CHARA Year in Review

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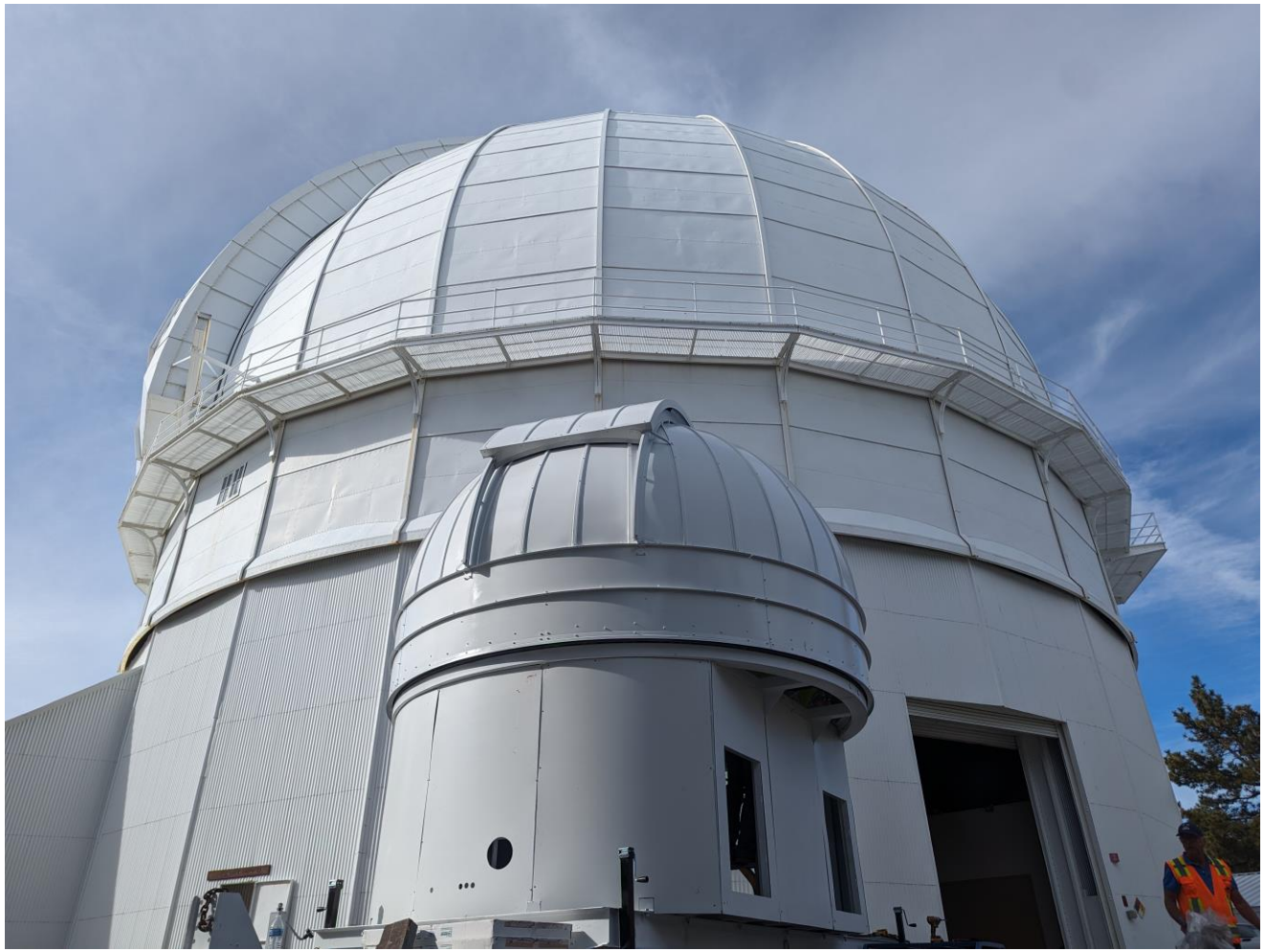
1. Introduction

- Welcome!
- Bienvenue à Tucson!
- CHARA Array Update
- Instrumentation Advances
- Scientific Discoveries
- Concluding Remarks



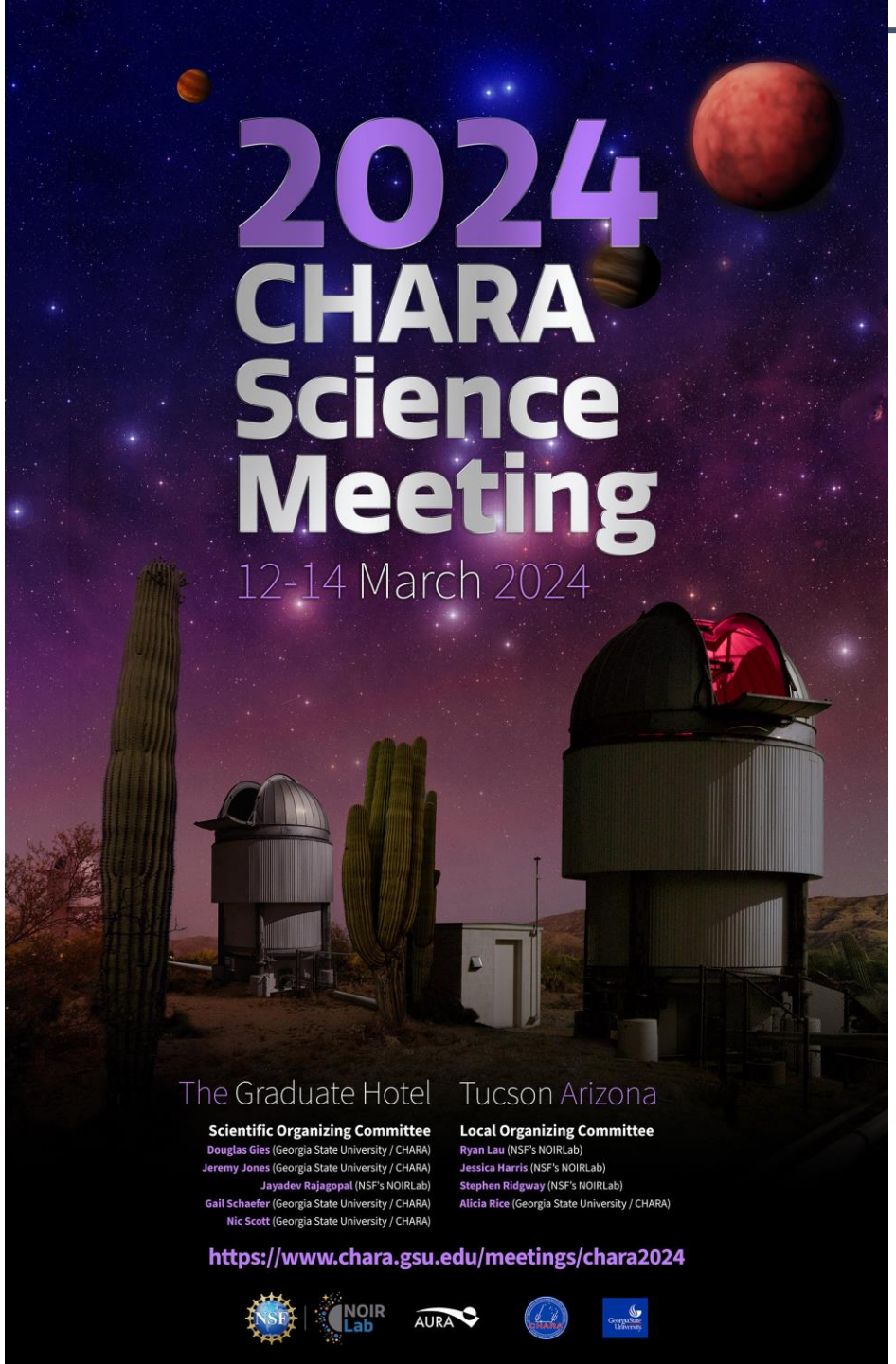
Many thanks to …

Patrick McCarthy & NOIRLab

Local Organizing Committee:
Ryan Lau, Jessica Harris,
Stephen Ridgway, Alicia Rice

