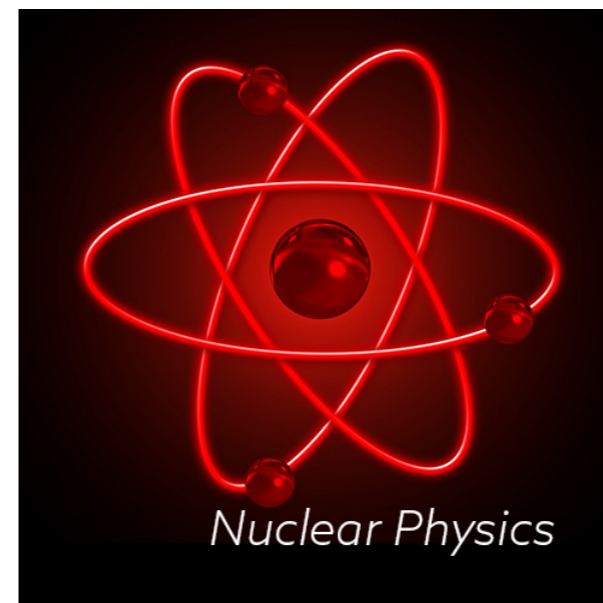
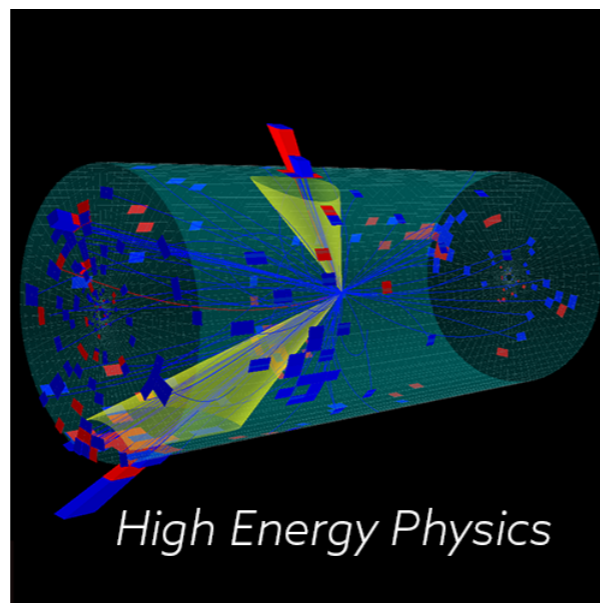
- Joint effort between UIUC/NCSA, LCO, PSU, Cornell, and UCSB to develop community infrastructure for time-domain and multi-messenger astrophysics
- Funded by NSF HDR (PI: Patrick Brady) and CSSI (PI: Gautham Narayan)
- Actively serving LVK Run O4 alerts over Hopskotch (<https://scimma.org/>)
- HERMES: User-friendly web-based UI for cross-platform community reports (<https://scimma.org/hermes.html>)



I ILLINOIS

Illinois Center for Advanced Studies of the Universe (ICASU)

- Started in 2020, Founding Director Prof. Nico Yunes
- ICASU research sits at the intersection of mathematics, computer science, astronomy and physics disciplines, such as nuclear physics, high energy physics, gravitation and cosmology.



Rationale for this Meeting

The discussions that led to this meeting started within the CMB-S4 Sources & Transients Working Group as we were building the case for mm-wave transients.

It was clear to everyone that we are on the cusp of a major disruption event once VRO/LSST begins operations.

It seemed like a good time to bring together all the various tribes working in transients and variables and look for common synergies and look forward at the big picture.

The Transient and Variable Universe

June 20–22, 2023

National Center for Supercomputing Applications
at the University of Illinois Urbana-Champaign

The Vera Rubin Observatory (VRO) and the Legacy Survey of Space and Time (LSST)

