



# The MACRO Consortium



Midwest Liberal Arts Colleges  
Collaboratively Operating A Robotic Observatory



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**IOWA**



# What is MACRO?

- The Macalester-Augustana-Coe Remote Observatory
- Educational and research consortium involving four liberal arts colleges and the University of Iowa
- On January 1, 2023, MACRO took over stewardship of the *Robert L. Mutel Telescope ("RLMT")*, located at the Winer Observatory in Sonoita, AZ
  - Elevation 4973 feet
  - Typical seeing 2.5"
  - 232 open sky nights in 2023



Snapshot from video available at

<https://macroconsortium.org/images/AAS244/MACRO+Winer.mp4>



# What is the *RLMT*?

- 0.51 m PlaneWave CDK 20
- $f/6.8$  Dall-Kirkham optics
- Mathis MI750 equatorial mount
- Andor iKon L936 CCD camera
- Two filter wheels
  - Sloan ( $u', g', r', i', z', y'$ )
  - Color (blue, green, red, luminance)
  - Narrow-band filters ( $H\alpha$ , [OIII], [SII])
  - Low-resolution grism  
( $R \approx 300$ ;  $400 \text{ nm} \lesssim \lambda \lesssim 720 \text{ nm}$ )
  - High-resolution grism  
( $R \approx 3000$ ;  $590 \text{ nm} \lesssim \lambda \lesssim 720 \text{ nm}$ )



The Robert L. Mutel Telescope (*RLMT*)

# How did MACRO come to be?

- Professor Mutel is a pioneer of robotic telescope operation
- Led more than 20 years of contiguous development of the observatory, training many dozens of undergraduate students



Professor Mutel with  
*Iowa Robotic  
Observatory* team  
members on the  
University of Iowa  
campus (1997)



*Credit: Robert Mutel*



*Credit: Robert Mutel*

The first student Winer  
Observatory visit  
(winter 1997-1998)

After a long and distinguished career, Professor Mutel took emeritus status.  
Former students came together to form the MACRO Consortium.



# What has MACRO enabled?



*RLMT* image of the Rosette Nebula (Iowa)

- Transformative addition to the astronomy programs at all four member liberal arts institutions
- Dramatic improvements in image depth and quality compared to on-campus facilities
- Design of project-based curricula that can leverage dedicated access to superior observing conditions
- Access to novel observing capabilities (e.g., grism spectroscopy, integral field spectroscopy)



# How do students interact with MACRO?

- Students have *guaranteed access* to the *RLMT*
- Robotic operation allows data to be acquired all night without supervision
- Hands-on operation possible with remote access to control computers
- Students design projects, oversee data acquisition, and begin working on calibrated data immediately



Macalester College students in spring 2023 advanced topics class that worked exclusively on *RLMT* DATA

# How is MACRO made possible?



- The *RLMT* and its instruments remain owned by the University of Iowa; they are assigned to the stewardship of the MACRO Consortium in perpetuity
- Member institutions contribute yearly to meet operational expenses

*RLMT* color image of field with variable extinction (Coe)

# How is MACRO made possible?



MACRO onsite, October 2023.  
Fourth from right is Dr. David Fowler, Macalester  
graduate and MACRO supporter.

- The *RLMT* and its instruments remain owned by the University of Iowa; they are assigned to the stewardship of the MACRO Consortium in perpetuity
- Member institutions contribute yearly to meet operational expenses
- Donor support from the college communities is critical