Scientific Organizing Committee:
Gail Schaefer, Jeremy Jones,
Jayadev Rajagopal, Nic Scott

National Science Foundation

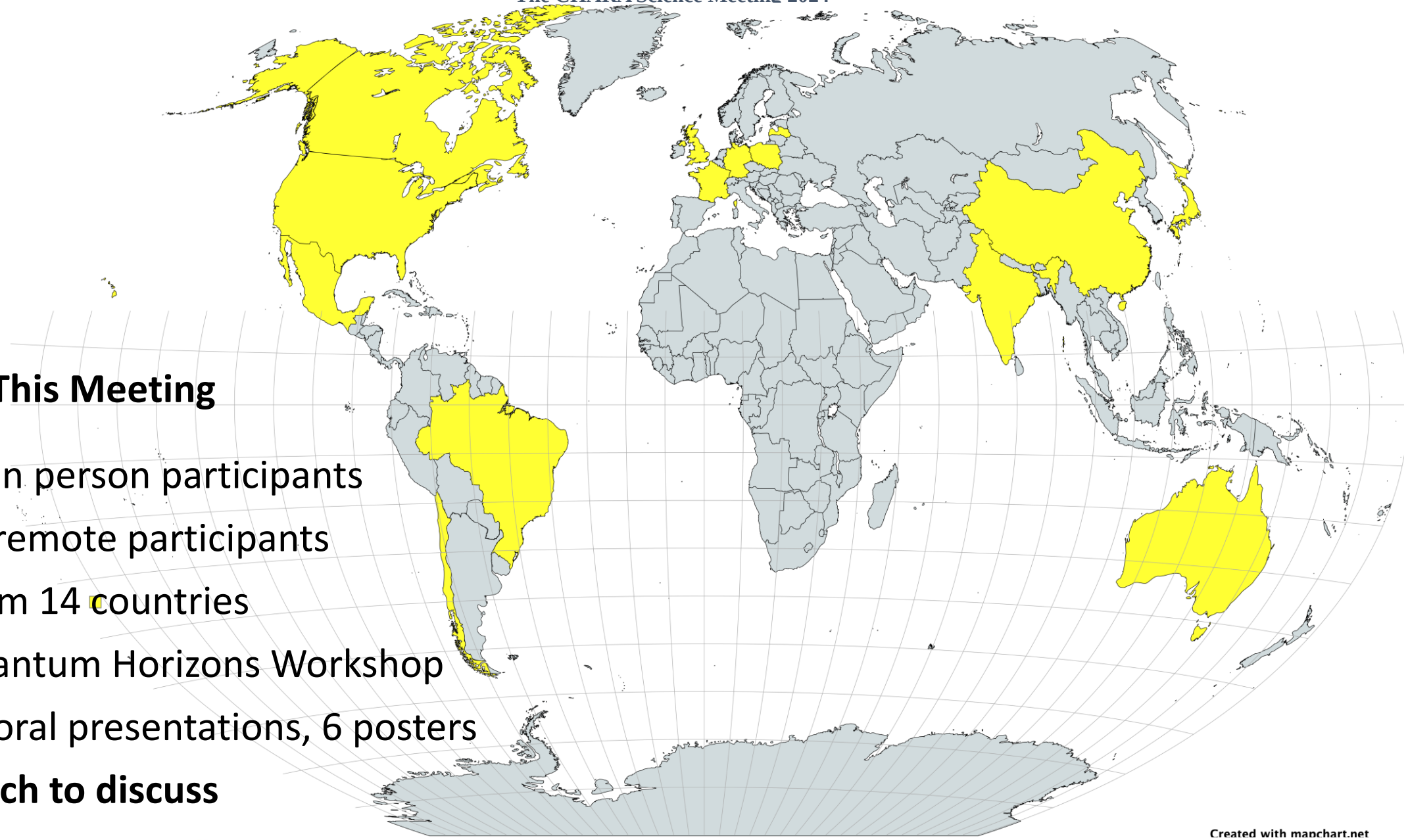


ANNUAL CHARA SCIENCE MEETINGS

https://www.chara.gsu.edu/news/meetings

- 2005 Paris
- **2006 Tucson**
- 2007 New York
- 2009 Nice
- 2010 Pasadena: Caltech
- 2011 Atlanta
- 2012 Atlanta
- 2013 Flagstaff
- 2014 Ann Arbor
- 2015 Atlanta
- 2016 Nice
- 2017 Pasadena: Carnegie
- 2018 Paris
- 2019 Flagstaff
- 2021 Virtual
- 2022 Exeter, UK
- 2023 Atlanta
- **2024 Tucson**

