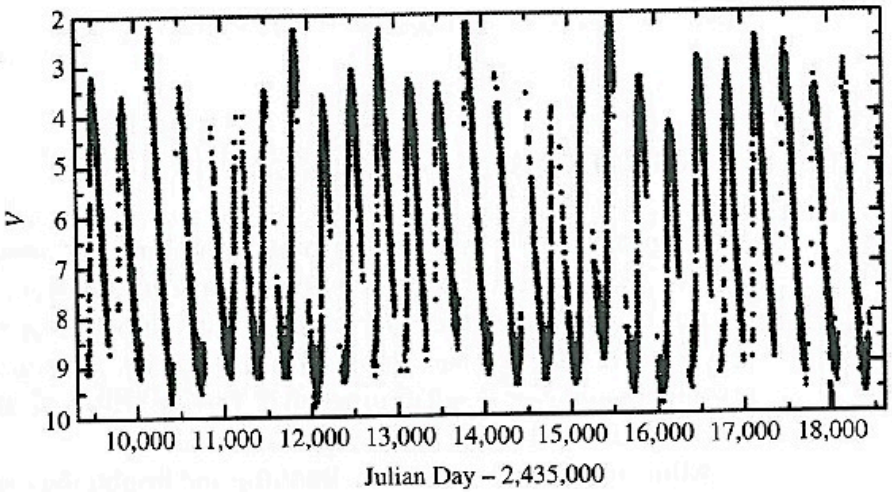
Astronomy 404
November 6, 2013

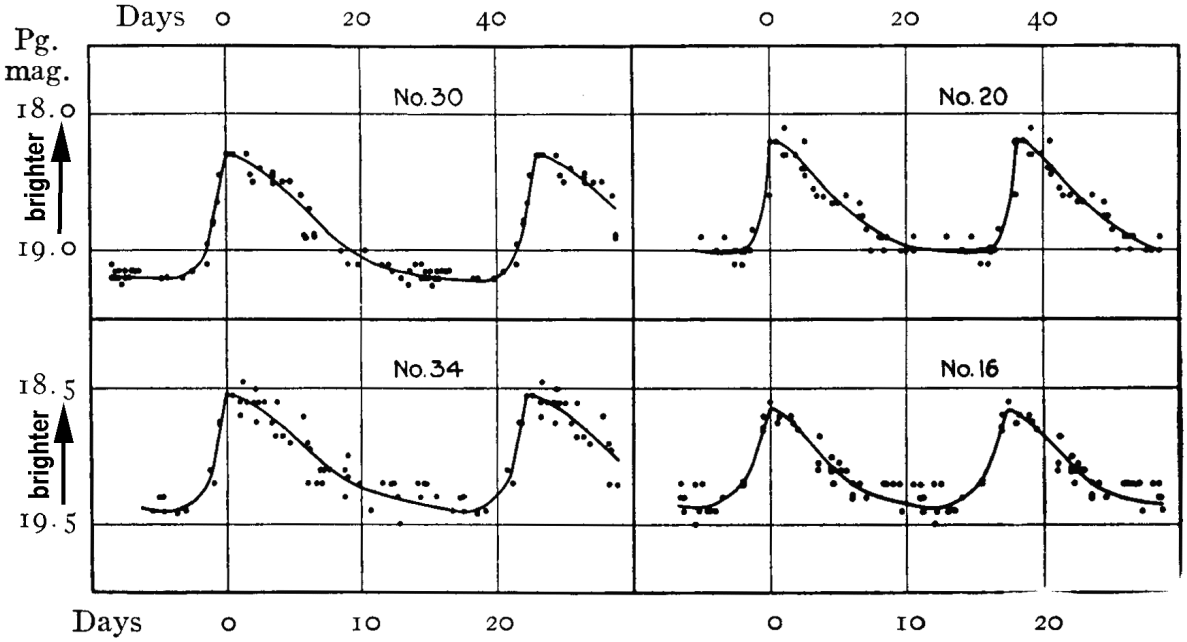
Chapter 14. Stellar Pulsation

Mira is a **long period variable**. δ Cephei is a **classical Cepheid**. Both are pulsating stars.