System first light: July 2024

Survey start: October 2024

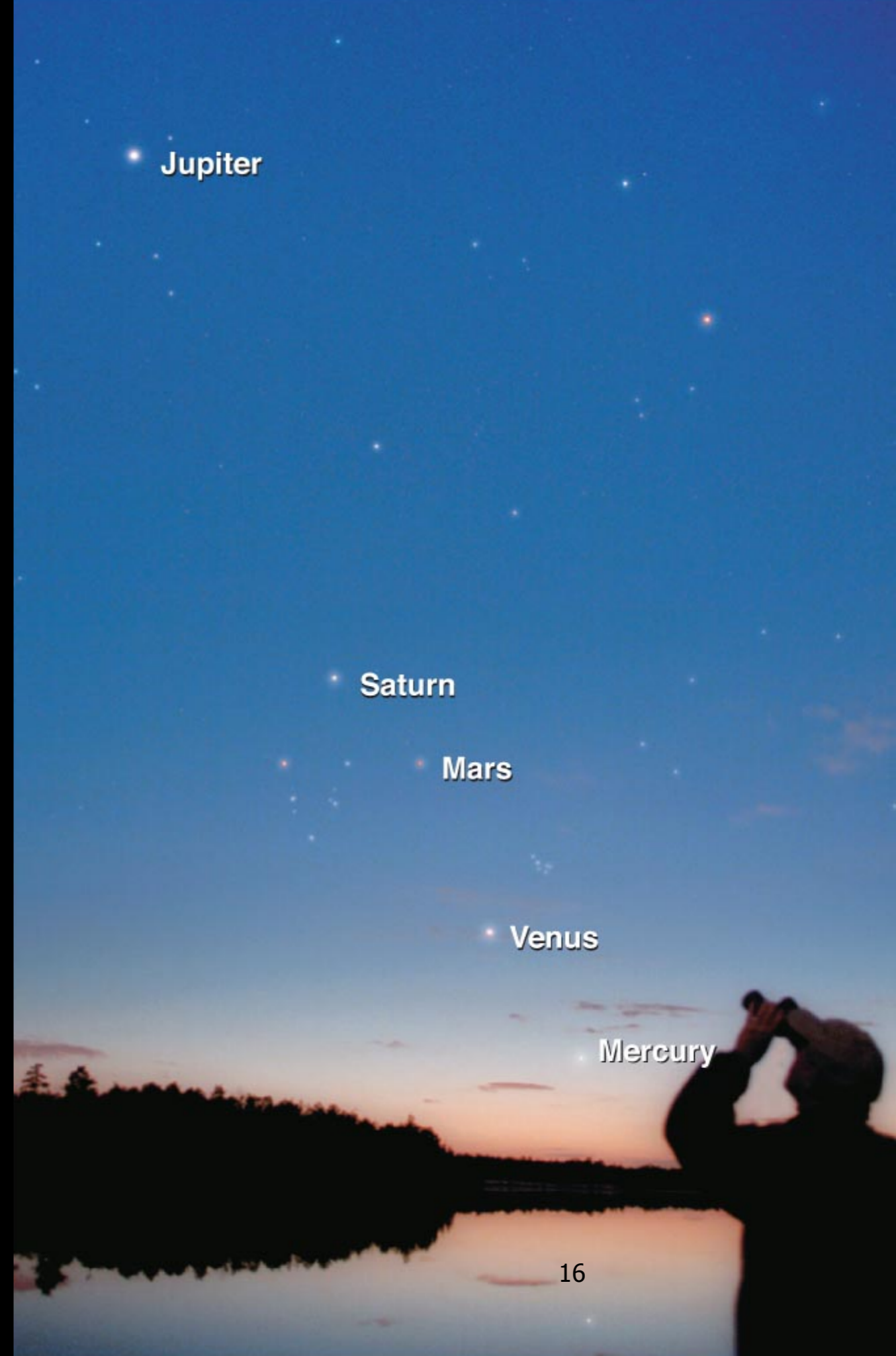


The ancients
knew of
5 planets



The ancients knew of 5 planets

The fact that these moved both
synchronously and abnormally
