Introductory Astronomy

Week 5: Stellar Evolution

Clip 8: Instability – Variable Stars

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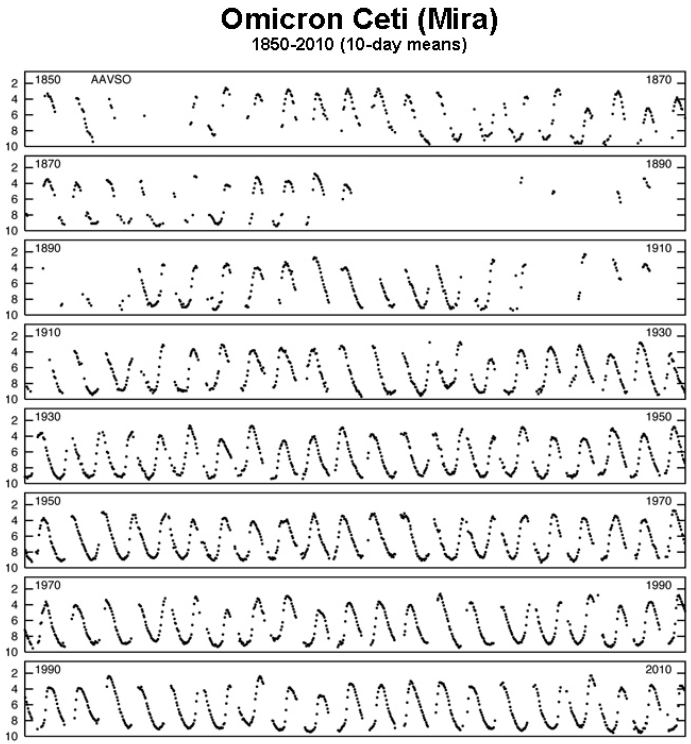
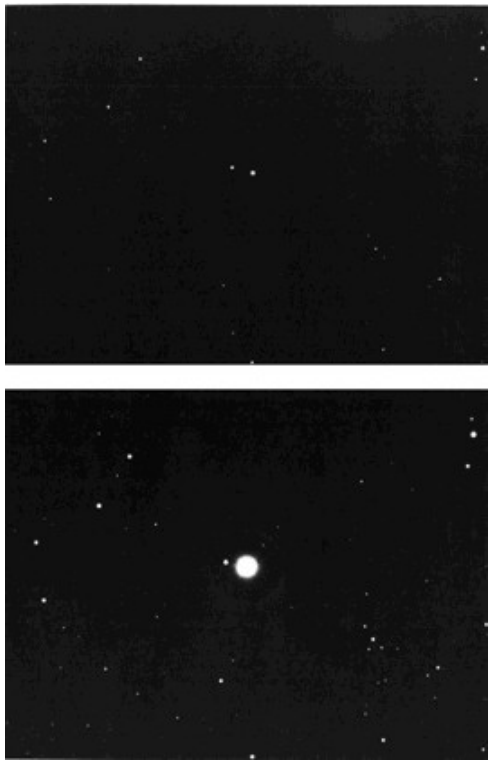
Variable Stars

- Some Giants and Hypergiants exhibit regular periodic change in luminosity
- Mira (Fabricius 1595) changes by factor of 100 with period of 332d
- LPV like Mira not well modelled





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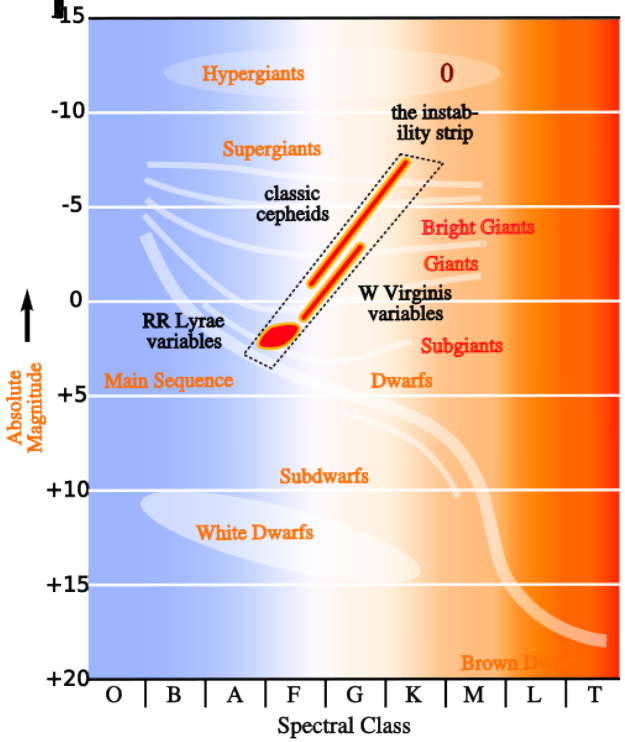
Instability Strip

- A nearly vertical region traversed by most massive stars on HB
- RR Lyrae: PII HB stars with periods of hours. Luminosity varies little (!)
- Cepheids (PI) , W Virginis (PII) periods of days.



