WHAT EXACTLY IS A CEPHEID?

- F-G-K Supergiants
- Mass \( \approx 4.0 M_{\odot} \)
- Radius \( \approx 35 M_{\odot} \)
- Lum. \( \approx 10^3 - 10^4 L_{\odot} \)
- Age \( \approx 10 - 250 \) Myr
- Periods \( \approx 2 - 50 \) days
- \( \delta \) Cep – prototype
- Intrinsic Variable Stars: Radial Pulsations

(Cox 1974)
Galactic Cepheid Period Distribution

Pulsation Period (days)
1215  Pegasus Cluster  14 March 1921  12" P.C.

Exp. 9h 30m - 10h 30m G.M.T.

Marion's "Record" Plate  Reptil

W.J.S.L.
The Magellanic Clouds
hot gas in the LMC
1777 VARIABLES IN THE MAGELLANIC CLOUDS.

By Henrietta S. Leavitt.

The variables appear to fall into three or four distinct groups. The majority of the light curves have a striking resemblance, in form, to those of cluster variables. As a rule, they are faint during the greater part of the time, the maxima being very brief, while the increase of light usually does not occupy more than from one-sixth to one-tenth of the entire period. It is worthy of notice that in Table VI the brighter variables have the longer periods.

cluster variables = cepheids
“it is worthy of notice that in Table VI the brighter stars have the longer periods”

**TABLE VI.**

PERIODS OF VARIABLES IN THE SMALL MAGELLANIC CLOUD.

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1912: paper published under name of Edward Pickering, reported work on 25 variable stars in the SMC ‘prepared by Miss Leavitt’

HARVARD COLLEGE OBSERVATORY.

CIRCULAR 173.

PERIODS OF 25 VARIABLE STARS IN THE SMALL MAGELLANIC CLOUD.

The following statement regarding the periods of 25 variable stars in the Small Magellanic Cloud has been prepared by Miss Leavitt.

EDWARD C. PICKERING.

MARCH 3, 1912.
A remarkable relation between the brightness of these variables and the length of their periods will be noticed.

PERIODS OF VARIABLE STARS IN THE SMALL MAGELLANIC CLOUD.

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The first period-luminosity diagram

lower curve: minimum brightnesses
upper curve: maximum brightnesses

note: plot on right is logarithmic, shows near straight line relationship
A straight line can readily be drawn among each of the two series of points corresponding to maxima and minima, thus showing that there is a simple relation between the brightness of the variables and their periods. The logarithm of the period increases by about 0.48 for each increase of one magnitude in brightness.
Since the variables are probably at nearly the same distance from the Earth, their periods are apparently associated with their actual emission of light,
Open Cluster (Pleiades) H-R Diagram

Globular Cluster (Palomar 3) H-R Diagram
Cepheids with periods of days

Instability strip

Polaris

Variable stars with periods of hours (called RR Lyrae variables)

Sun

Luminosity (solar units)

Surface temperature (Kelvin)
THE COSMIC DISTANCE LADDER

- Hypergiants
- Supergiants
- Classic cepheids
- Bright Giants
- W Virginis variables
- Subgiants
- RR Lyrae variables
- Main Sequence
- Dwarfs
- Subdwarfs
- White Dwarfs
- Brown Dwarfs

Spectral Class: O | B | A | F | G | K | M | L | T

Absolute Magnitude

Milky Way ($10^5$ ly)

nearby galaxies ($10^7$ ly)

galaxy clusters ($10^{10}$ ly)

white dwarf supernovae

Tully–Fisher relation

distant standards

Hubble's law: $d = \frac{V}{H_0}$

relative apparent brightness

main-sequence fitting

luminosity vs. period

surface temperature (K)

Cepheids

related standards
STEPPING OUT INTO THE UNIVERSE

Figure from Riess et al. (2016)