Atlanta, March 2023

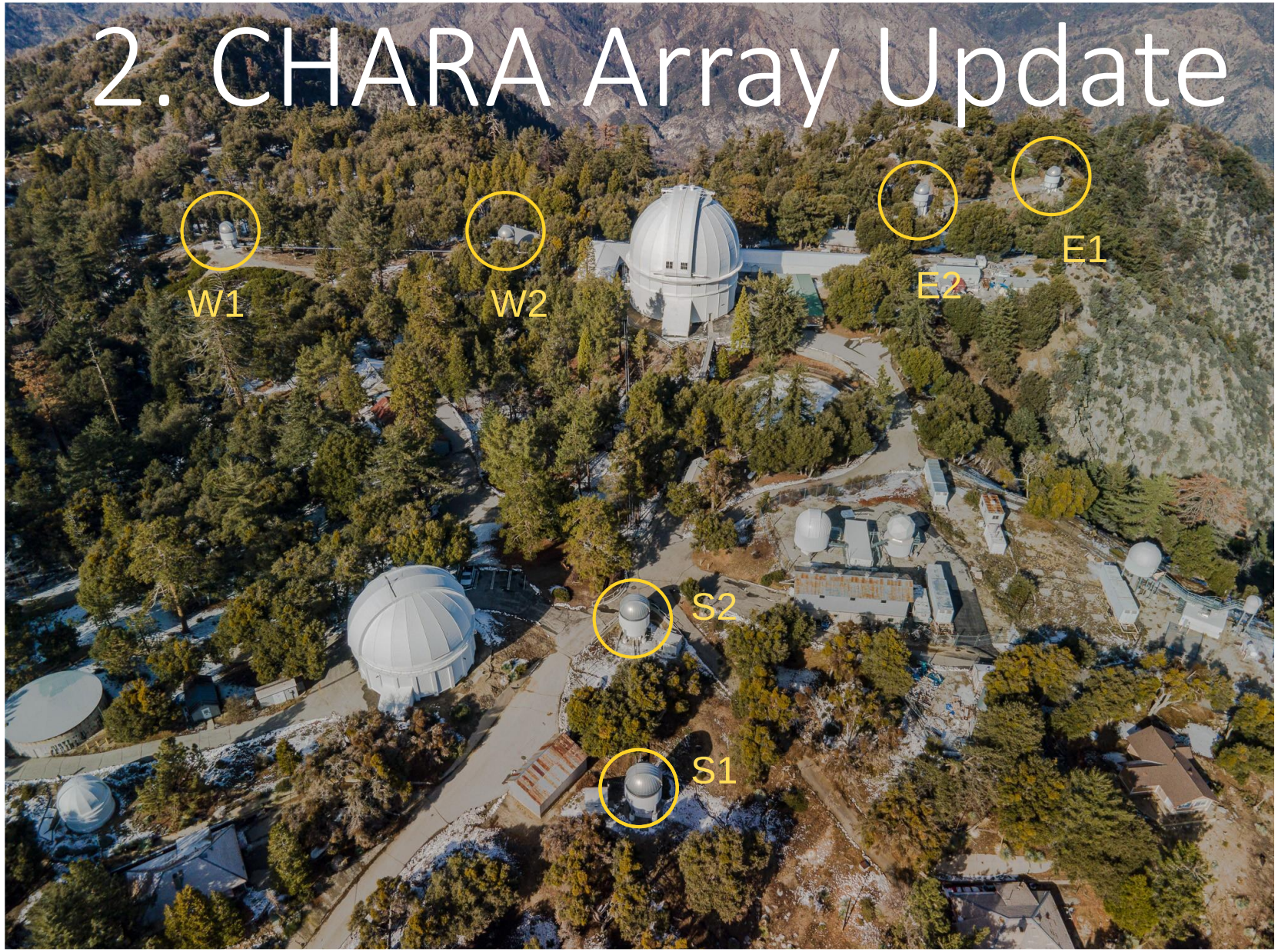


This Meeting

- 46 in person participants
- 41 remote participants
- From 14 countries
- Quantum Horizons Workshop
- 40 oral presentations, 6 posters
- **Much to discuss**

2. CHARA Array Update

- CHARA Array at Mount Wilson Obs.
- Better than ever after 20 years of work
- Two observing semesters:
  A (March - July)
  B (August – December)
- 2024B proposals are due Monday, April 1
- Internal collaboration submission OR NOIRLab solicitation



CHARA Staff Transitions

- **Julien Dejonghe** (OCA) returned to Nice
- **Matthew Anderson** (10 year) moved to Georgia Tech
- **Steve Golden** (20 year) retired but will return part-time for site management
- **Norm Vargas** (12 year) moving from telescope operator to Assistant Site Manager; ***seeking a new telescope operator***
- Welcome to **Karolina Kubiak** (postdoc, optical lab)
- Welcome to **Becky Flores** (GSU graduate student, telescope operator)

The GSU 2023 Ignite Award winners

Research Impact Award: The CHARA Array of Georgia State University, consisting of Gail Schaefer, Theo ten Brummelaar, Nic Scott, Narsireddy Anugu, Nils Turner, Christopher Farrington, Jeremy Jones and Cyprien Lanthermann

The CHARA Array is one of the most complex astronomical facilities ever built, and the work of this team has led to the discoveries of magnetic storms on the surfaces of stars, the expanding fireball from a nova explosion and the gas and dust ring surrounding a supermassive black hole.

GSU Transitions

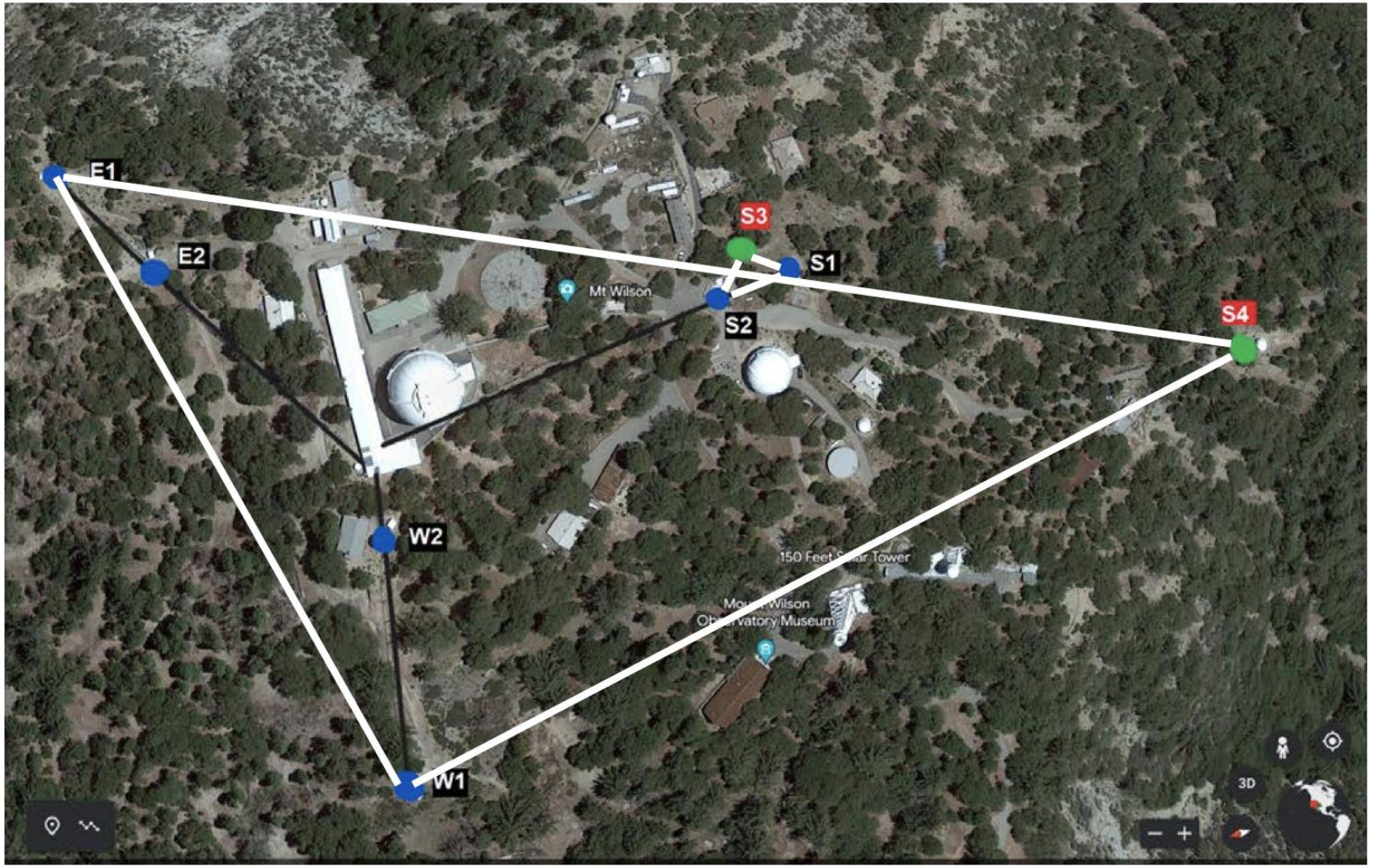
- **President Brian Blake**
- **Provost**
  Nicolle Parsons-Pollard
- **Vice President for Research**
  Donald Hamelberg
- **Dean Lindsey Cohen**
  (College of Arts & Sciences)

