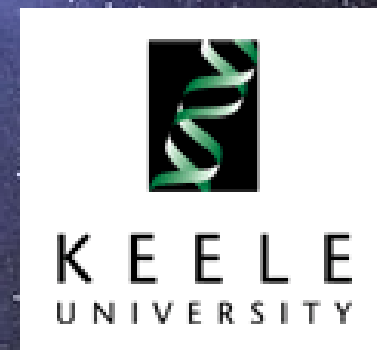


HD 23642 REVISITED

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Distance to the Pleiades

- 'Long' distance is 132 ± 3 pc
 - main sequence fitting (Johnson 1957, Meynet et al 1993)
 - HD 23642 (Munari et al 2004) and Atlas (Pan et al 2004)
- 'Short' distance is 118 ± 3 pc
 - Hipparcos (Perryman et al 1997, Robichon et al 1999)
- Possible solution: Pleiades is metal-poor
 - (van Leeuwen 1999, Castellani et al 2002)
 - but Boesgaard & Friel (1990) spectroscopy gives solar Z
 - Stello & Nissen (2001) analysis also disagrees with this
- Possible solution: Hipparcos parallaxes correlated
 - (Pinsonneault et al 1998, Makarov 2002)

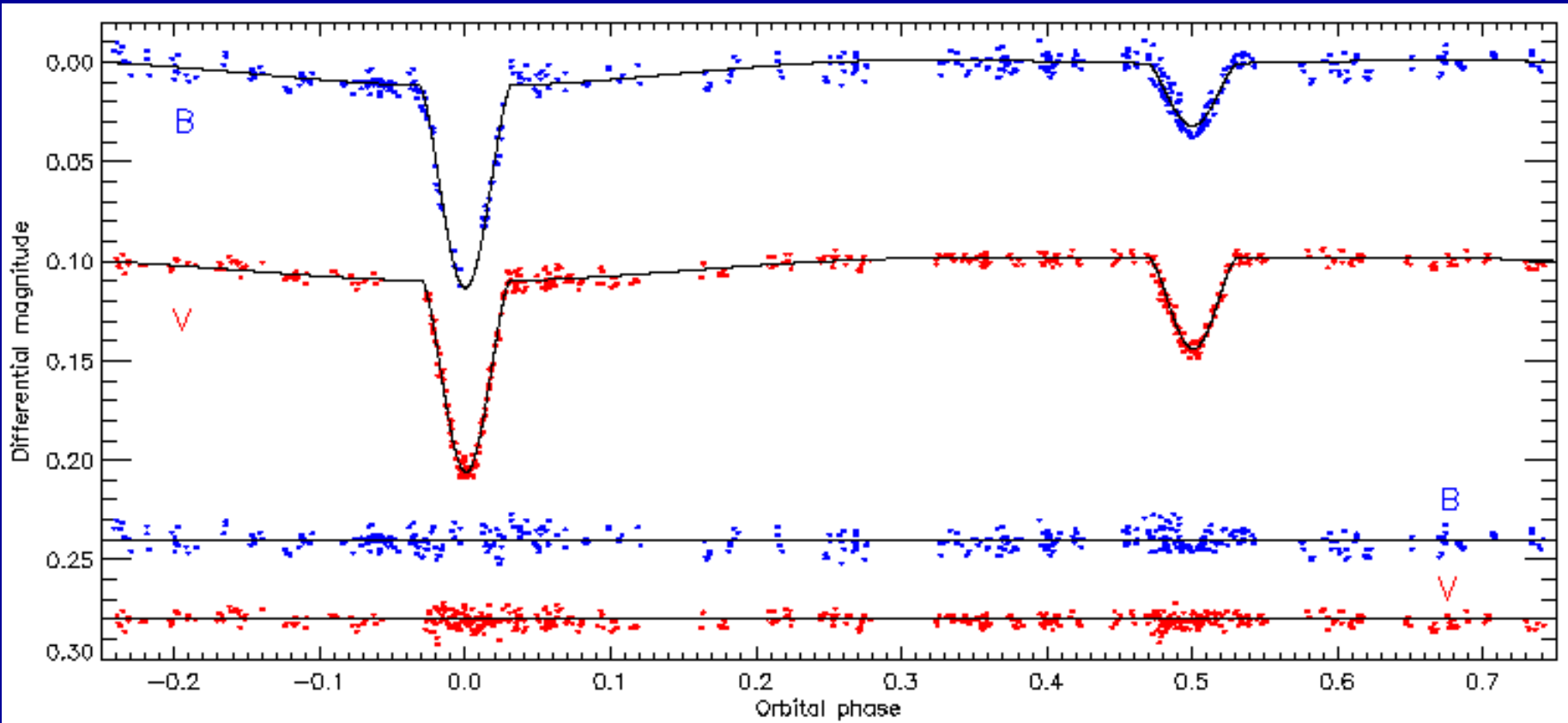
Eclipsing binary HD 23642

- Spectroscopic binary discovered in 1957 by Pearce (1957) and (Abt 1958)
- Eclipses found in Hipparcos light curves (Torres 2003)