across the celestial sphere
was a major clue to the
structure and nature of the
Solar System and the Universe





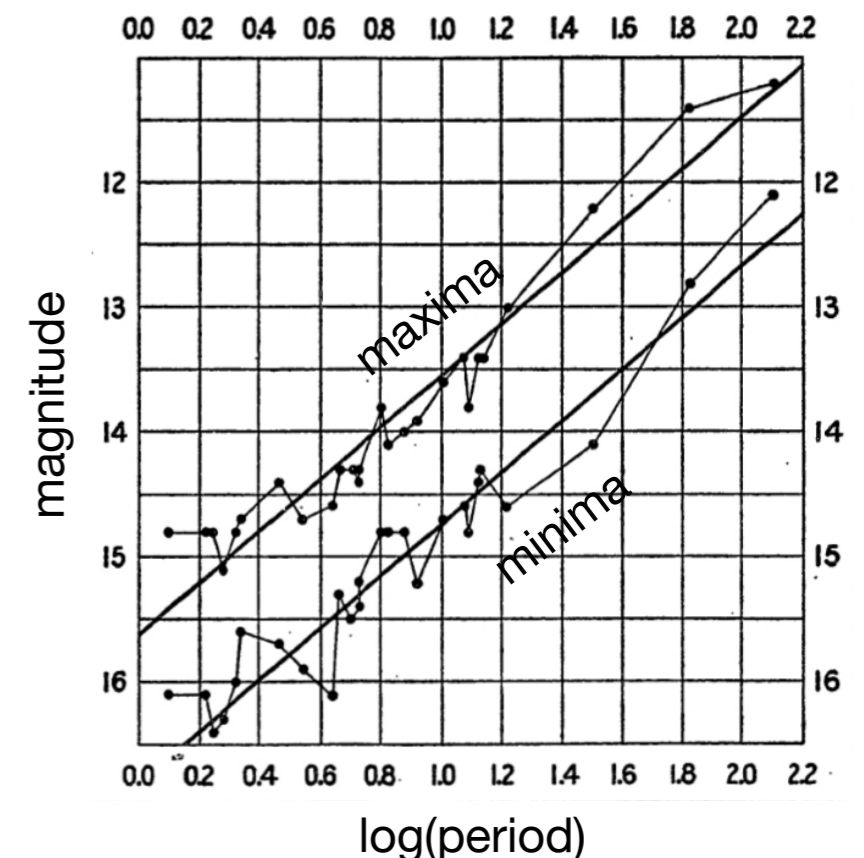
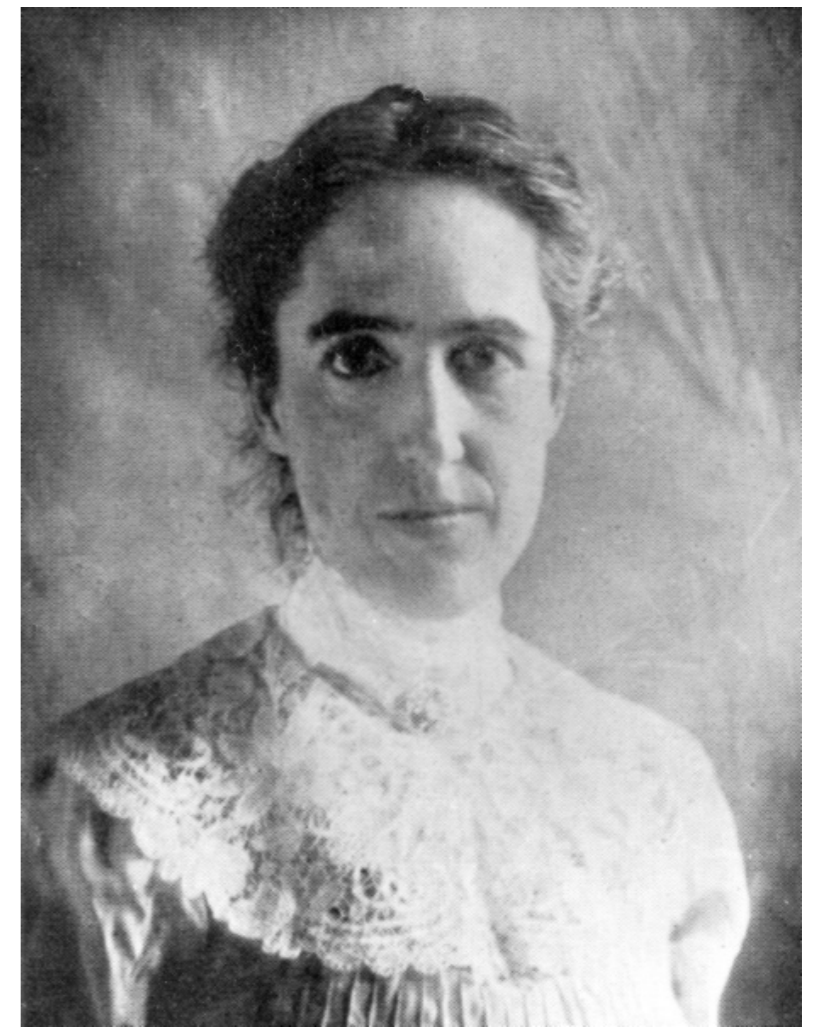
Charles Messier

