The Evolution of Low and Intermediate Mass Stars

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Summer 2010

1. The Death of Low and Intermediate Mass Stars

A. What does "Low and Intermediate" mean?
   a) Typically stars with mass less than 8 solar masses

B. How do these stars end their lives? (the canonical picture)
   a) Outer layers ejected as a planetary nebula (PN).
   b) The core contracts and heats to become a white dwarf.

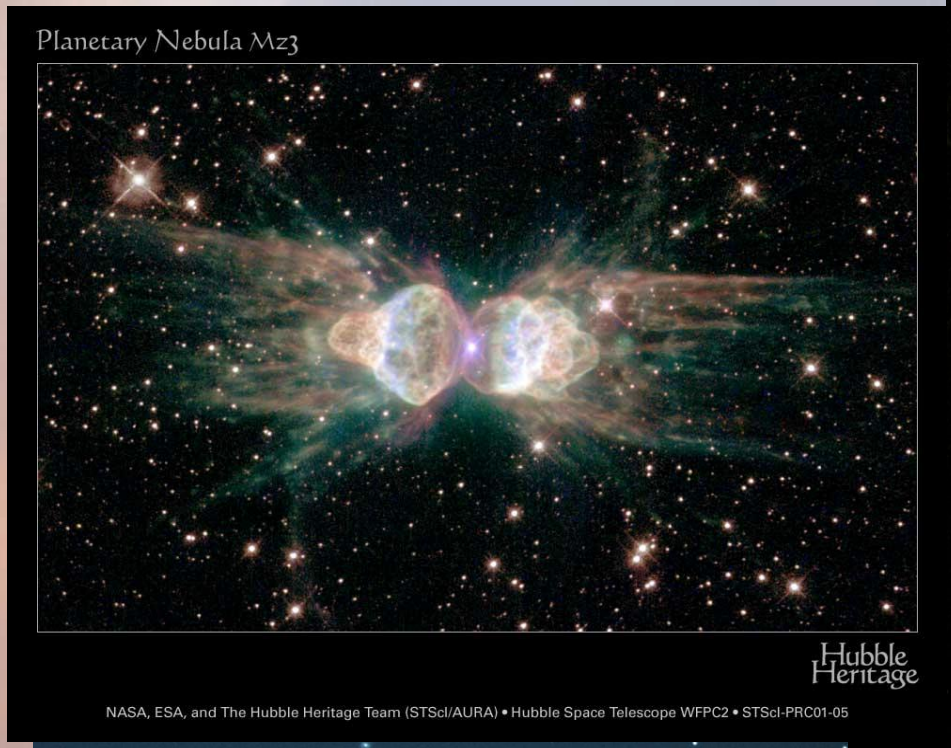
C. Do they all *really* do this?
   a) No. Stars with mass less than 1 solar mass do not have hot enough cores to ionize the gas
   b) Some suggestion that *NONE* should!