- Plan to visit CHARA in October
- GSU College of Arts & Sciences is a key contributor to CHARA operations

New Proposals Pending

- NSF Astronomy and Astrophysics Grants
  High Angular Resolution Community Science at the CHARA Array
- NSF Advanced Technologies and Instrumentation
  Next Generation Adaptive Optics and Improved Sensitivity for the CHARA Array
- NSF Major Research Instrumentation
  MRI: Track 2 Development of a Kilometer Baseline for the CHARA Array

3. Instrumentation Advances



A seventh, mobile telescope for the CHARA Array

Small triangle for big stars S1-S2-**S3** (23 m)

Big triangle for small stars E1-W1-**S4** (550 m)

- 1 m aperture PlaneWave telescope with AO bench (installation March 19)
- Beam transport using single mode PM optical fibers for *H*-band
- Six matched fiber cables of 660 m length for 2 mobile and 4 existing sites
- Talks by **Ligon, Farrington, Koehler, Scott**
- Funded by NSF/MRI grant

Beam Combiners

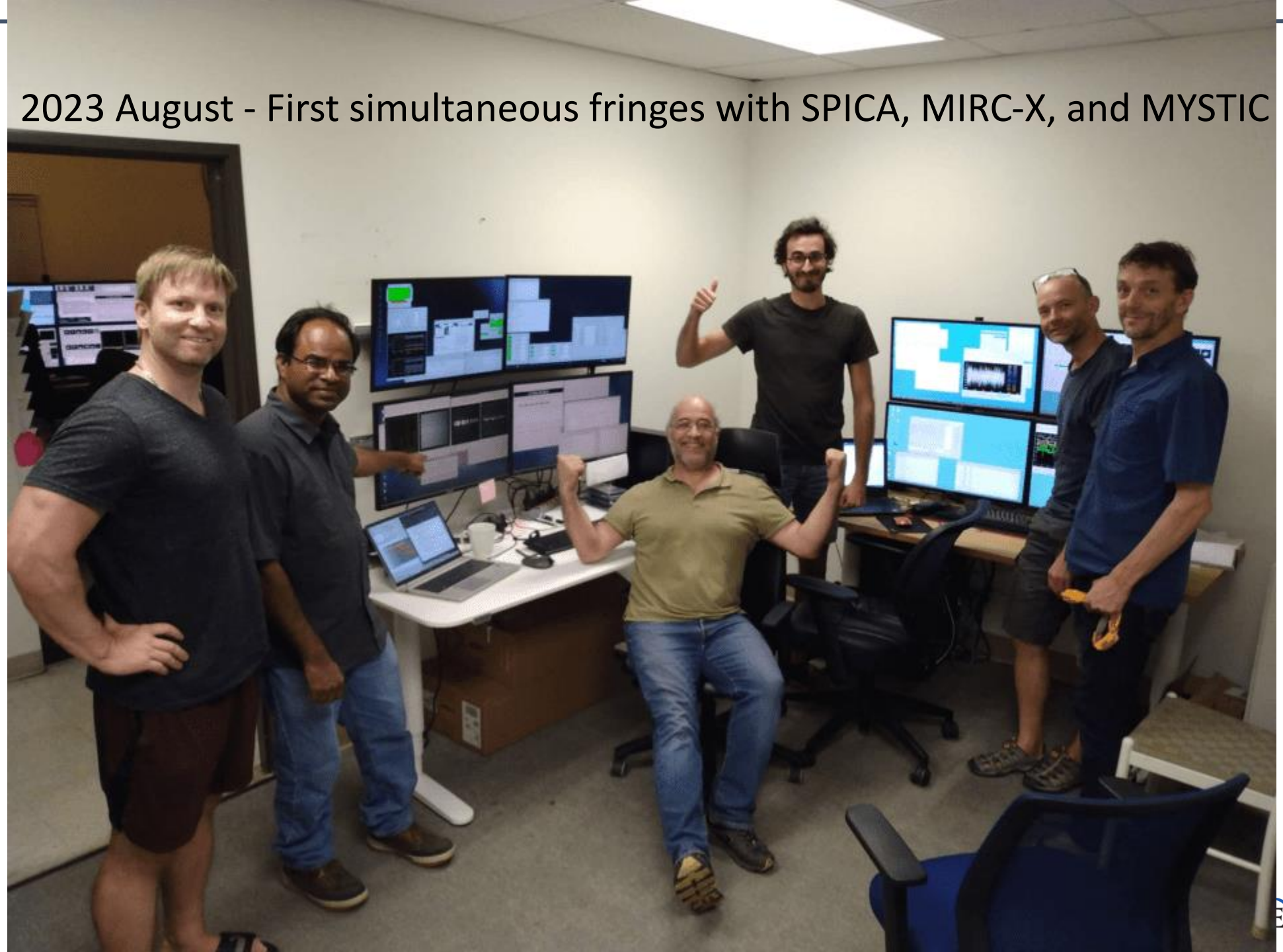
MIRC-X (H-band) / **MYSTIC** (K-band)

- 6T combiner
- Ideal for imaging applications
- New modes, improvements
- Talk by **Monnier**

SPICA (visible-band)

- 6T combiner, survey work
- Now commissioning
- Joint risk in 2024B
- Talk by **Mourard**

2023 August - First simultaneous fringes with SPICA, MIRC-X, and MYSTIC



Beam Combiners

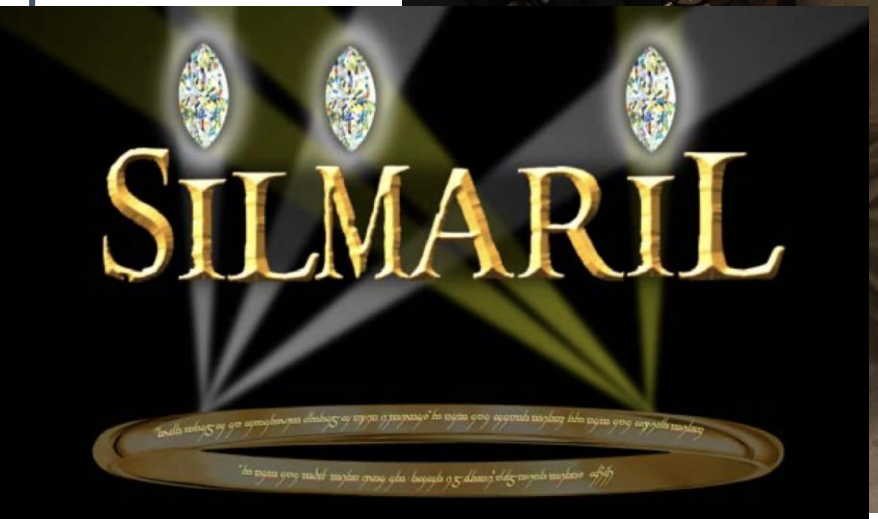
Silmaril (J,H,K-band)