- 1730–1817
- Devoted his life to astronomy after witnessing Haley's comet.
- Worked for the French Naval Observatory, used a 4" refracting telescope.
- By 1789 he had found between 13–21 comets.
- Made the first catalog of the deep sky.

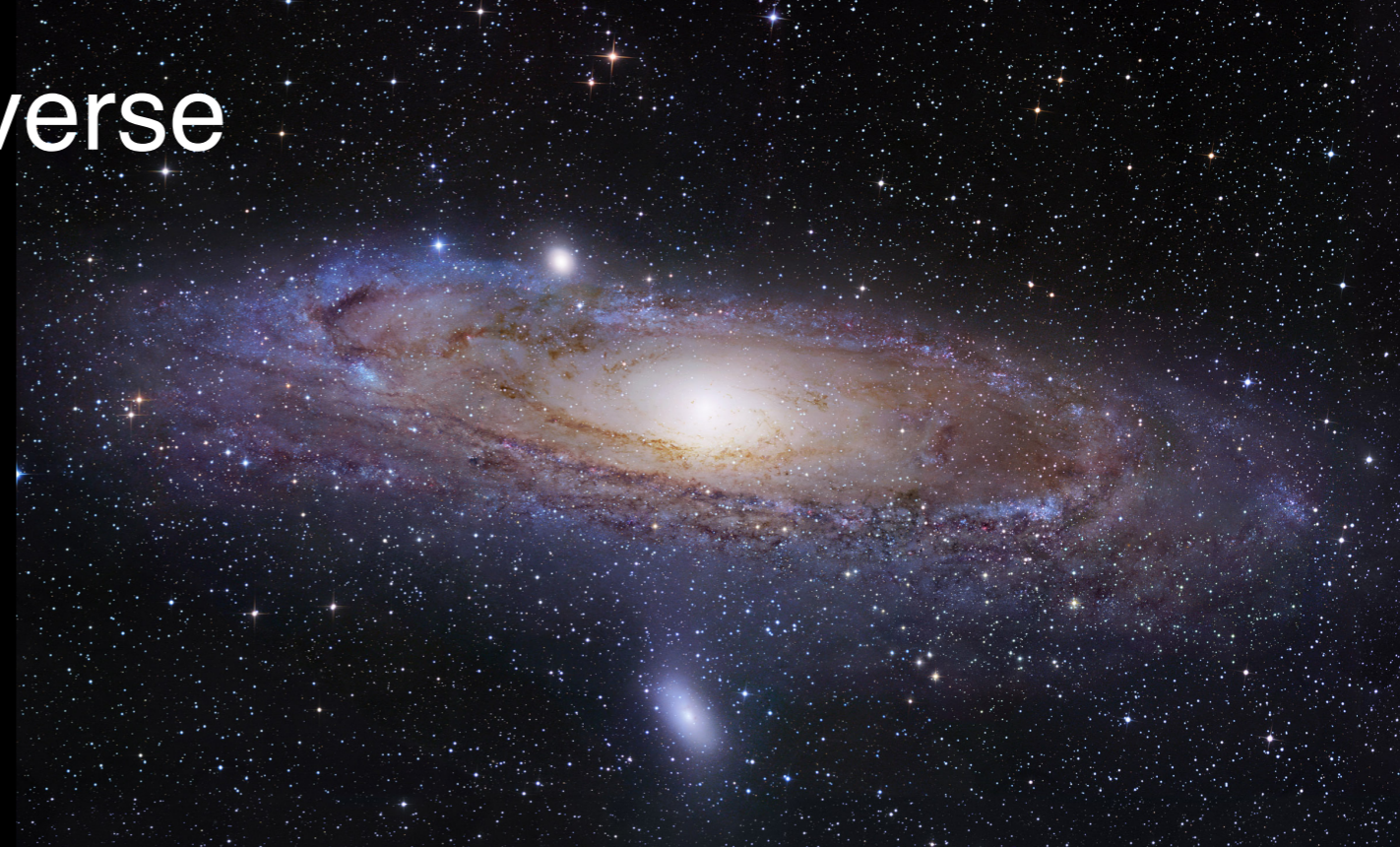
Henrietta Swan Leavitt

Discovered Cepheid variable stars as standard candles

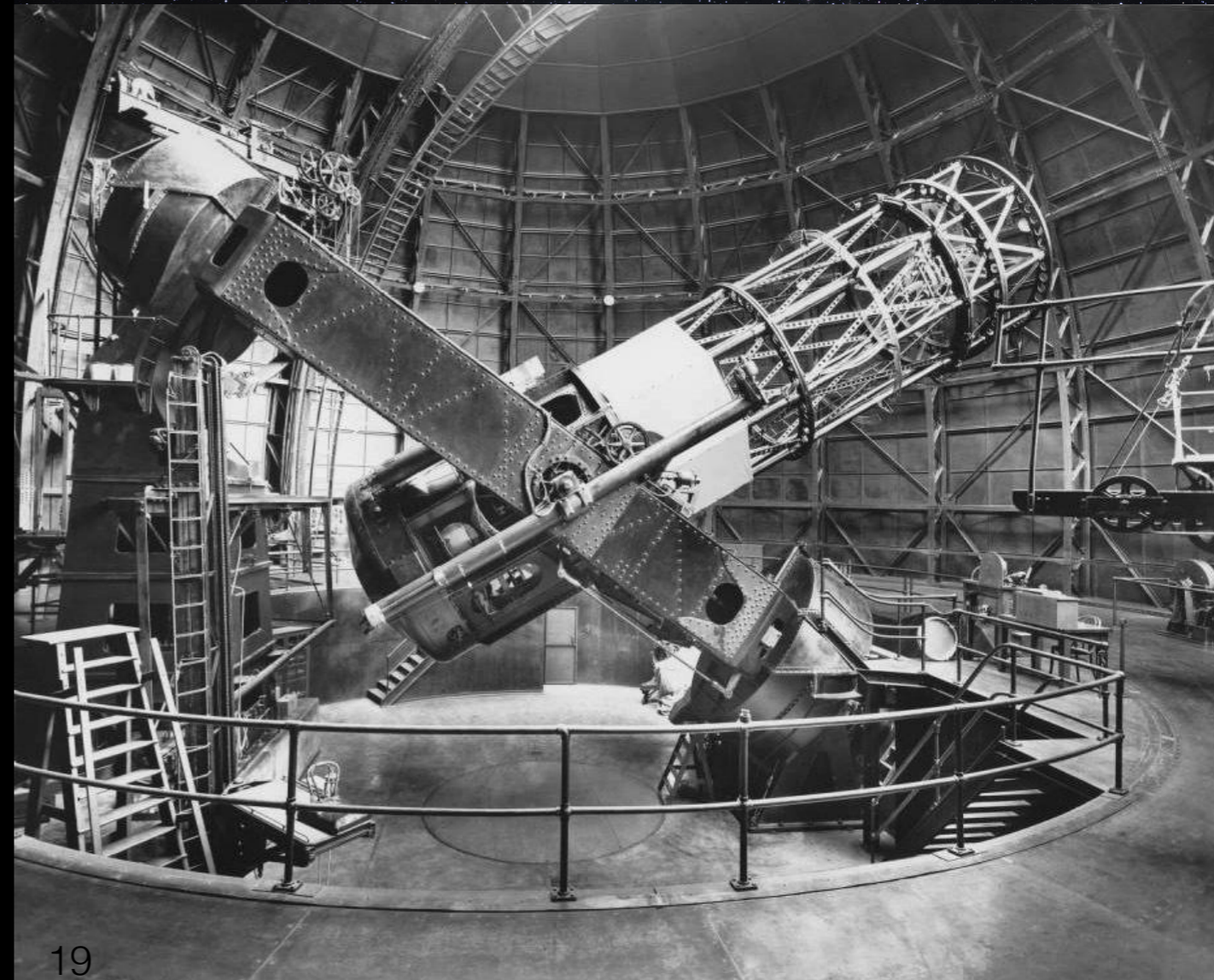
- Graduated from Radcliff College in 1892.
- Hired as a staff astronomer ("human computer") in 1902 at the Harvard College Observatory
- Tasked with measuring photographic plates to catalog the positions and brightness of stars in the Magellanic Clouds.
- She cataloged 1,722 Cepheid variable stars and discovered the relation between the luminosity and the period of Cepheid variables
- This paper (1912) provided the first standard candle to measure the distance to other galaxies.