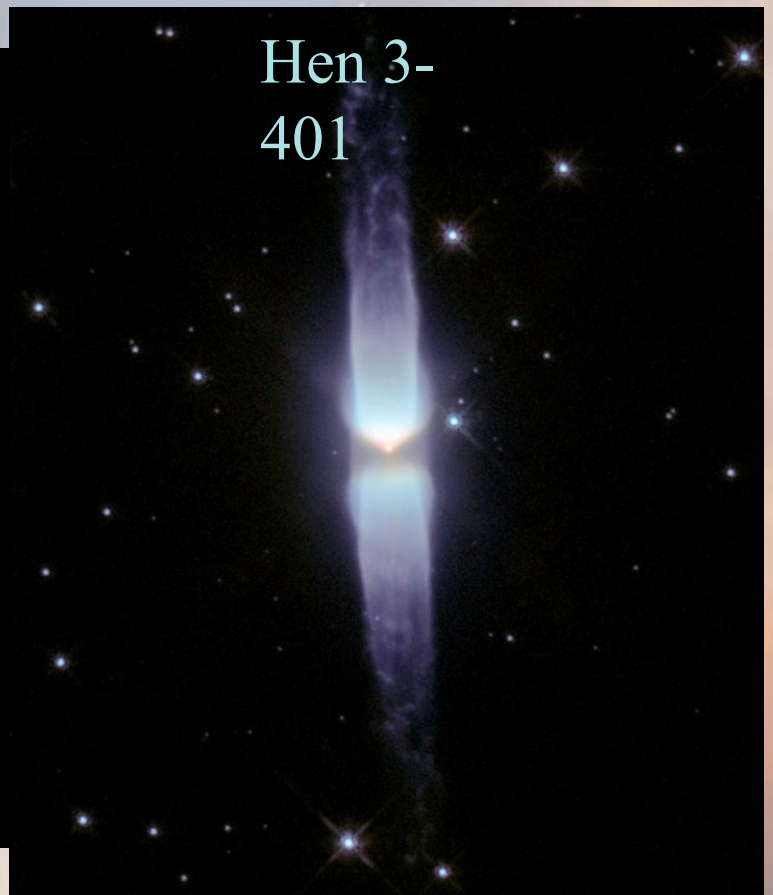
2. Shaping Methods

A. The shapes of PNe give us a hint

a) PNe come in all sorts of shapes, typically categorized generally as: round, elliptical, and bipolar

b) There are also substructures, such as point symmetry, FLIERs, haloes, etc.





2. Shaping Methods

B.Shapes may be caused by several mechanisms

a)gravitational interactions ⇒ binary stars

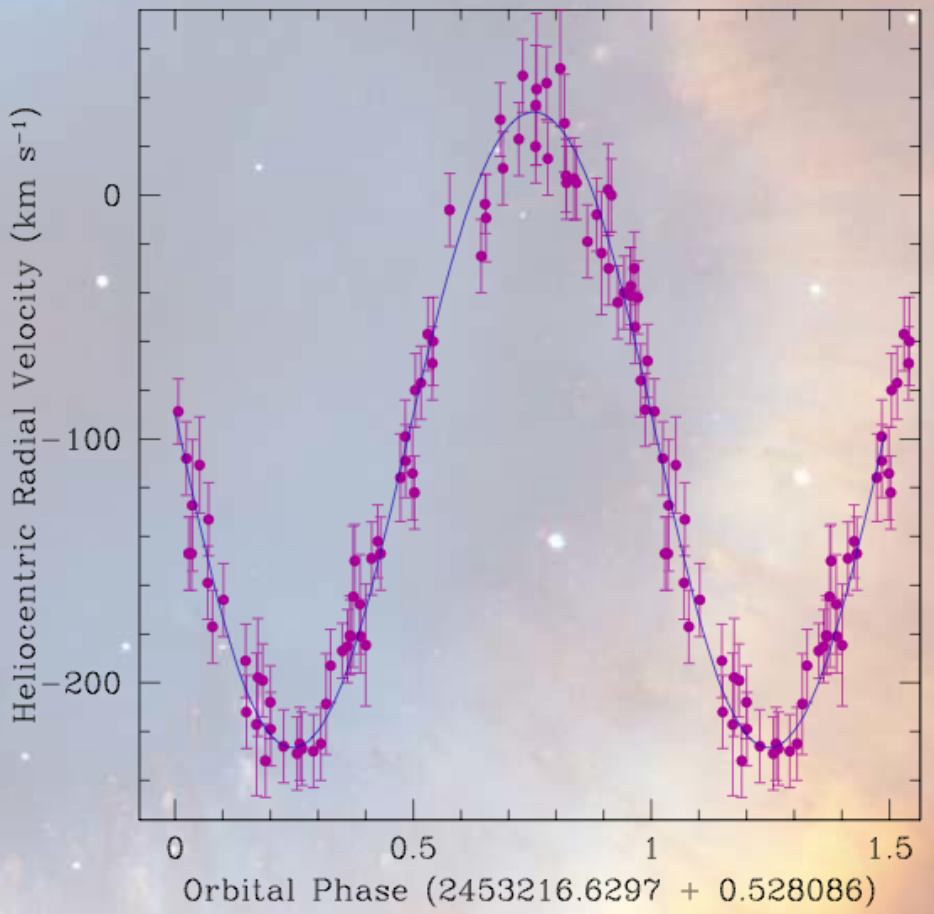
b)magnetic fields

•Also ⇒ binary stars (need source of angular momentum)

