Stellar Astrophysics with SIM and Optical Long Baseline Interferometry

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Selected topics in Stellar Physics

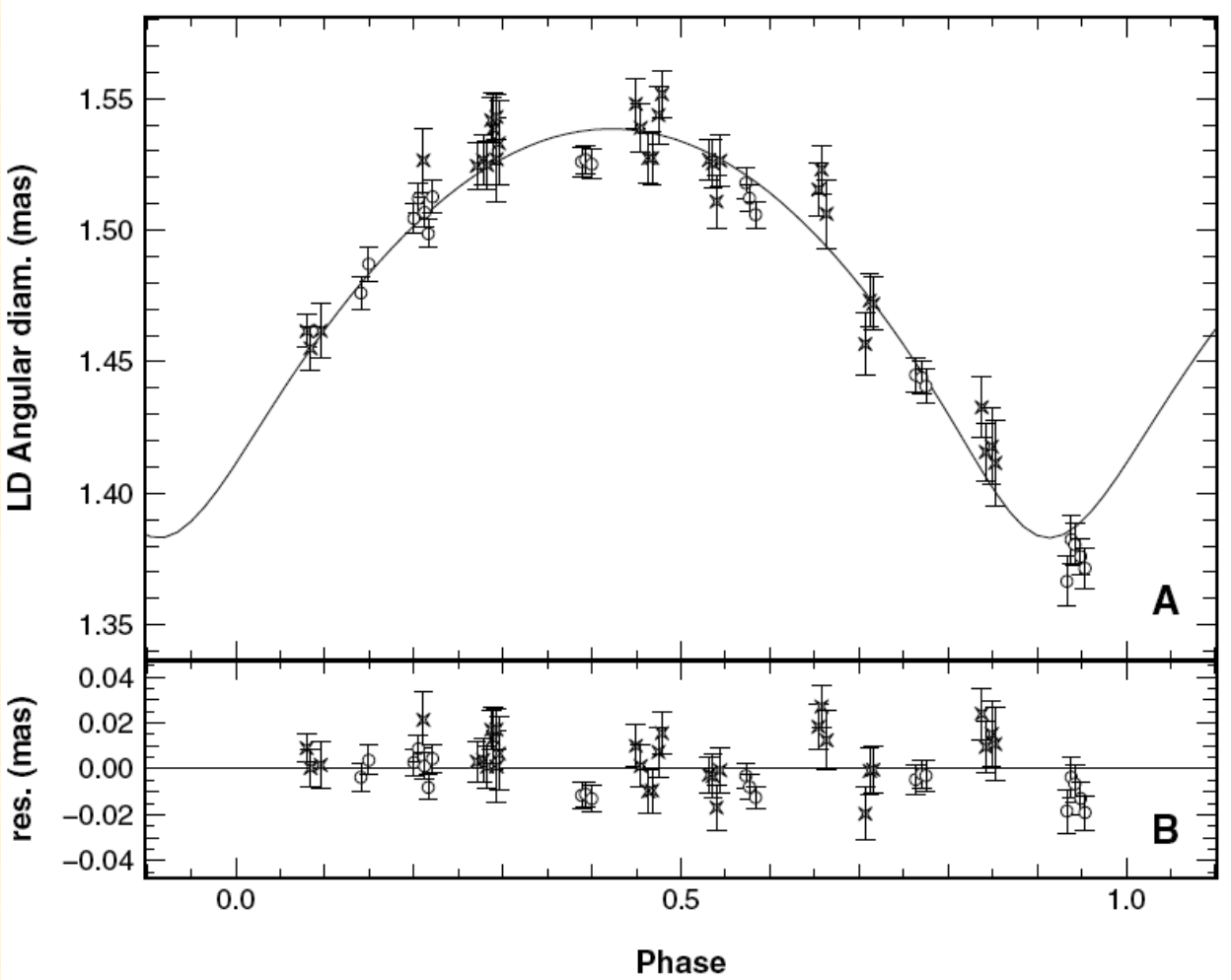
- Cepheids and Distance Measurement
- Fundamental Parameters of Massive stars
- Asteroseismology, Stellar Radii and Masses
- Cataclysmic Variables, Algols and Post Main Sequence Evolution

For each of these programs, GAIA does not offer a realistic alternative owing to the brightness of targets, expected errors, and/or observational cadence.

