Ongoing Reduction of PTI Giant Diameters

“I’m Not Dead Yet”

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Palomar Testbed Interferometer

- 2-way beam combination
  - 3×50cm apertures
  - 110-m, 2×85m baselines
  - 3-way development incomplete
- H-, K-band operation
- Dual-beam astrometry demonstration
- Automated sequenced observations
  - Very good for survey work
- Operated 1996-2008
- h-index=30
A Tangential Note on $h$-index

- Number where a citation rank-ordered list of papers has the $h^{th}$ paper number still greater than number of citations
- Attempts to quantify – in a single number – your productivity (number of papers) and your impact (number of citations)
  - Unintentionally ranks longevity, too
  - Eminently unfair, inaccurate, and widely used
  - It can be gamed
  - Applied to individuals and facilities
- One should be aware of one’s $h$-index
  - And your Erdős–Bacon number, too (mine is 9)
The H-R diagram of Astronomers

Peer reviewed scientific papers
(Including fractional papers in preparation for those with few papers)

*Includes associated others. Apologies to Hertzprung and Russell. ¹Productive but generally invisible.

NOTE: As in astronomy, the numbers are correct to a factor of a few. Most of the grey points are purely representative.
PTI’s Greatest Hits
(ranked by citations for first paper of category)

- Radii & $T_{\text{EFF}}$ for GKM Giants (van Belle+ 1999)
- Altair oblateness (van Belle+ 2001, Domiciano de Souza+ 2005)
- Atlas distance (Pan+ 2004)
- M dwarf diameters (Lane+ 2001)
- FU Ori (Malbet+ 1998, Malbet+ 2005)
- Vega diameter (Ciardi+ 2001)
- Cepheids (Lane+ 2002, Lane+ 2000, Marengo+ 2003)
- Miras (Thompson, Creech-Eakman & van Belle 2002a,b)
- Nova RS Oph, V838 Mon (Monnier+ 2006, Lane+ 2005)
- 51 Peg (Boden+ 1998)
- PTI Calibrators (van Belle+ 2008)
Giant Star Survey

- van Belle+ 1999: 59 giants
- Poor $F_{\text{BOL}}$ data
- SED fitting was crude
- $A_V$ correction was poor (at best)
- Old Hipparcos distances
Giant Star Survey MkII

- Significantly larger sample
  - 240 ‘normal’ giants
    - 9.6 nights each
  - 63 Miras
    - 17 nights each
    - Some up to 97 nights
- Improved SED fitting (see next)
- New Hipparcos distances: 2-3× improvement

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Improved SED Fitting

- Far richer photometry data sets
  - VizieR, GCPD
- Empirical spectral templates
  - Pickles (1998)
- True reddening fitting
- Spectrophotometry now also available
- $F_{\text{BOL}}$ errors improve from ~10% to ~0.5%
  - Had been limiting term in $T_{\text{EFF}}$ determinations
- New AndyCode™ - sedFit v2.0 in ‘alpha’ testing
**HD194093 Net SED Model**

- **Fit \( \chi^2 \) PDF:** 0.89 (69.1 / 78 DF)
- **Est \( F_{\text{bol}} \):** 3.842e-06 +/- 5.222e-08 erg cm\(^{-2}\) s\(^{-1}\)
- **Model \( T_{\text{eff}} \):** 5750 +/- 250 K
- **Est Diam:** 3.25 +/- 0.283 mas
- **Est \( A_V \):** 0.242 +/- 0.0124 mag
Expected Improvement: $T_{\text{EFF}}$

- $\sigma_{\text{T}_{\text{EFF}}}$~125K should improve to $\sigma_{\text{T}_{\text{EFF}}}$~25K
- Entirely new realm of precision
  - Can explore 2$^{\text{nd}}$ order effects – eg. metallicity
Preliminary Radius Results

- As a function of spectral type and V-K color
- Still need de-redden V-K results
- Separation of (mis-) classification of luminosity types?
- Highlights the need for better parallaxes
  - Some benefit from Gaia, but bright limit will be a problem
NPOI Data

- Matching V-band data for this sample
  - Currently ~30 objects with NPOI & PTI data
- Insights on limb darkening
  - eg. Predicted by Davis Tango & Booth (2000), but needs to be measured
PTI Data Flow

- Level 0 – raw data
  - eg. flat, dark, ratio corrected, ‘data editing’
- Level 1 – instrument calibrated
  - eg. flat, dark, ratio corrected, ‘data editing’
  - end of night script
- Level 2 – observationally calibrated
  - normalized $V^2$’s
  - wbCalib/nbCalib
- Level 3 – model applied
  - eg. uniform disk fit
  - fitSingle
  - wrapper scripts
[Data Flow Demonstration Here]
Example Mira Variable: R Boo

- Period = 223d
- SpType = M4e-M8e
- Observed 88 nights over 8 years (!)
- Follows up on findings of Thompson+ (2002a,b) and van Belle+ (1996, 1997, 2002)
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PTI Carbon Stars

- 41 stars with diameters
  - $T_{\text{EFF}}$ determination
  - $R$ difficult, distances poor
- Roughly a dozen with multiple baselines
  - Sufficient $\{u,v\}$ for ‘shapes’
- Are all carbon stars ‘non-spherical’?
  - Hot spots
  - Rotationally oblate
PTI Carbon Stars