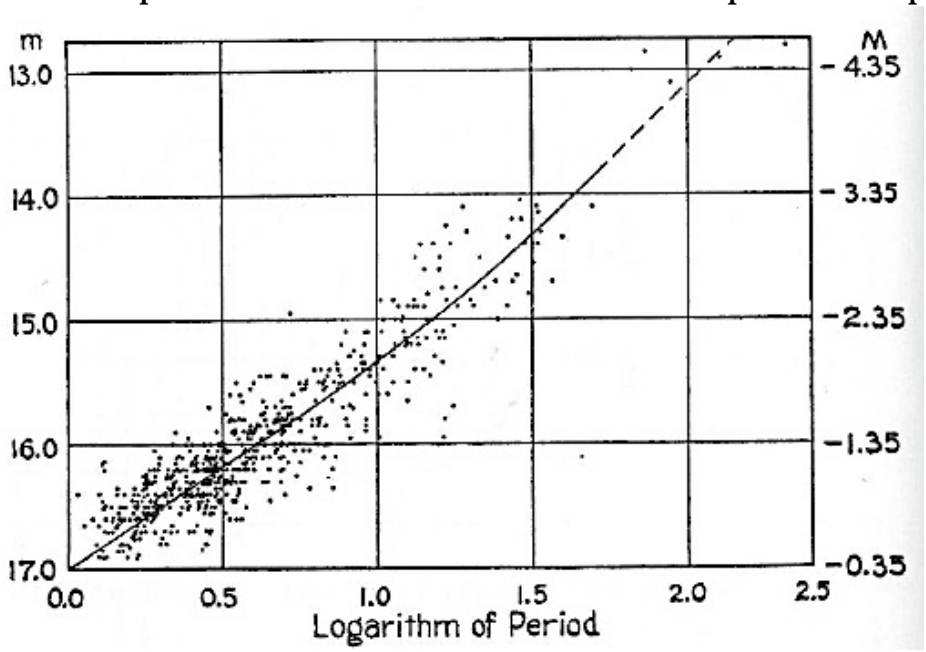
Light curve of Mira:

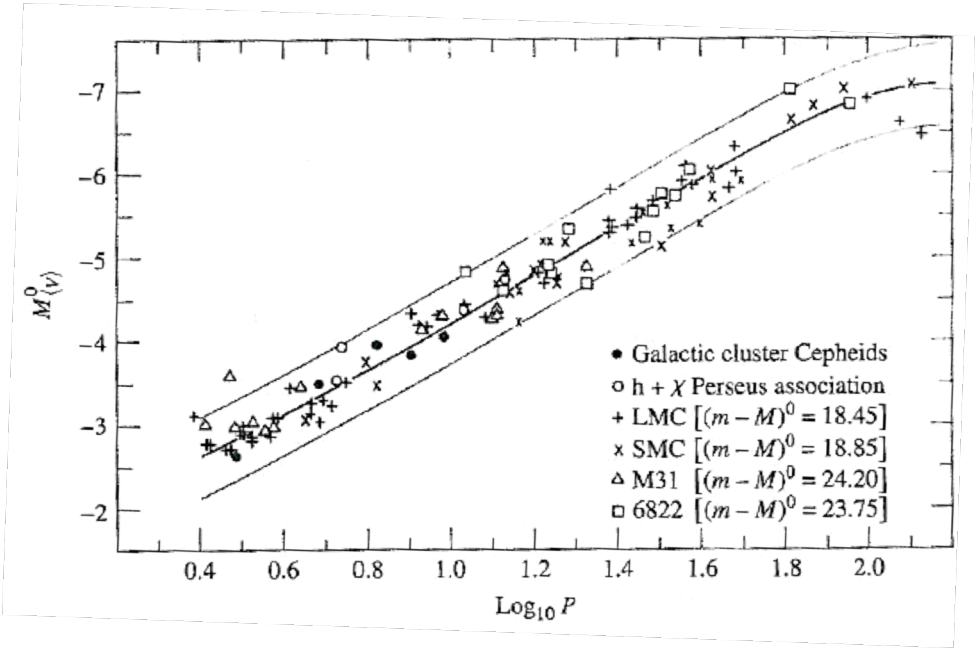


Light curves of 4 Cepheid variables in M33:



Henrietta Swan Leavitt discovered ~2400 classical Cepheids in the Small Magellanic Cloud, and found that the apparent magnitudes of these Cepheids are correlated with their pulsation periods!