Cepheids - understanding biases in P-L

- Cepheid P-L is still a fundamental check on the extragalactic distance scale.
- The Baade-Wesselink calibration of the P-L zero point will be no better than the *p*-factor, which can be determined to 1% with SIM plus interferometry
- Circumstellar envelopes can bias P-L. SIM + interferometry can characterize these envelopes.
- Detailed measurements of the dynamics of pulsation may enable modeling that can validate P-L for different metalicities.
- The discrepancy between evolutionary and pulsation masses can be investigated with astrometric masses for some of the many binary Cepheids.

δ Cep: Determination of *p*-factor

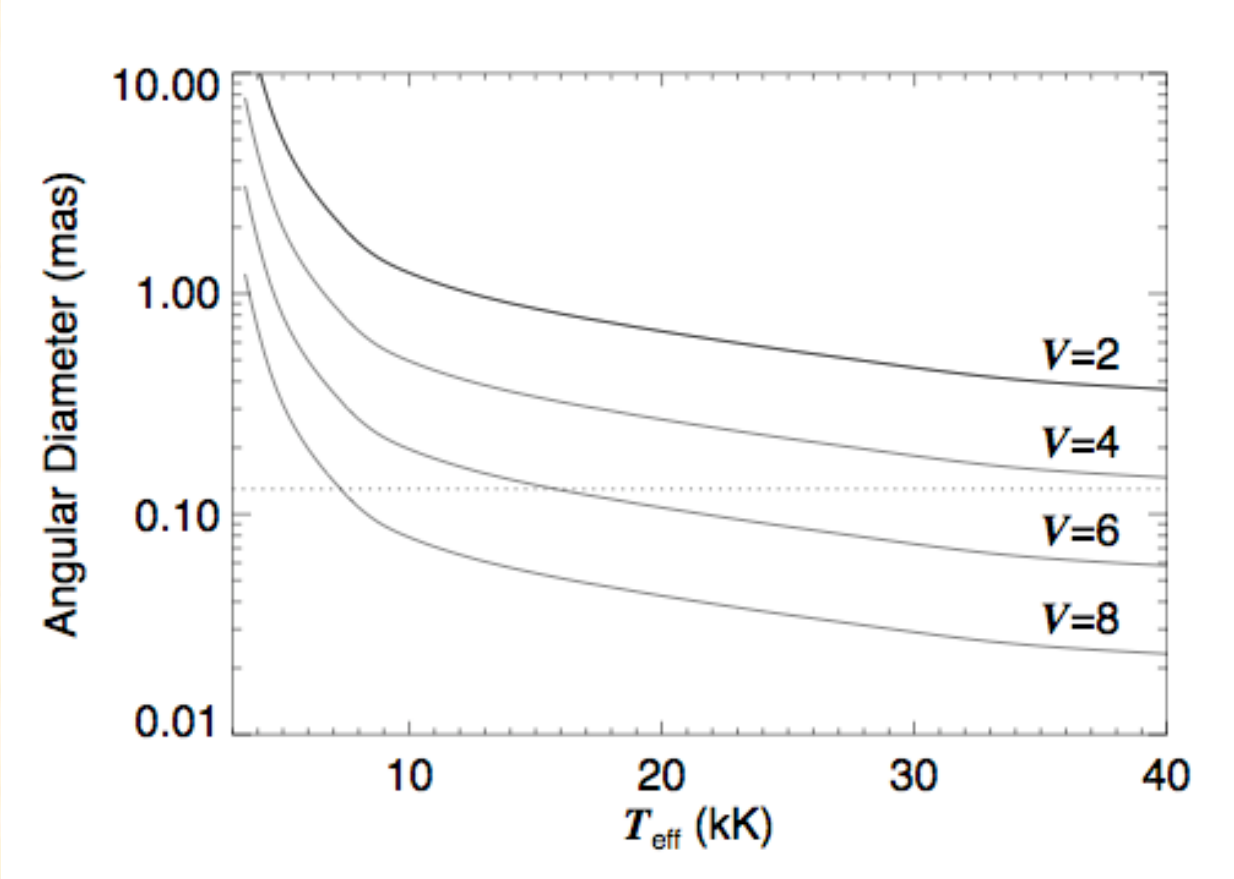


Combining angular diameter with distance, the p-factor is determined to within 4%, entirely limited by the uncertainty in the distance.

Fundamental Parameters of Massive Stars

- Massive (O and B) stars are among the brightest objects in galaxies and play a central role in conditioning the Interstellar Medium.
- Fundamental parameters are poorly known.
- The observational H-R diagram only loosely constrains evolutionary models.
- SIM distances will determine O star luminosities to 5%, 10X better than current.
- Interferometric radii will determine O-star temperatures with 1-2% accuracy.