3. Central Stars of Planetary Nebulae

NGC 6026

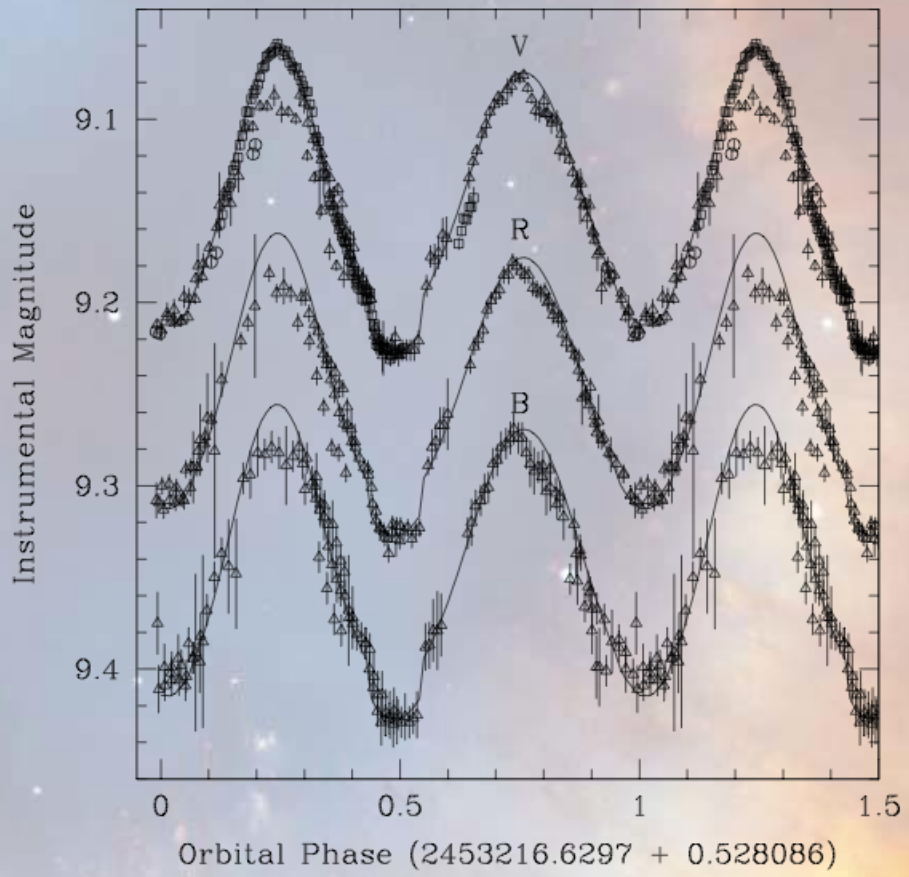
- Radial Velocities show definite variations, so it IS a binary
- RV variation period: 0.528 d



3. Central Stars of Planetary Nebulae

NGC 6026

- Radial Velocities show definite variations, so it IS a binary
- RV variation period: 0.528 d
- Light variations as well