- Period: 2.46 days Spectral type: A0 Vp (Si) + Am
- Munari et al found distance: 131.9 ± 2.1 pc
 - Light curve fitted using Wilson-Devinney code
 - Distance comes from M_{bol} and bolometric corrections

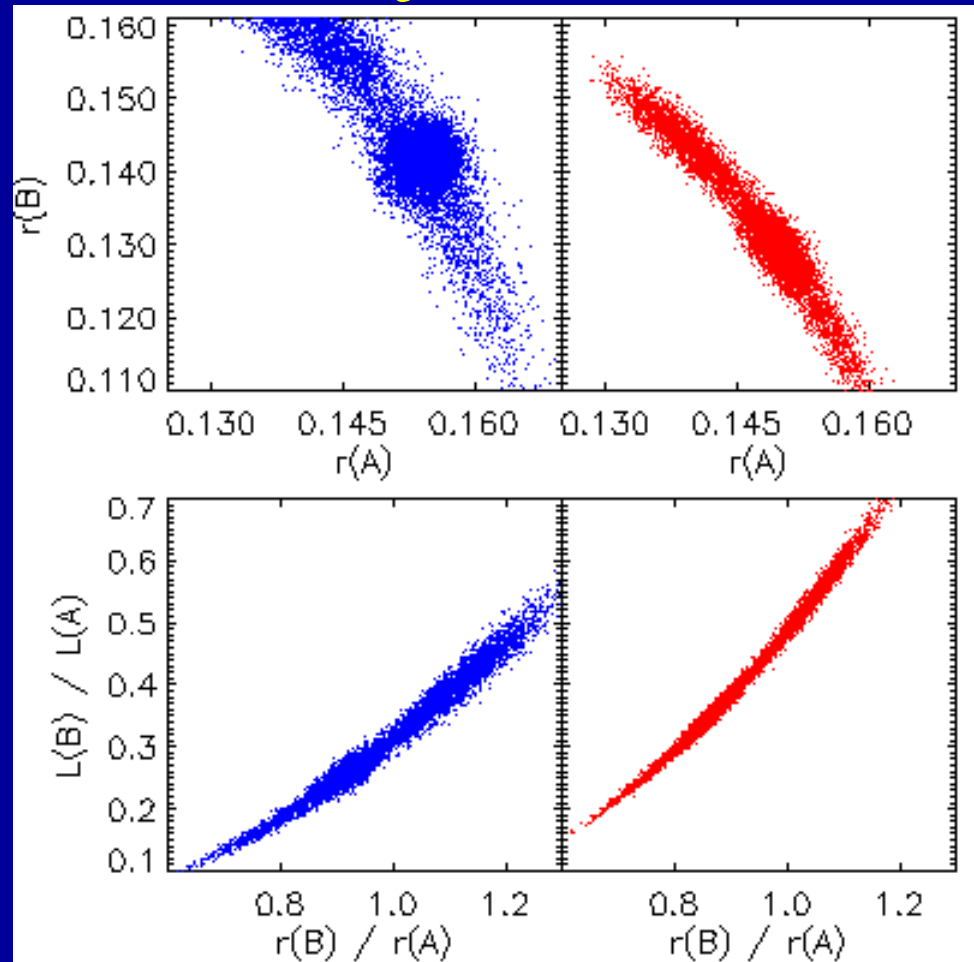
Light curve analysis



- *B* and *V* light curves observed by Munari et al
 - Light curves analysed using EBOP
 - Spectroscopic light ratio (Torres 2003) used
 - Possible 5% third light included