# How does MACRO operate?

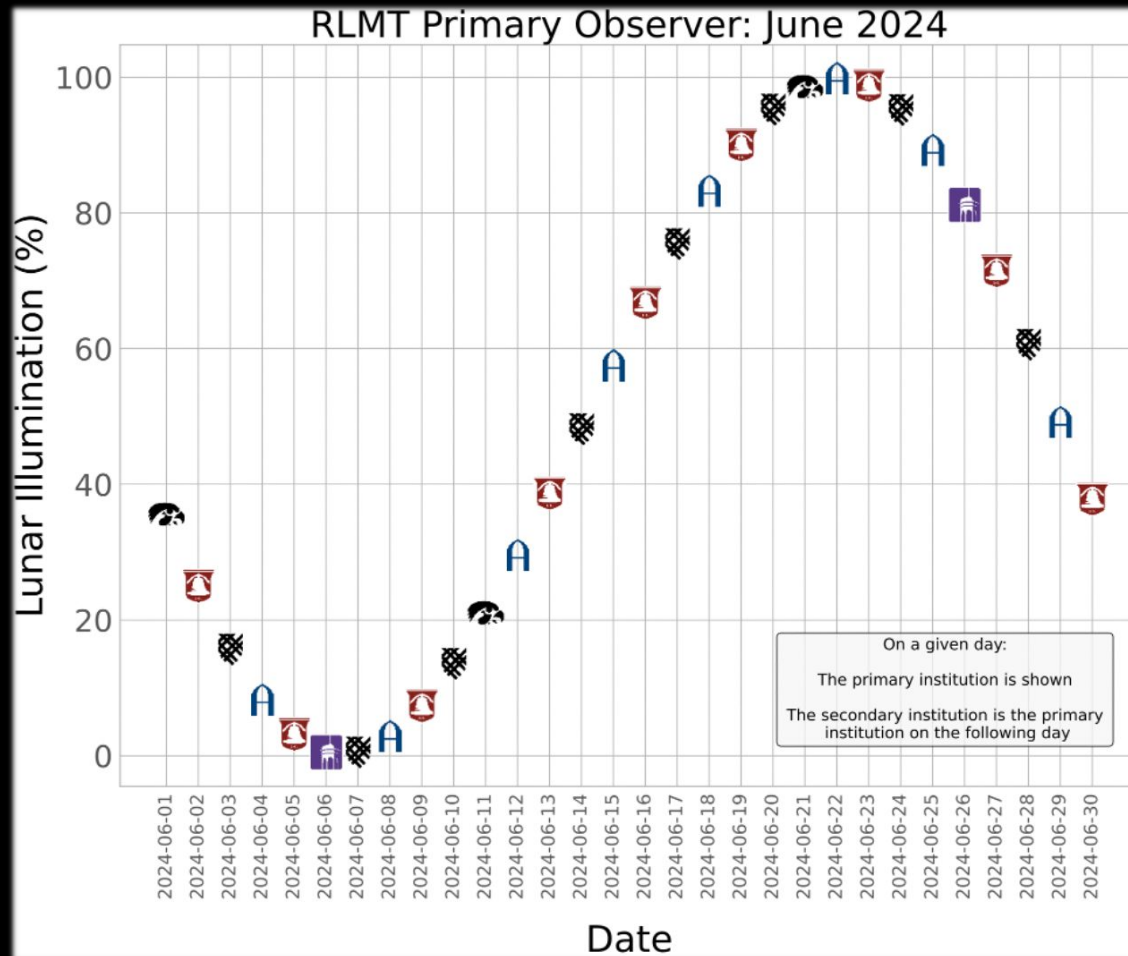
- Formal and legally binding *Operating Agreement* details all aspects of consortial operation
- Macalester College acts as the *fiscal agent* for the consortium
- Institutional leads serve on the MACRO “board of directors” to determine direction and major initiatives
- Weekly consortium-wide meetings to discuss ongoing projects, issues, etc.



Macalester College community members at the RLMT in March 2024

# How does MACRO schedule the *RLMT*?

- Each institution is assigned a fraction of the total observing time available as “primary”
- Institutions cycle through calendar to equitably distribute weather and Lunar illumination
- Ongoing classes get priority when needed
- Data is freely available to all consortium members

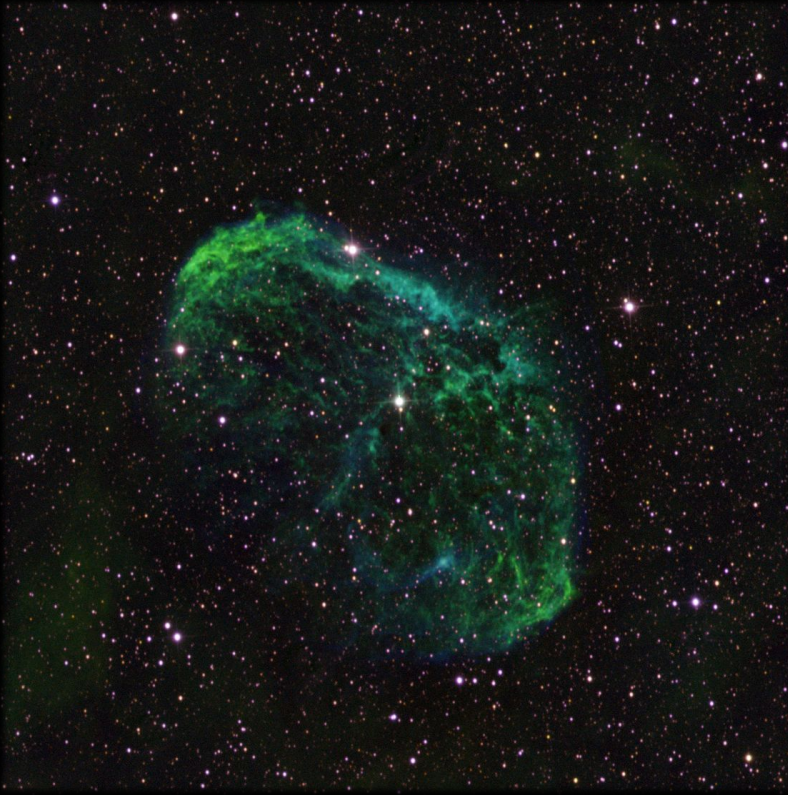


# What is next for MACRO and the *RLMT*?

- Commissioning of new observing capabilities:
  - High-resolution grism (228.05)
  - 19-fiber IFU system (228.04)
  - Guiding capabilities
- Inaugural “MACRO Summer Program” in 2024
  - Simultaneous *RLMT* and *VLA* imaging of a dramatic “polar” system (228.17)
  - Machine learning techniques applied to the *RLMT* archive



*RLMT* color image of the NGC 6047 galaxy group (Knox)



RLMT color image of the Crescent Nebula  
(NGC 6888; poster 228.06)

## How Can I Learn More About The MACRO Consortium?

- Visit the accompanying poster session (#228)!!
- Visit [macroconsortium.org](http://macroconsortium.org)
- Come chat with any of us!!