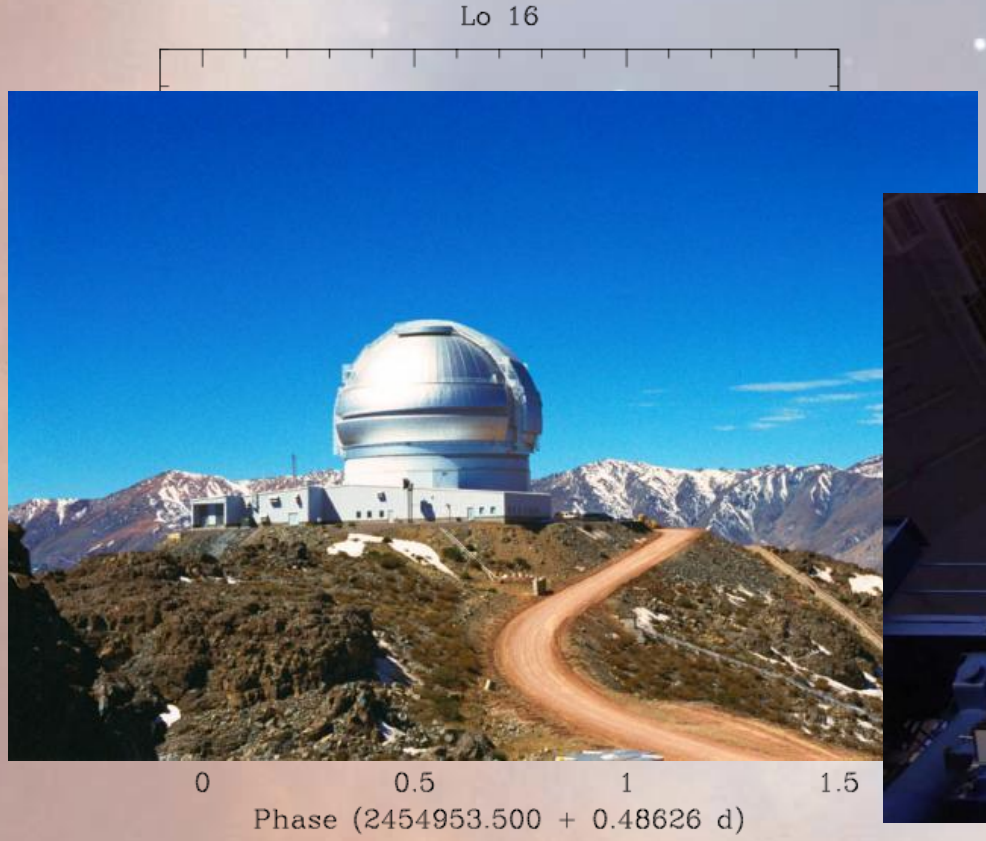
4. Student Involvement

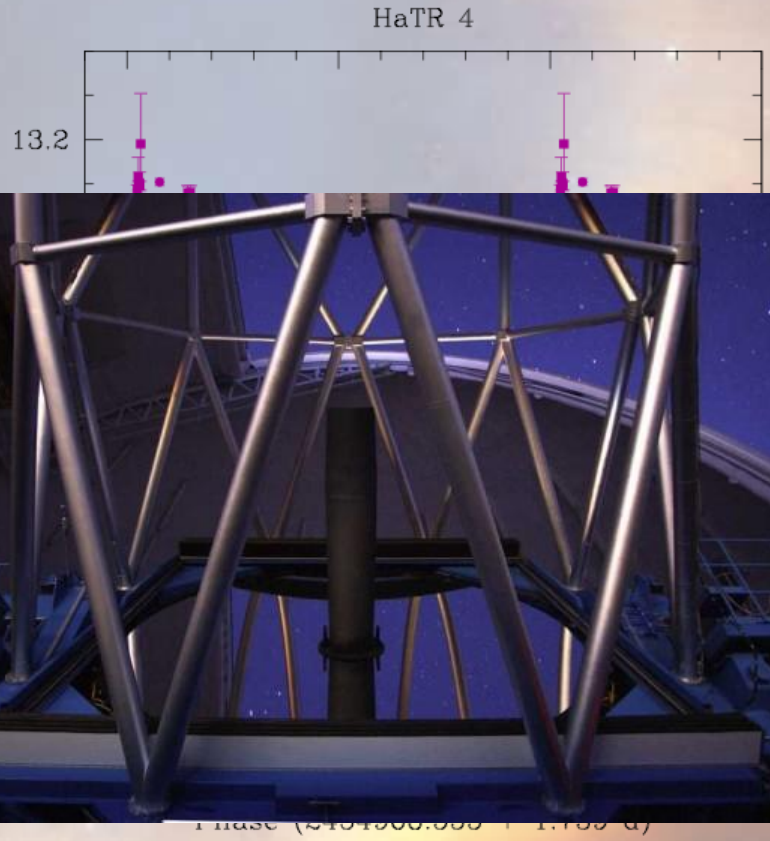
A. Observations of known but poorly studied systems

a) Only 11 of the 37 catalogued systems are well studied.