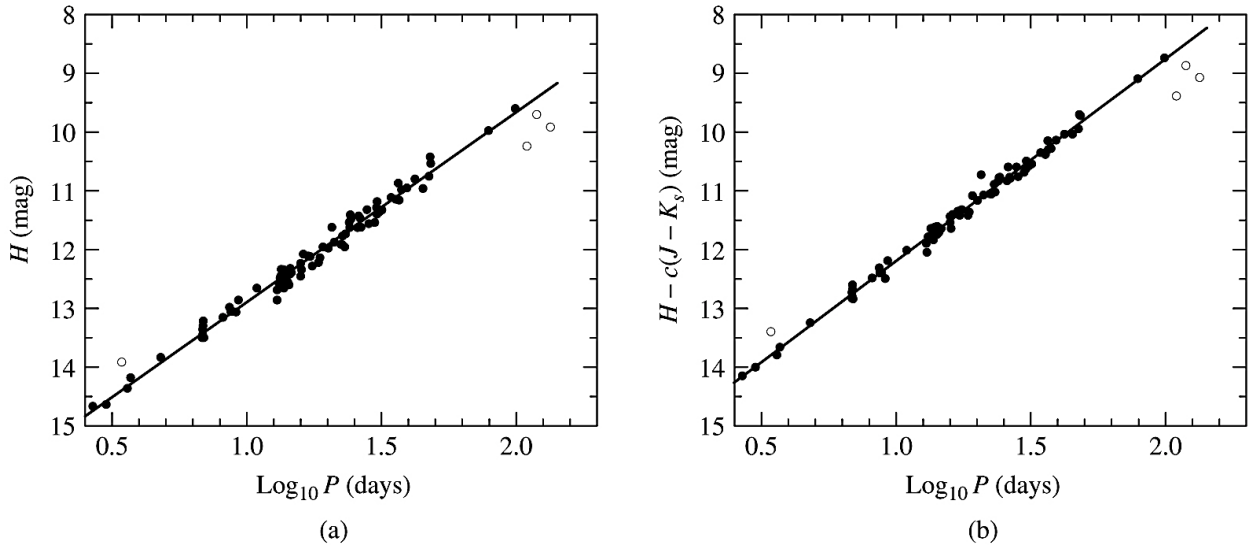




Using Cepheids in clusters or in nearby galaxies with known distances, the period-luminosity relation can be calibrated:

$$M_{(V)} = -2.81 \log_{10} P_{\mathrm{d}} - 1.43,$$

Some of the scatter in the P-L plot is caused by extinction. As extinction effects are smaller in near-IR, the P-L relation is better determined in, for example, *H* band (1.654 μm).

