3. What are cepheids?

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A cepheid variable is a type of star that pulsates radially

↳ Varying in both: diameter and temperature
↳ Well-defined stable period and amplitude
⇒ "Just" by observing its pulsation period you can get its true luminosity and this leads to the distance by comparing this to the apparent brightness
↳ The name has its origin in the Cephus constellation. Here, the first cepheid was found (Delta Cephei)

Zusatzfrage: Wie führt man mit Cepheiden eine Entfernungsmessung durch?

Die absolute Helligkeit M eines Cepheiden steht in Relation zu seiner Pulsationsperiode P

$$M = -2{,}81 \cdot \log(P/\text{Tage}) - 1{,}43$$

Mit der gemessenen Helligkeit m ergibt sich:

$$D = 10^{(m-M+5)/5}$$

wobei D die Distanz des Objektes ist. Aber wie kommen wir auf diesen Zusammenhang?

⇒ Die Perioden-Leuchtkraft-Beziehung musste erstmal kalibriert werden ...
Also wurde zu erst durch andere Verfahren (z.B. Parallaxe, Theorie, direkte Messungen, ...) die Entfernung bestimmt und daraus dann dieser Zusammenhang gezogen.

Classes of cepheid variables:

- Classical cepheid: also known as Population I Cepheids, type I Cepheids, or Delta Cepheid variables)
  ↳ Very regular pulsations (~ days to months)
  ↳ Population I variable stars: 4-20 times more massive than our sun and about 700.000 times more luminous
  ↳ They are yellow bright giants and supergiants
  ↳ Their radii change by ≈25% during a pulsation cycle
  ↳ These are used to establish distances to galaxies in the local group and beyond (and the Hubble constant)

- Type II Cepheids: also Population II Cepheids
  ↳ Cycle time: 1-50 days
  ↳ Typically metal-poor, about 10 Gyr old and low mass (half our sun)
  ↳ These are used to establish distances to the Galactic Center, globular clusters, and galaxies

- Anomalous Cepheids:
  ↳ Cycle time: < 2 days
  ↳ Higher mass than type II cepheids
  ↳ Still unclear whether they are young stars on a "turned-back" horizontal branch, blue straggler or a mix of both

main sequence stars: very bright and bluer than stars at the turn off point see Hertzsprung-Russel diagram

- Double-mode Cepheids:
  - ↳ Pulsate in two modes at the same time
  - ↳ Just a small proportion of Cepheids
  - ↳ Even less with three modes or more

They sound like a perfect way to measure great distances. But what about the uncertainties? The uncertainties are bound to:

- The nature of the period-luminosity relation in various passbands
- The impact of metallicity on both the zero-point and slope of those relations
- Effects of photometric contamination (blending)
- Changing extinction law on Cepheid distances

These uncertainties lead to values for the Hubble constant ranging between $60 \frac{km}{s Mpc}$ and $80 \frac{km}{s Mpc}$
Delta Cephei is used as calibration as there are also precise parallax measurements from the Hubble telescope