b) We have photometry of an additional five

c) Spectroscopy of four of these on the way (Gemini South)





4. Student Involvement

B. Ongoing survey to discover more binaries

a) SARA North

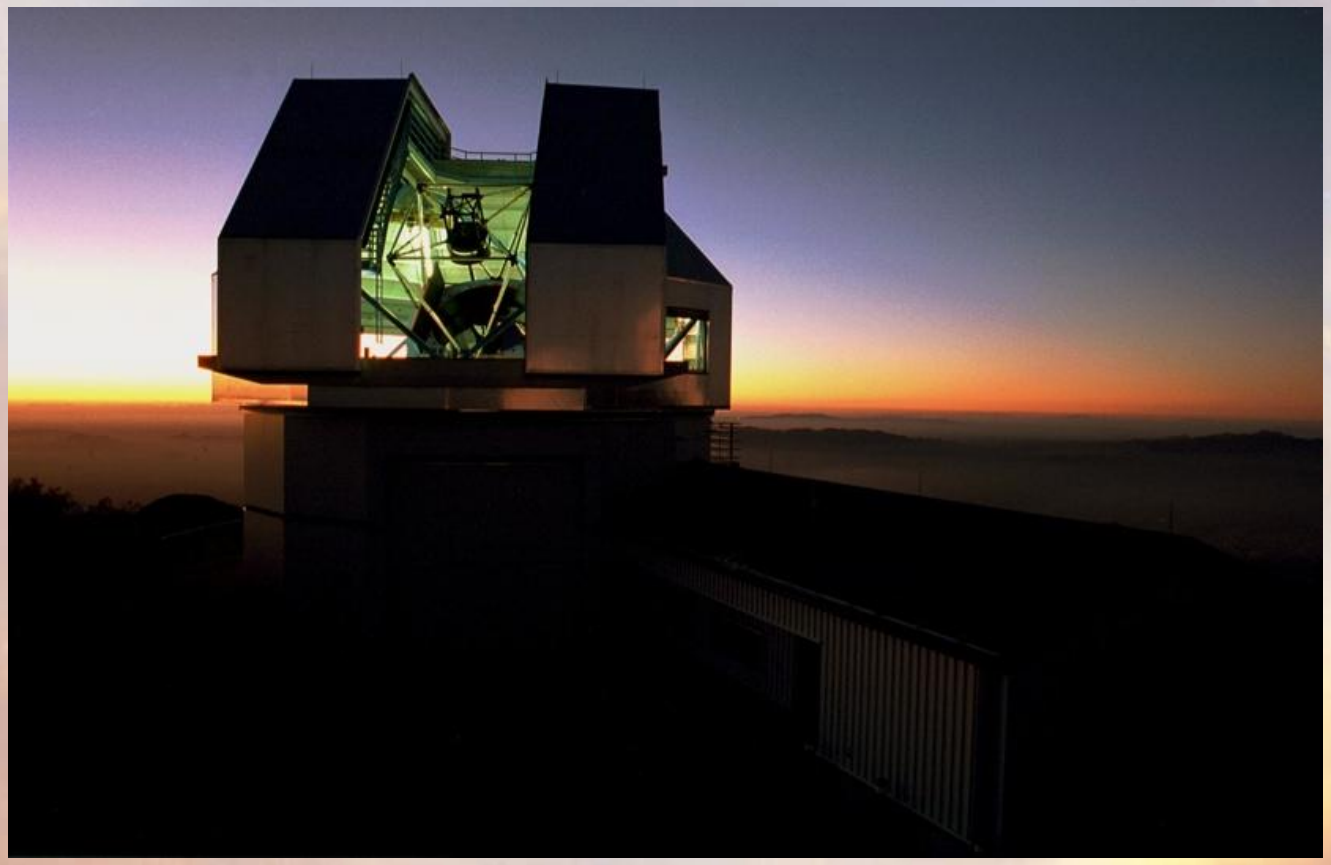
b) and SARA South (first lig

4. Student Involvement

B. Ongoing survey to discover more binaries

c) Near infrared search for cool companion stars at WIYN telescope

- Observations in June



4. Student Involvement

C.Students Research positions

a)Plan ten weeks, starting and ending dates negotiable

b)On-campus housing provided (pending approval)