Interferometric Studies of Hot Stars

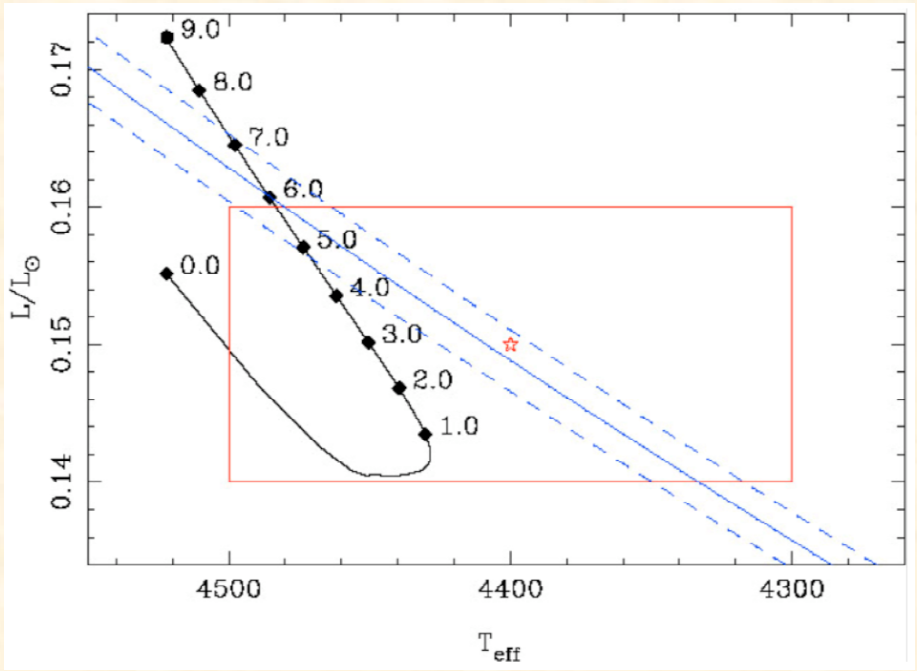


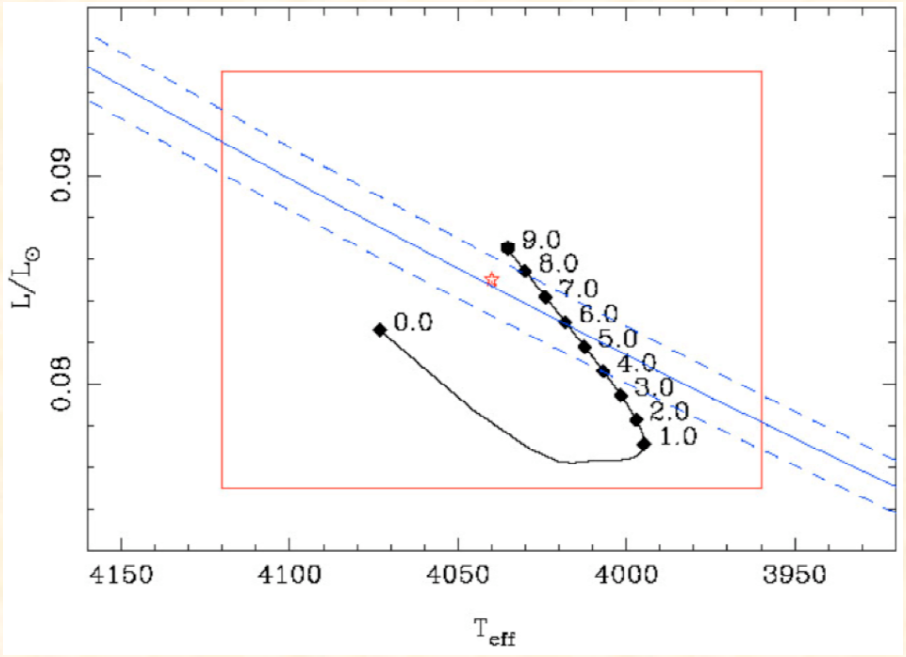
Predicted angular diameter vs Teff. The expected lower limit for angular diameter measurements with the CHARA Array is 0.13 mas.

Asteroseismology, Stellar Radii and Masses

- The radius of a main sequence star constrains very tightly the age.
- The addition of asteroseismic frequencies strongly constrains, in addition, the mass. This combination of interferometry and seismology provide the only available method for determining the mass of single stars.
- Several hundred stars are accessible to high accuracy angular diameter measurements by interferometry at the 1% level or better. The available Hipparcos distances currently do not match this interferometric accuracy! And GAIA will not improve the situation as stars fainter than V ~ 6 are beyond reach of the radial velocity asteroseismic campaigns.