- 3T combiner
  (ten Brummelaar, Tuthill, Lanthermann)
- Designed for high sensitivity and faint targets
- First fringe August 2023 with CRED-2 camera on loan from Lowell Observatory
- CRED-1 coming
- Talk by **Lanthermann**

CHARIOT (J,H,K-band)

- **CH**ARA **Ar**ray **I**ntegrated **O**ptics **T**estbed
- Ultrafast laser inscription of integrated optics
- replacing JouFLU experiment
- Scott, Leibnitz Institute for Astrophysics Potsdam (AIP)

2023 August –
First fringes for Silmaril



Telescopes and All

- New mount drives are planned;
  New motors and controllers for the dome cylinders;
  talk by **Scott**

- AO Systems
  One TelAO DM under repair;
  New software suite (ten Brummelaar);
  talk by **Kubiak**

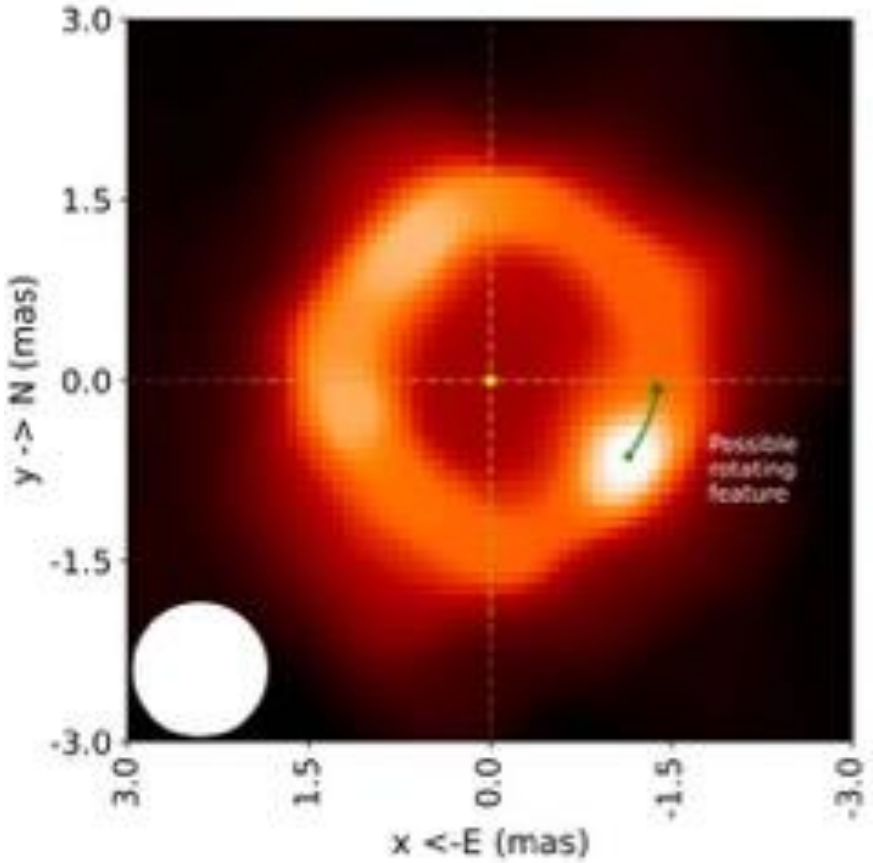
- OPLE Delay Lines
  Diagnosis of intermittent jumps in position;
  talk by **Anugu**

- New vacuum pump for light pipes

- New backup generator ordered

4. Scientific Discoveries

- 14 papers over last year,
  total of 248 to date
- http://www.chara.gsu.edu/astronomers/journal-articles
- Topics include:
  - stellar angular diameters and radii, temperatures, ages
  - imaging circumstellar disks
  - evolved stars and mass loss
  - binary stars and stellar multiplicity



Herbig Be star HD190073;
Ibrahim et al. (2023)

Science from the open access program: AAS Special Session, January 10, New Orleans

Noura Ibrahim, University of Michigan,
Imaging complex temporal variations in the disks of Herbig stars

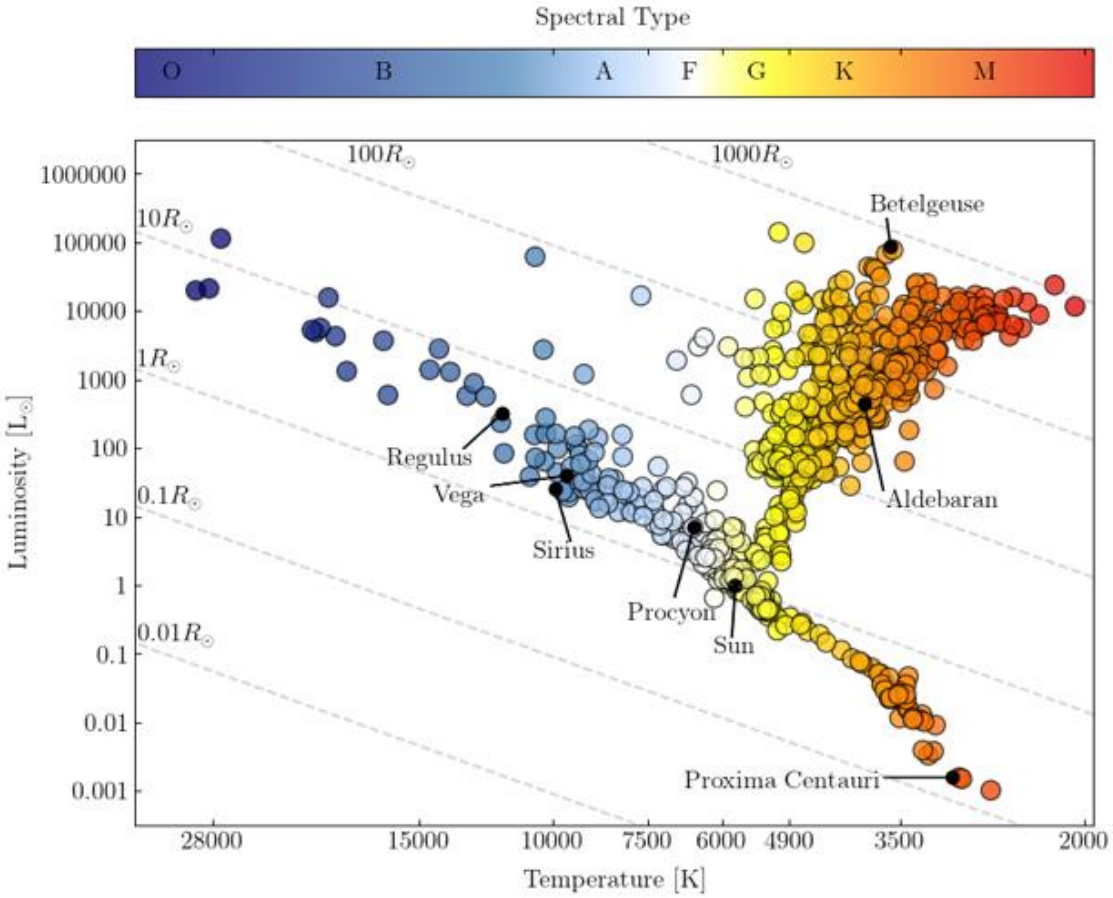
Matthew De Furio, University of Texas at Austin,
The Multiplicity of A-type Stars at Small Separations