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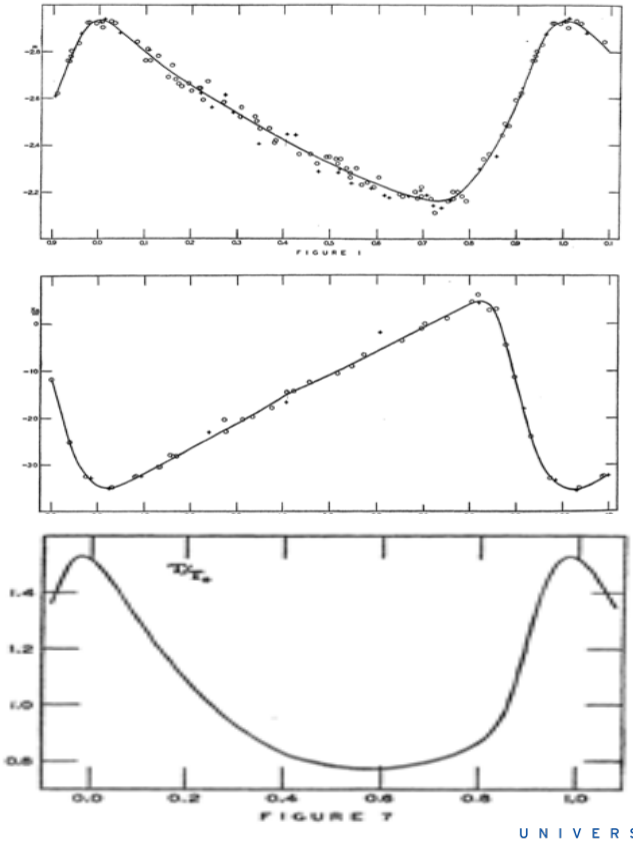
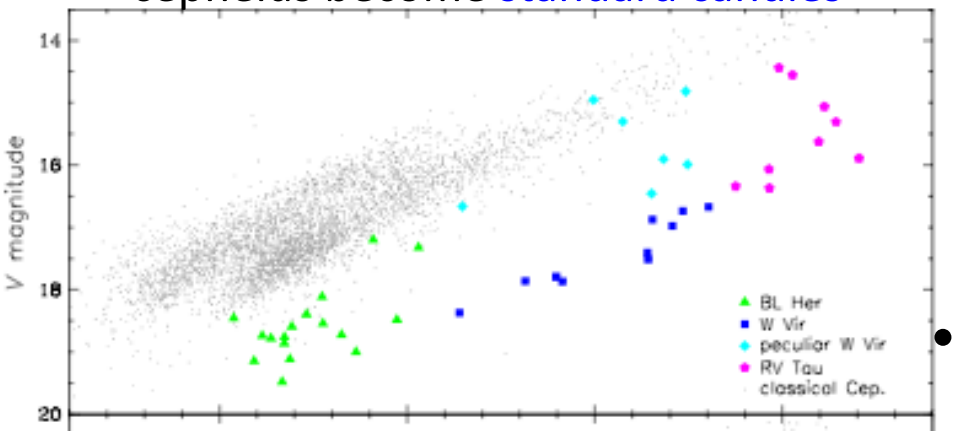
Why They Pulse

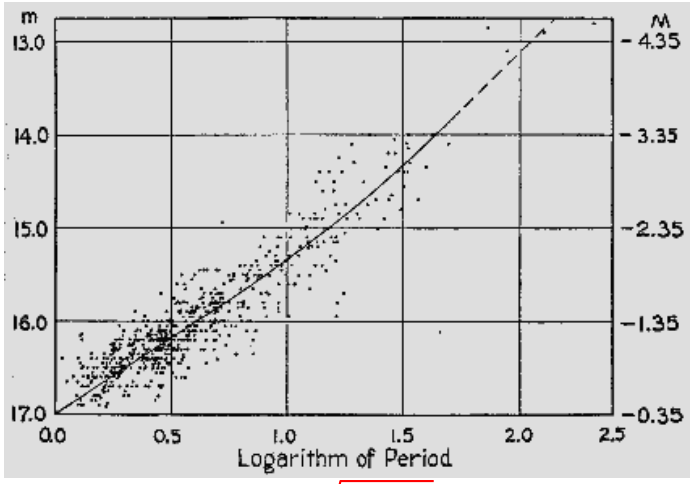
- Cepheids oscillate in size (radial oscillation)
- Temperature and luminosity peak during rapid expansion
- Eddington: Compression increases opacity in layer trapping energy and propelling layer up where it expands, releases energy
- Problem: compression reduces opacity due to heating
- Solution: compression ionizes Helium so less heating. Expansion reduces ionization – κ-mechanism
- Instability strip has partially ionized Helium at suitable depth



Why We Care

- Leavitt 1908: Period-Luminosity Relation for SMC cepheids
- Luminous cepheids have longer periods
- With calibration in globular clusters cepheids become standard candles





$$D = \sqrt{\frac{L}{4\pi b}}$$

- Later: W Virginis PLR less luminous for same period

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Credits

- Mira Image: C. Evans, UNC http://user.physics.unc.edu/~evans/pub/A31/Lecture18-Stellar-Evolution/mira-variable.jpg
- Mira Light Curve: AAVSO http://www.aavso.org/
- Instability Strip: Wikimedia/Rursus http://en.wikipedia.org/wiki/File:HR-diag-instability-strip.svg
- δ-Cephei Light Curve: M. Schwarzschild, Harvard College Observatory Circular 431 (1938) http://adsabs.harvard.edu/full/1938HarCi.431....1S
- Period-Luminosity: From I. Soszynski et al http://arxiv.org/abs/1005.3544

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