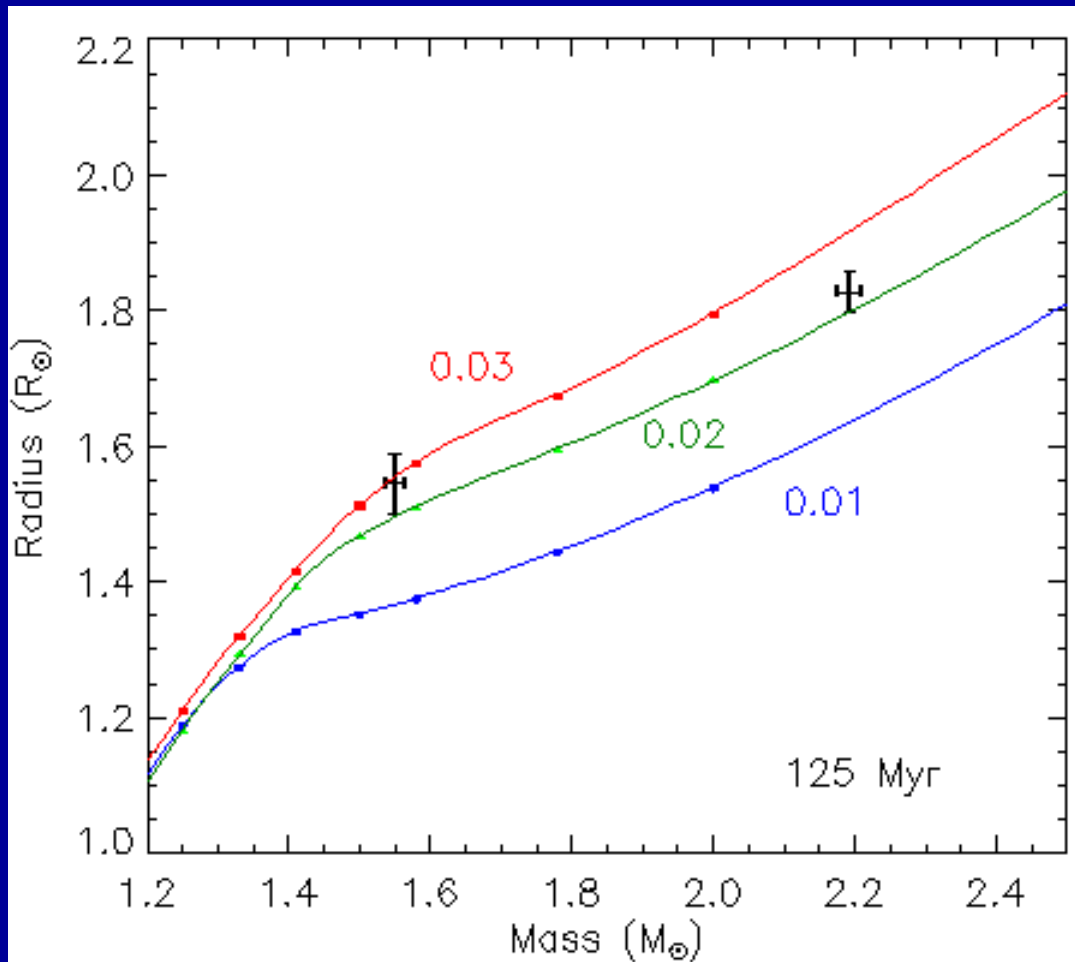
Monte Carlo analysis

- Used Monte Carlo simulations to find light curve uncertainties
 - Limb darkening coefficients perturbed
 - Diagram shows the parameter correlations for which the spectroscopic light ratio was needed to avoid
 - Munari uncertainties underestimated



- Effective temperatures found from spectral synthesis
 - 9750 ± 250 K and 7600 ± 400 K including peculiarity

Pleiades has solar metal abundance



Granada theoretical models
(age 125 Myr, $Z = 0.01, 0.02, 0.03$)

- Masses and radii:
 - $M_1 = 2.19 \pm 0.02$
 - $M_2 = 1.55 \pm 0.02$
 - $R_1 = 1.83 \pm 0.03$
 - $R_2 = 1.55 \pm 0.05$
- Comparison with Granada models gives $Z \approx 0.02$
 - Pleiades distance scales cannot be reconciled by adopting a low metal abundance

Distance to the Pleiades

- Distance from luminosity + bolometric correction:
 - $L = 4 \pi R^2 \sigma T_{\text{eff}}^4 \Rightarrow M_{\text{bol}}$
 - $M_{\text{bol}} + \text{B.C.} + V \Rightarrow M_V + V \Rightarrow \text{distance}$
- Problems:
 - B.C.s are model-dependent
 - Needs fundamental effective temperatures
 - Solar M_{bol} and luminosity are slightly uncertain
 - Consistent solar M_{bol} and luminosity values needed
- Munari's distance to the Pleiades: $131.9 \pm 2.1 \text{ pc}$
 - What we get using Bessell (1998) B.C.s: $134.5 \pm 2.5 \text{ pc}$
 - What we get using Flower (1996) B.C.s: $135.4 \pm 2.6 \text{ pc}$
 - What we get using our analysis: $138.1 \pm 4.7 \text{ pc}$

Distance from surface brightness calibrations

- Use zeroth-magnitude angular diameter $\Phi^{(m=0)}$
 - $S_V = V_0 - 5 \log \Phi$ so $\Phi^{(m=0)} = \Phi 10^{(0.2 m)} = 0.2 S_V$
 - Kervella et al (2004) give $\Phi^{(m=0)} \text{ -- } \log T_{\text{eff}}$ calibrations

$$d = 10^{0.2m_\lambda} \sqrt{\left[\frac{2R_A}{\phi_A^{(m_\lambda=0)}} \right]^2 + \left[\frac{2R_B}{\phi_B^{(m_\lambda=0)}} \right]^2}$$

- Use 2MASS JHK photometry: IR relations better
 - Distance found: $139.1 \pm 3.6 \text{ pc}$
 - Individual uncertainties:
 - Effective temperatures: 0.7 pc 1.4 pc
 - Stellar radii: 1.4 pc 1.5 pc
 - Apparent K magnitude: 2.1 pc
 - 'Cosmic' scatter in calibration: 1.4 pc

The Pleiades distance is?

- Long distance scale: 132 ± 3 pc
 - main sequence fitting
 - study of astrometric binary Atlas
- Short distance scale: 118 ± 3 pc
 - Hipparcos parallaxes
- Distance to HD 23642: 139 ± 4 pc
 - only weakly dependent on temperatures and radii
- The Pleiades is not metal-poor
 - from comparison between the masses and radii and theoretical evolutionary models
- HD 23642 needs better light curves + spectroscopy