Eric Sandquist, San Diego State University, *Mapping Binary Orbits in Star Clusters*

Rachael Roettenbacher, University of Michigan, *Maps of Starspots*

Elias Aydi, Michigan State University, *CHARA early imaging of nova ejecta reveals evidence for multiple outflows and delayed ejection*

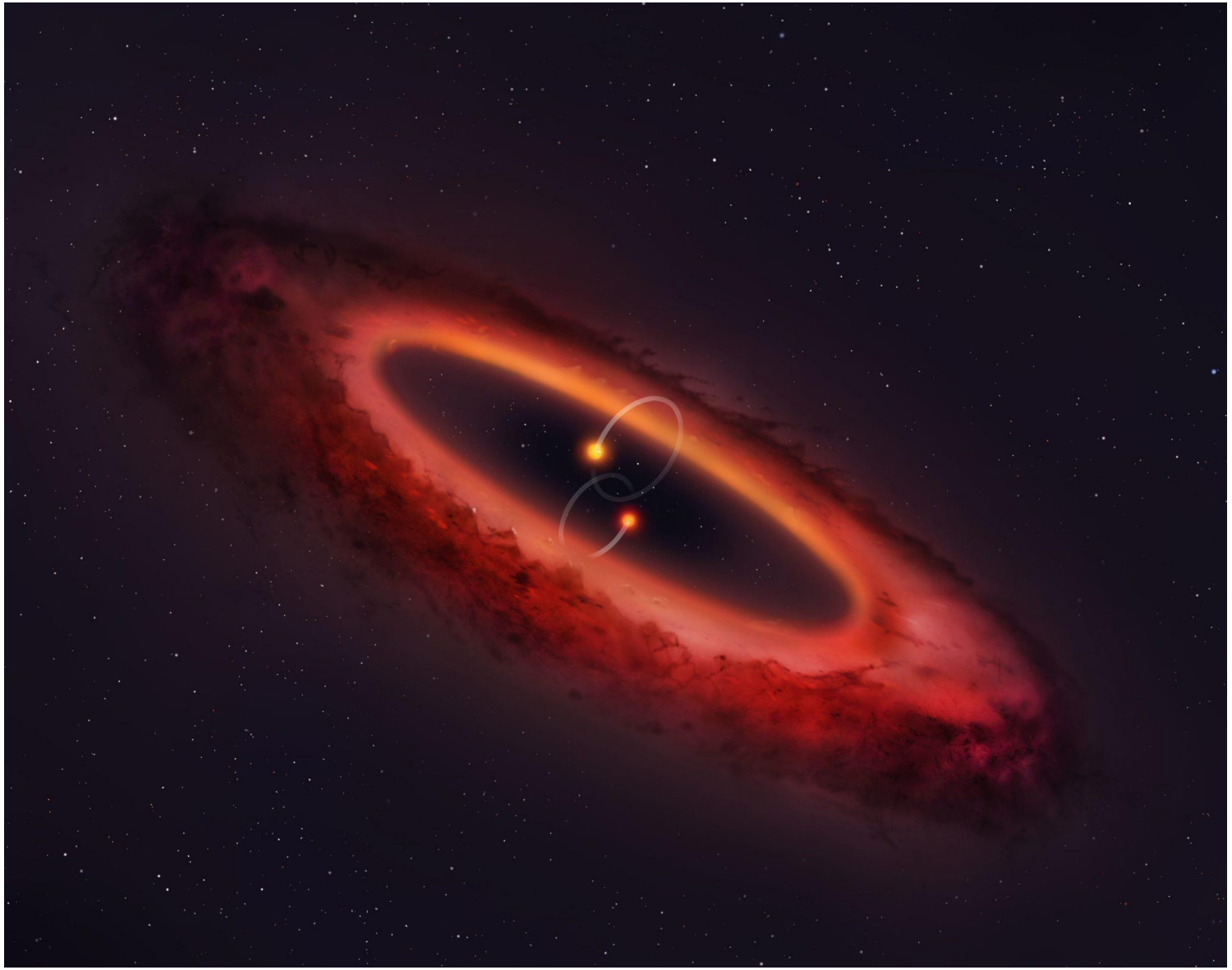
Stephen Ridgway, NOIRLab, *The long arc of stellar interferometry*



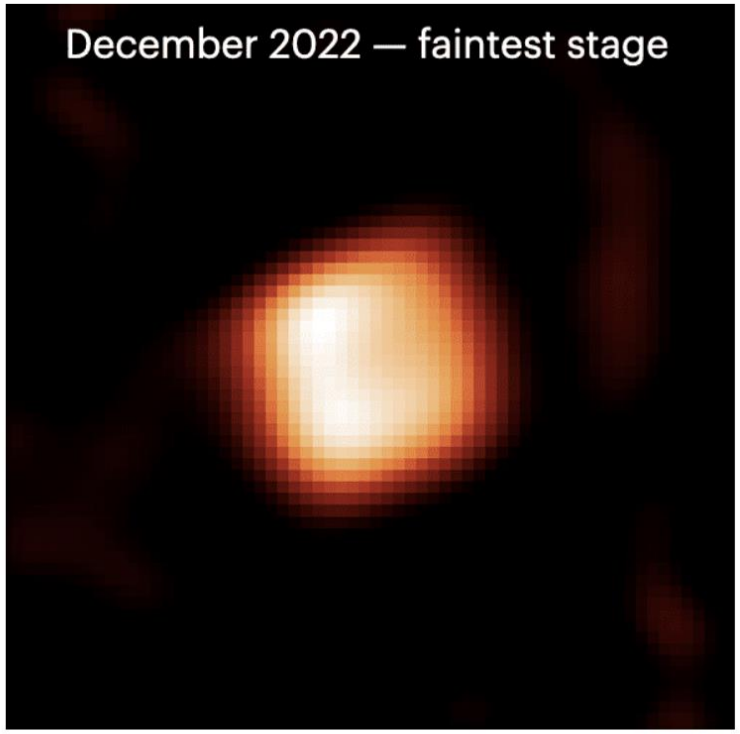
Birthday present HRD (Ashley Elliott, LSU)