c)Data reduction & analysis - photometry & spectroscopy

d)Some binary star modeling

e)One position via VU funding (minimum 2nd half of the summer)

•Applications through the department - due Wed. Feb. 24th

a)One position via SARA REU program

•Application online - Deadline is Feb. 5!

•students **must** speak with me before applying

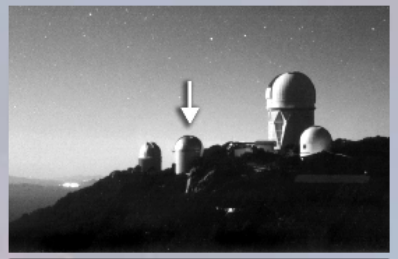
Summer 2010

Undergraduate Research Internships In Astronomy

Southeastern Association for Research in Astronomy

Florida Institute of Technology, East Tennessee State University, Florida International University, Valdosta State University, Clemson University, Ball State University, Agnes Scott College, University of Alabama, Valparaiso University and Butler University

The Southeastern Association for Research in Astronomy expects to host a "Research Experiences for Undergraduates" program sponsored by the National Science Foundation in the summer of 2010. Each SARA summer intern will work closely with a faculty mentor at one of the 10 SARA universities. In addition to observing with the SARA 0.9-m telescope at Kitt Peak in Arizona, the summer activities will include a number of social events and excursions, as well as workshops on observational techniques data reduction, current events in astronomy, job opportunities in astronomy and scientific ethics. Participants will present research results at a final workshop near the end of summer and prepare a manuscript for publication in *JSARA* (see www.jsara.org).



Eligible applicants must be enrolled in a degree program leading to a baccalaureate or associate degree, and must be citizens or permanent residents of the United States or its possessions. A major in astronomy is not required, but a demonstrated interest and adequate math/science background are essential. Eight- to 10-week appointments may begin as early as mid-May or extend as late as early August, depending on the participant's academic calendar and particular SARA host site. Each participant will receive a stipend of $4,500 for the summer. In addition, all necessary lodging and travel expenses during the summer will be paid by SARA, including up to $500 round-trip travel between the student's home and the SARA host institution.

RESEARCH AREAS

- *Minor Planets and Comets*
- *Binary Stars: Cataclysmic, Massive or Wide*
- *Variable Stars: Miras, Delta Scuti, etc.*
- *Stellar Activity and Evolution*
- *Hot Stars: Atmospheres and Winds in Collision*
- *Galactic Morphology, Dynamics and Evolution*
- *Multiwavelength Extragalactic Astronomy*
- *Active Galactic Nuclei: Blazars and Quasars*
- *Supernovae and Gamma Ray Bursts*
- *And related topics*

TO APPLY:

Visit www.astro.fit.edu/sara-reu for full instructions and to complete the online application form.

Information required for this form includes your name, address, e-mail address, contact phone numbers, a 250–500 word essay describing your research interests and career goals, names and contact information for two faculty members who will submit letters of reference on your behalf (via e-mail), your GPA, and your science and math course grades. In addition, you must submit by e-mail a scan of an official university transcript. Women, minorities, disabled persons and veterans are especially encouraged to apply. Applications that are not complete by the deadline may not be considered.

All application materials must be received by February 5, 2010.

Appointments will be announced beginning March 1, 2010.

SEND INQUIRIES AND APPLICATIONS TO

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Application forms and information may be obtained at our Web site:

www.astro.fit.edu/sara-reu

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