Hubble Discovers the Universe

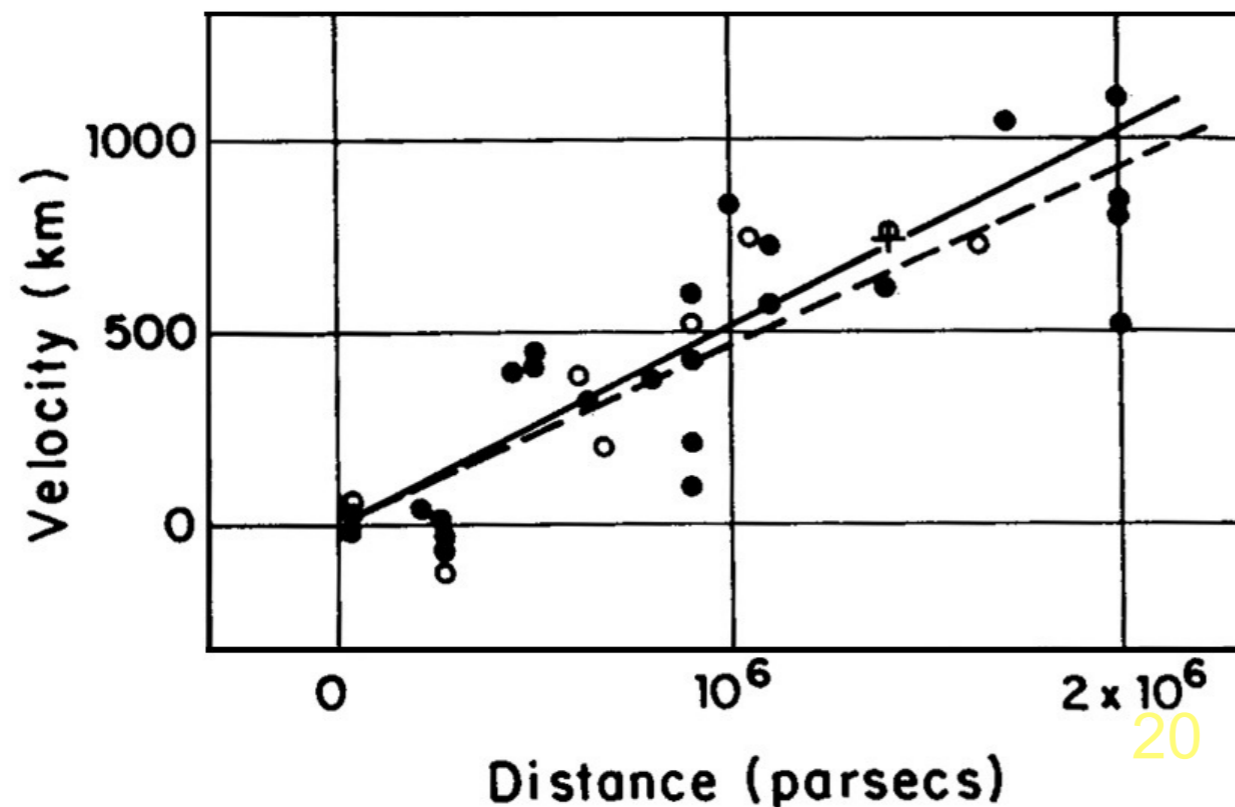
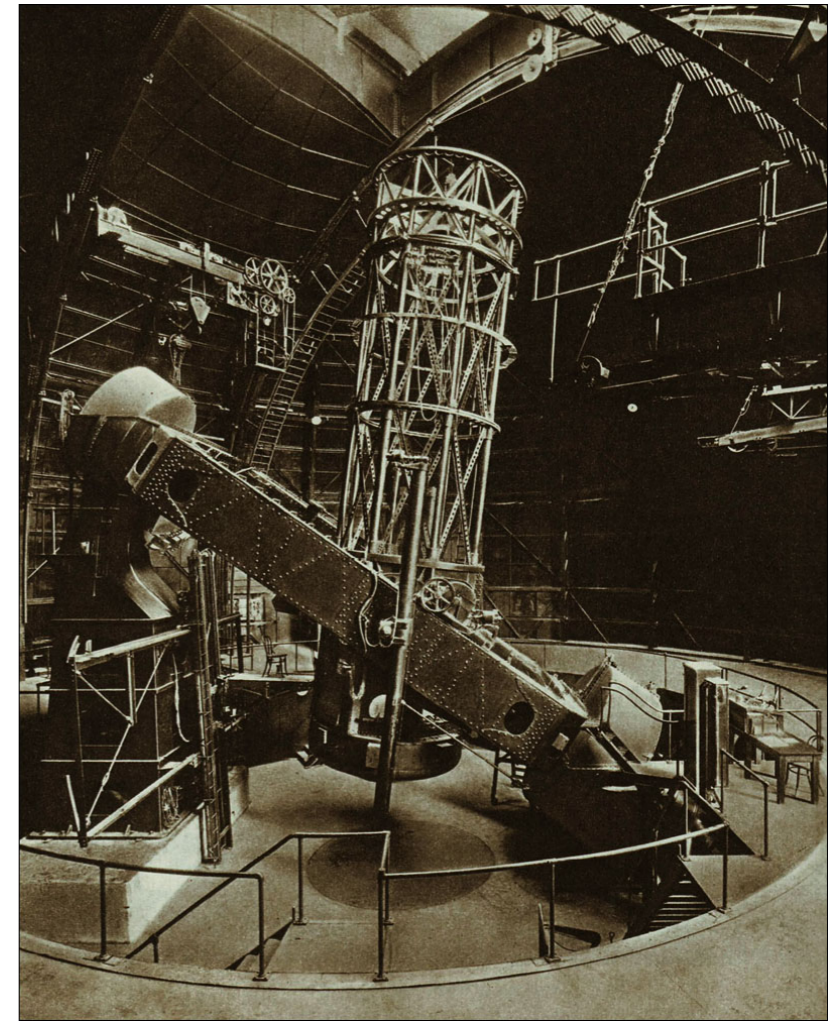


- In 1917 the 100" (2.5m) Hooker Telescope on Mt Wilson was completed. It was the largest and most powerful telescope in the world until 1949.
- In 1923 Edwin Hubble used it to measure the distance to Andromeda. (1 million light years away)
- This completely revolutionized our understanding of the Universe.



The Universe is Expanding

- In 1922 Edwin Hubble determined the distance to the nebulae by observing cepheid variable stars.
- He used the 100-inch Hooker Telescope on Mt. Wilson, which was the most powerful telescope on Earth from 1917—1948
- Hubble combined the distances from Cepheid variables and the radial velocities from Vesto Slipher's spectroscopic redshifts.
- In 1929 he reported the "redshift distance law of galaxies" thereby demonstrating that the Universe, once assumed to be unchanging, was expanding