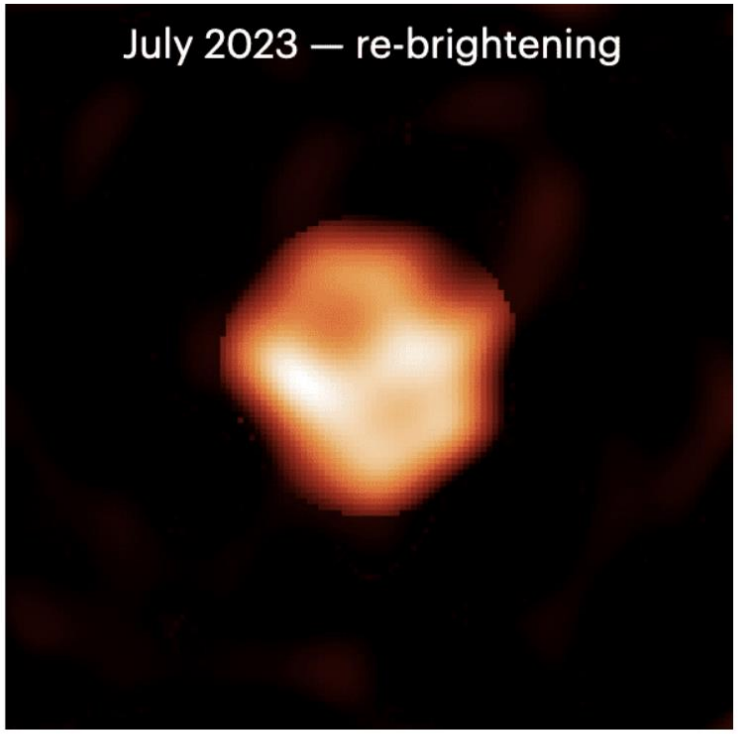
Young Planets Around Old Stars? Astronomers Believe Unseen Planets Exist in Empty Space at Center of Dust Disk

- Anugu et al. (2023) found orbit of post-AGB binary AC Her
- Martin et al. (2023) showed outer dust ring is perpendicular to the orbit
- Inner disk cleared by planet?
- If so, then AC Her is the first **polar circumbinary planet**



A Colossal Star Erupts: Examining One of the Largest Stars in the Milky Way As It Fades From View



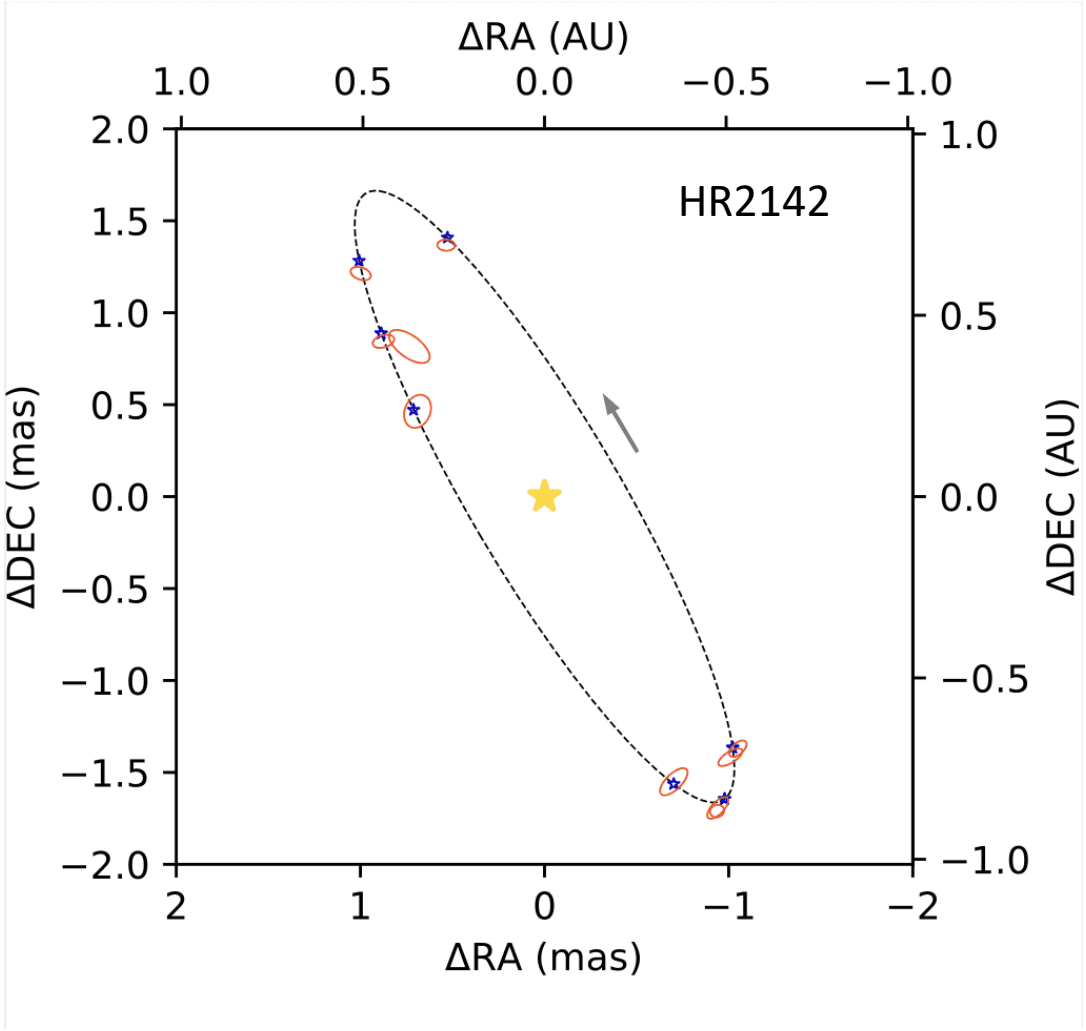


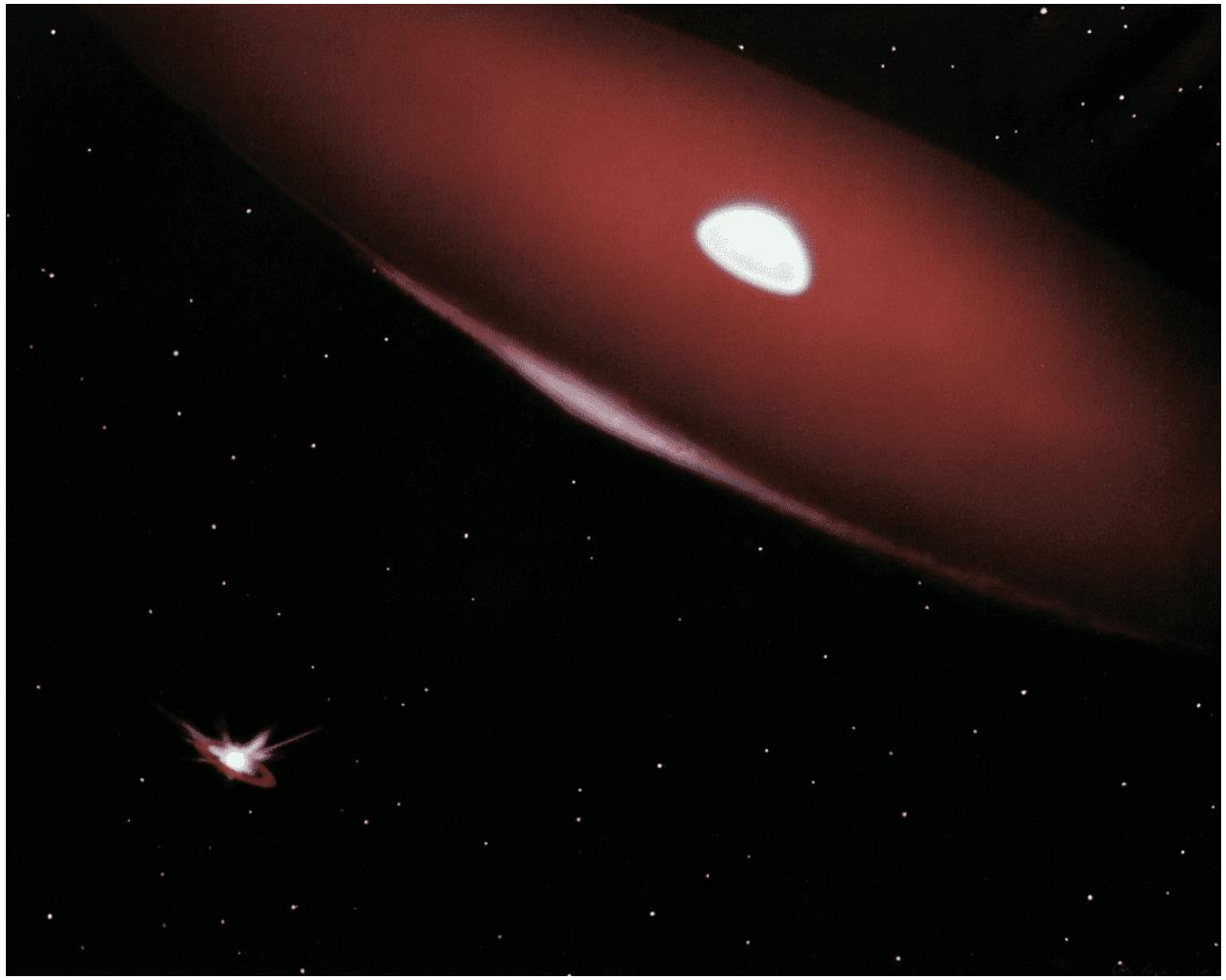
CHARA Array false-color images of RW Cephei from December 2022 (left) and Jul 2023 (right). The patchy appearance results from dust created by a huge ejection from the star. The star is huge but it is so far away that it appears about one million times smaller than the full moon in the sky.