Precision Radii and Masses





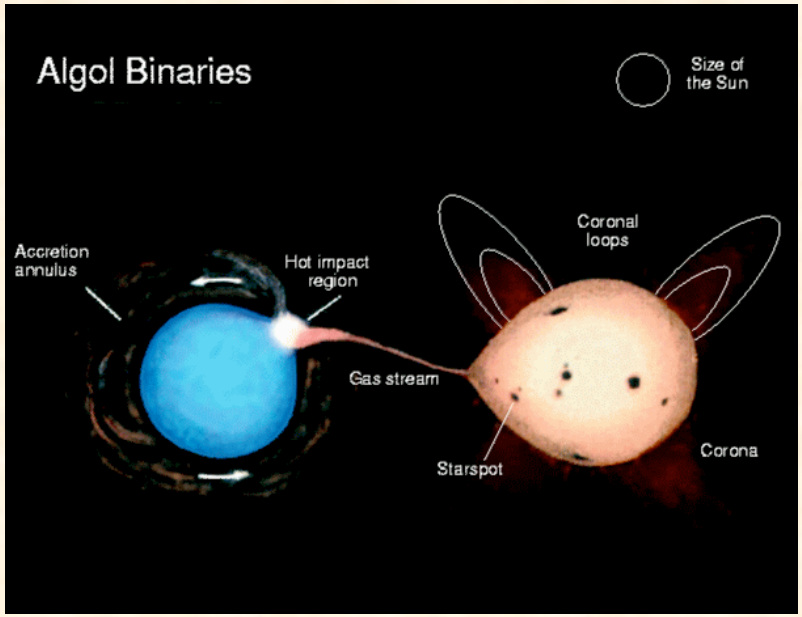
The stellar radius strongly locks the modeled age, as in this diagram for 61 Cyg A and B. When asteroseismic measurements are also available, the mass is also tightly constrained.

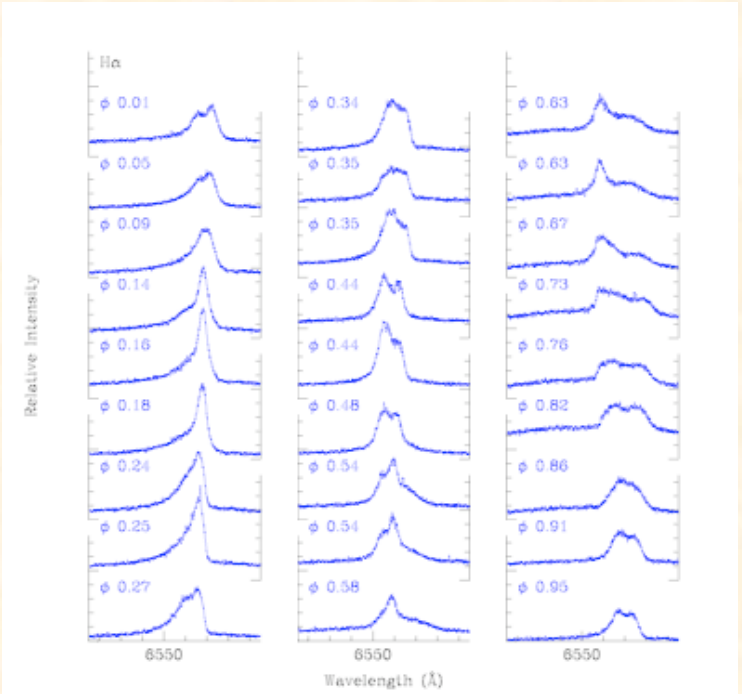
Cataclysmic Variables, Algols and Post Main Sequence Evolution

- Cataclysmic variables (CVs) are of broad interest for their relation to novae, dwarf novae, SNIa, low mass X-ray sources, and their revelations of accretion disk and jet processes.
- Like many binaries, they present a pairing that defies explanation.
- Low gravity shells surrounding the stars can masquerade as atmospheres presenting an incorrect spectral type and luminosity class
- We will employ interferometry and astrometry to determine orbits and masses for a selected set of post-Algol systems to expose their likely evolutionary path as well as explore if they are indeed the source population of the majority of interacting binaries.

Cataclysmic Variables - Why SIM?

- Mass loss in winds or streams make radial velocity measurements highly uncertain.
- Apparent semi-major axis motions ~ 100 μarcsec.
- Observing times scheduled to orbital phase.





“The proposal is a pastiche of the eclectic and the fundamental.”

Primary reviewer