The Expansion of the Universe

THE ASTROPHYSICAL JOURNAL, 826:56 (31pp), 2016 July 20
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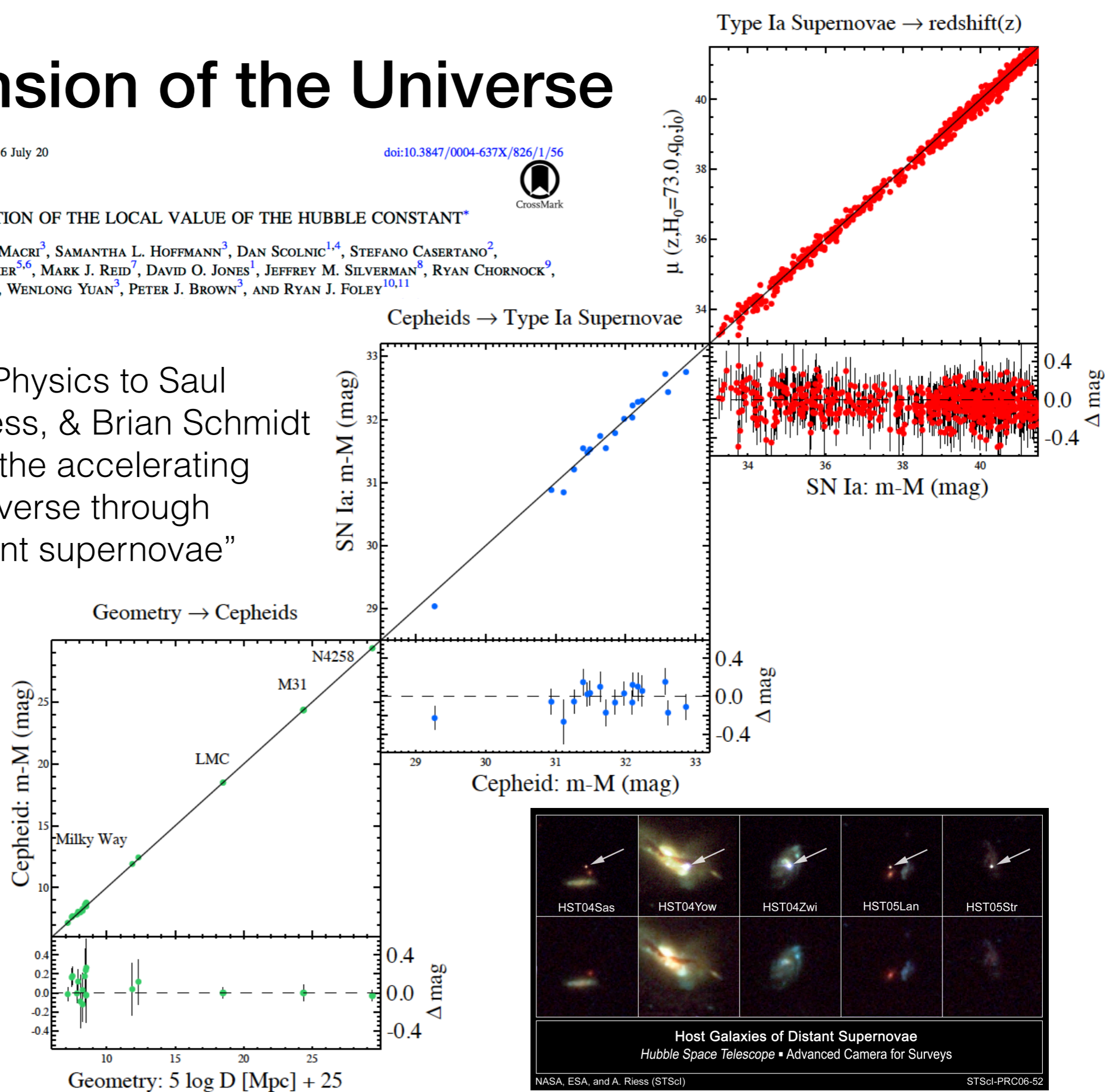