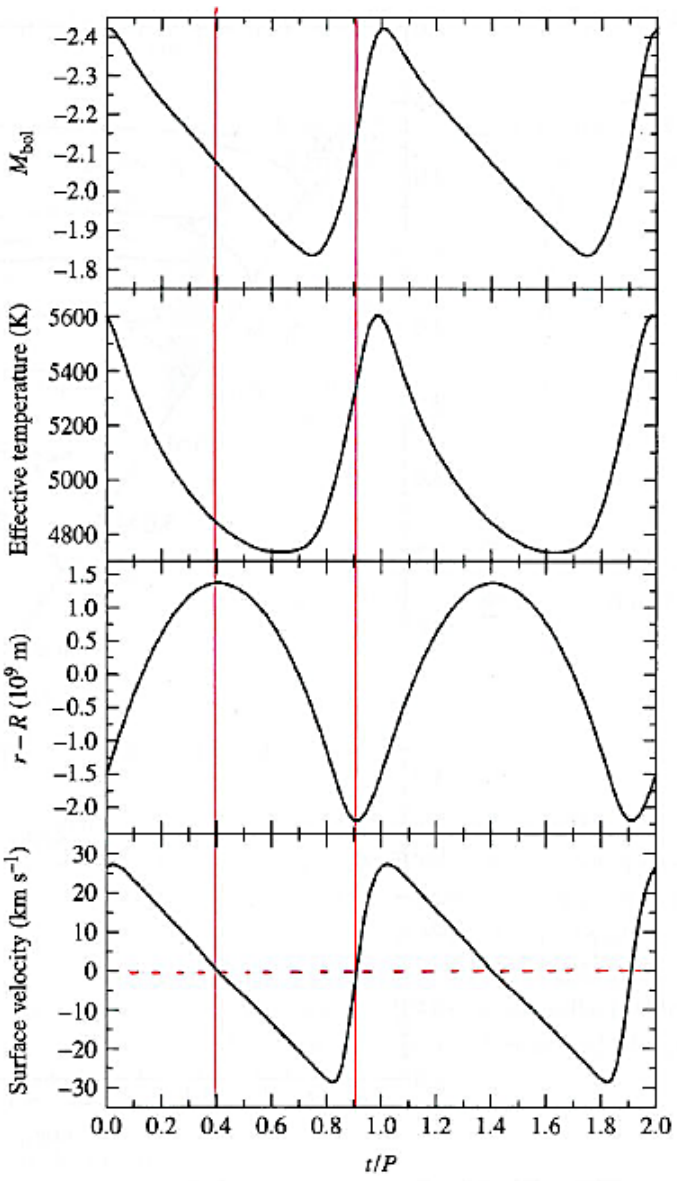


$$H = -3.234 \log_{10} P_{\rm d} + 16.079.$$

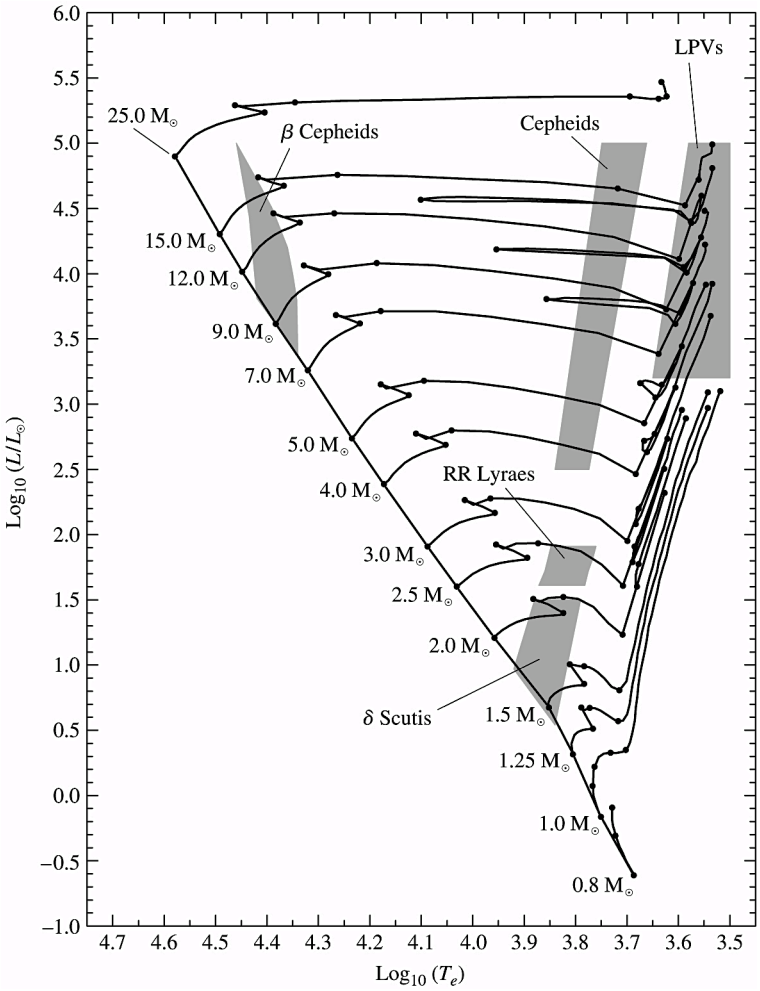
The scatter can be further reduced, if a color term is added in the fit.

$$H = -3.428 \log_{10} P_{\rm d} + 1.54(J - K_s) + 15.637.$$

where *J* and K_s bands are centered at 1.215 and 2.157 μm, respectively.



The luminosity follows the surface velocity well – the star is brightest when the surface is expanding outward the fastest. There is a phase lag of the maximum luminosity behind the minimum radius.



Type	Range of Periods	Population Type	Radial or Nonradial
Long-Period Variables	100–700 days	I,II	R
Classical Cepheids	1–50 days	I	R
W Virginis stars	2–45 days	II	R
RR Lyrae stars	1.5–24 hours	II	R
δ Scuti stars	1–3 hours	I	R,NR
β Cephei stars	3–7 hours	I	R,NR
ZZ Ceti stars	100–1000 seconds	I	NR