- Great Dimming of the Yellow Hypergiant RW Cep (2022)
- Anugu et al. (2023) showed patchy appearance related to mass ejection and dust formation
- New CHARA images; talk by **Anugu**

Finding Cannibalized Stars

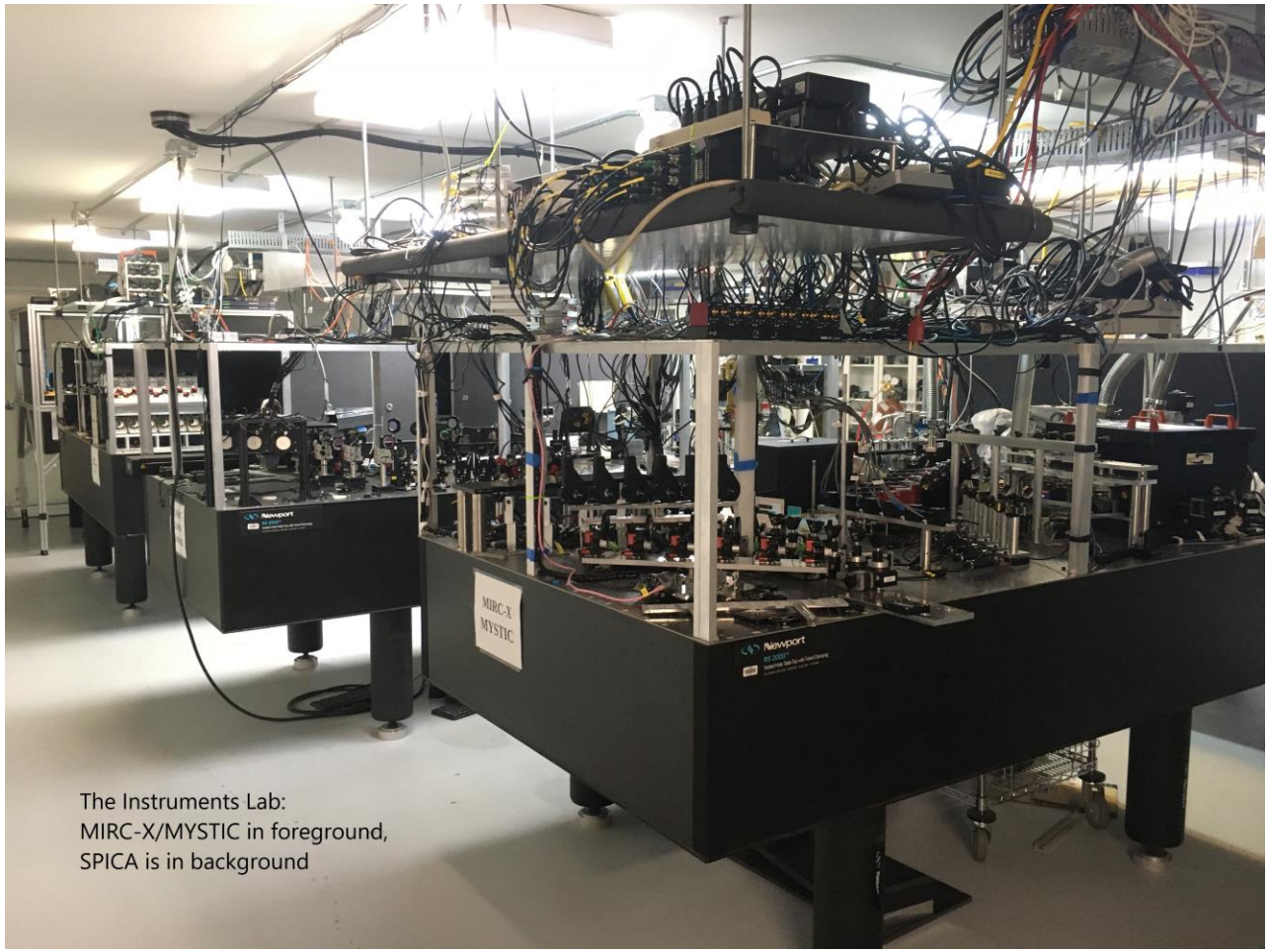
Stripped relics of mass transfer;
talk by **Klement**





5. Concluding Remarks

- CHARA Array is now better than ever thanks to a year of major accomplishments
- New observational programs possible with improved beam combiners and 7th telescope
- CHARA as a center for technical innovation and experiments (Quantum Horizons Workshop)



The Instruments Lab:
MIRC-X/MYSTIC in foreground,
SPICA is in background

A future with our key scientific partners

- *University of Michigan*
  John Monnier
- *University of Exeter*
  Stefan Kraus
- *Observatoire de la Cote d'Azur*
  Denis Mourard
- *Observatoire de Paris*
  Vincent Coude du Foresto
- *Université de Limoges*
  Ludovic Grossard
- *University of Sydney*
  Peter Tuthill
- *Australian National University*
  Mike Ireland
- *Kyoto Sangyo University*
  Makoto Kishimoto
- *NSF's National Optical-Infrared Astronomy Laboratory (NOIRLab)*
  Jayadev Rajagopal

Special thanks to …

- **All the participants at this meeting (foster new collaborations and friendships)**
- **The CHARA Array staff**
- **National Science Foundation**
- **Georgia State University**