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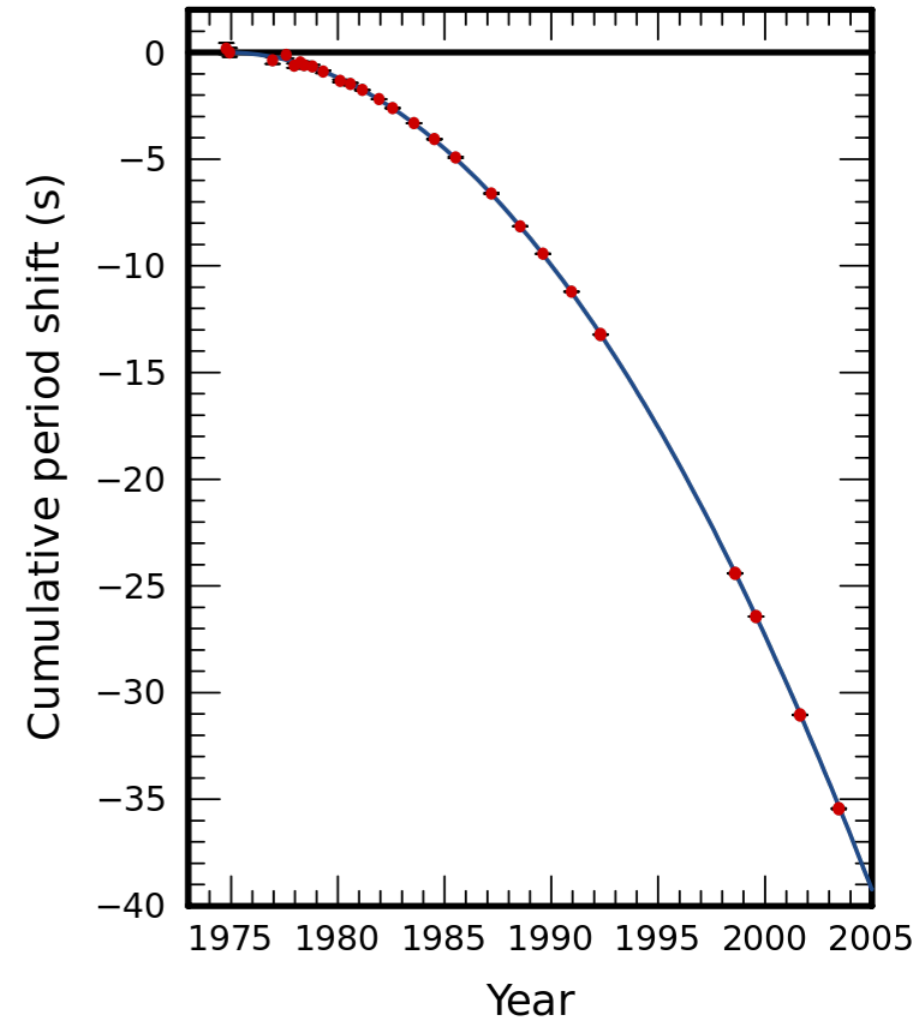
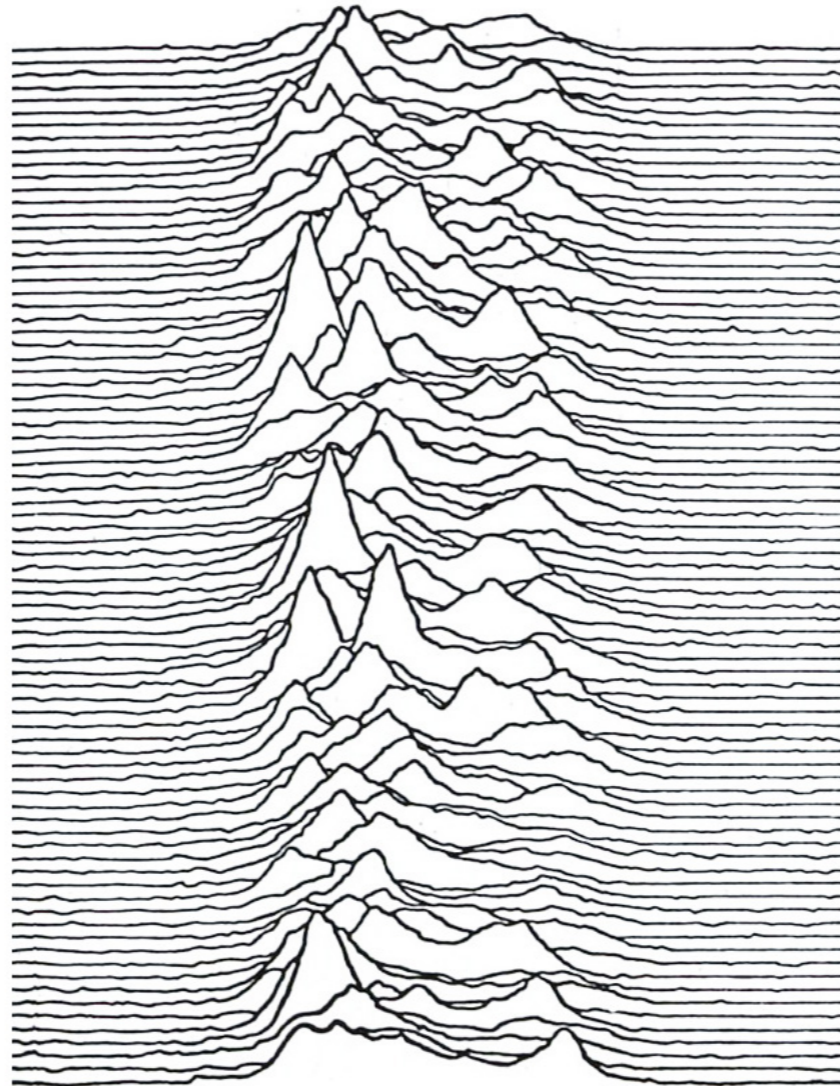
A 2.4% DETERMINATION OF THE LOCAL VALUE OF THE HUBBLE CONSTANT*

ADAM G. RIESS^{1,2}, LUCAS M. MACRI³, SAMANTHA L. HOFFMANN³, DAN SCOLNIC^{1,4}, STEFANO CASERTANO²,
 ALEXEI V. FILIPPENKO⁵, BRAD E. TUCKER^{5,6}, MARK J. REID⁷, DAVID O. JONES¹, JEFFREY M. SILVERMAN⁸, RYAN CHORNOCK⁹,
 PETER CHALLIS⁷, WENLONG YUAN³, PETER J. BROWN³, AND RYAN J. FOLEY^{10,11}

2011 Nobel Prize in Physics to Saul Perlmutter, Adam Riess, & Brian Schmidt
 “for the discovery of the accelerating expansion of the Universe through observations of distant supernovae”

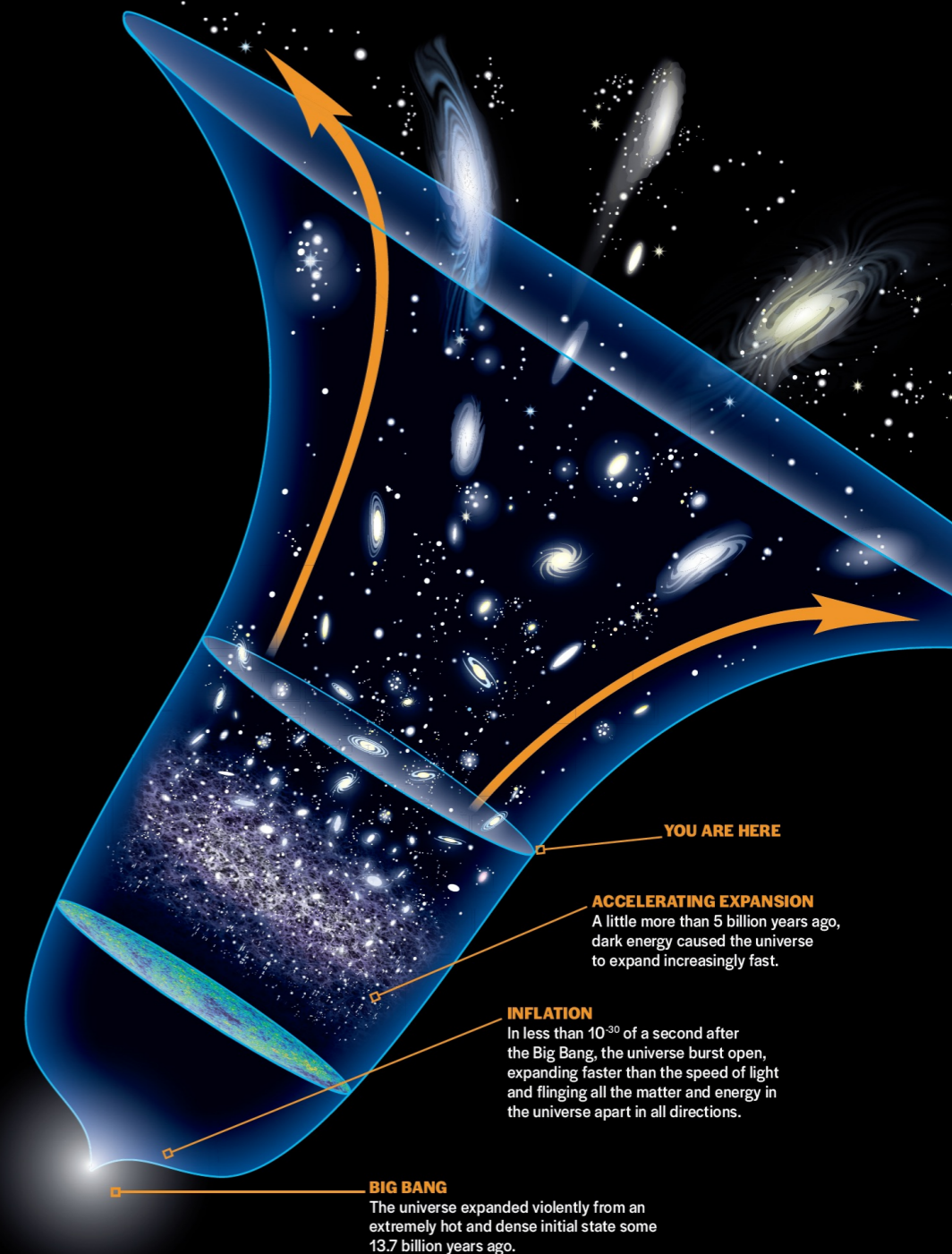


Radio Astronomy Pulsars and Relativity

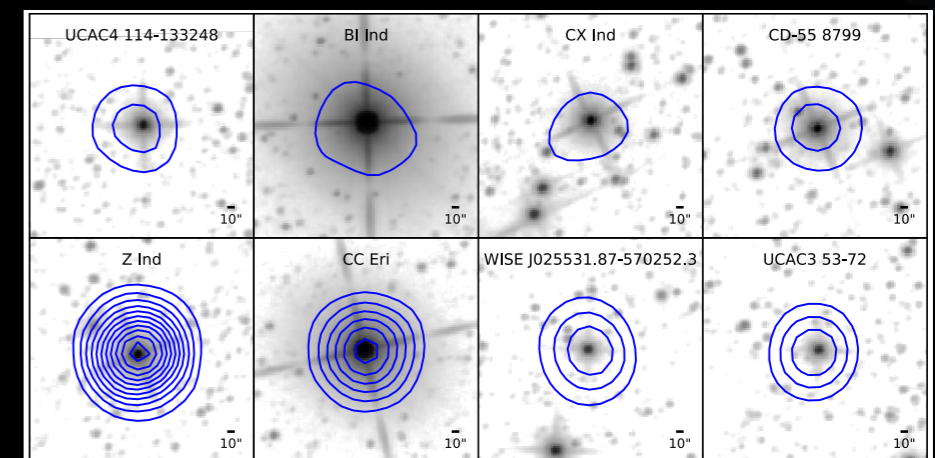


- In 1967 Cambridge graduate student Jocelyn Bell Burnell discovered the first pulsar.
- In 1974 Sir Martin Ryle and Antony Hewish shared the Nobel Prize in Physics -- Ryle for interferometry and Hewish for the discovery of pulsars.
- In 1974 Russell Hulse and Joe Taylor from U. Mass discovered a binary neutron star system. They used Arecibo to measure the spin down, which was the first indirect detection of gravitational waves, and won them a Nobel Prize in 1993.

The beginning of the universe ...



... and opening the mm-wave transient sky with SPT and CMB-S4



Organizers:

LOC:

Jay Alameda, U. Illinois / NCSA

Alisha Funkhouser-Walker, U. Illinois / NCSA

Felipe Menanteau, U. Illinois / NCSA

Gautham Narayan, U. Illinois / NCSA

Nico Yunes, U. Illinois

Joaquin Vieira, U. Illinois / NCSA

SOC:

Marco Ajello, Clemson University

Barnali Das, University of Delaware

Gregg Hallinan, Caltech

Julie McEnery, NASA Goddard

Tom Maccarone, Texas Tech University

Philip Lucas, University of Hertfordshire

Gautham Narayan, U. Illinois / NCSA

Rachel Osten, Space Telescope Science Institute

Nico Yunes, U. Illinois

Joaquin Vieira, U. Illinois / NCSA

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Loose Ends:

- Code of Conduct
 - Any issues, contact Joaquin or Alisha or any member of the LOC or SOC
- COVID protocols
- Slack (see email from Alisha on 6/6/23)
- Live Zoom Webinar (see email from Alisha on 6/6/23)
- Space at NCSA is available for discussions, hacking, or a quiet spot for a Zoom call. Just contact anyone on the LOC.
- Twitter tag: #tvu23

The
Transient and
Variable Universe

Our Assignment:

I hope this meeting stimulates new ideas,
makes new scientific connections,
propels us out of the pandemic,
and prepares us for the exciting upcoming
era of time-domain surveys.

Let's be visionary.
Let's be nice.

The
Transient and
Variable Universe