

# The Hertzsprung-Russell Diagram

Dwarfs and Giants

# Classification of Stars

- 1603: Johann Bayer classified stars based on:
  - their brightness
  - their location in the sky
- Still used for brightest stars



# Classification of Stars

- ~1700: John Flamsteed classified stars based on:
  - their location in a constellation, from west to east
- Still used for many stars



# Secchi Classification of Stars

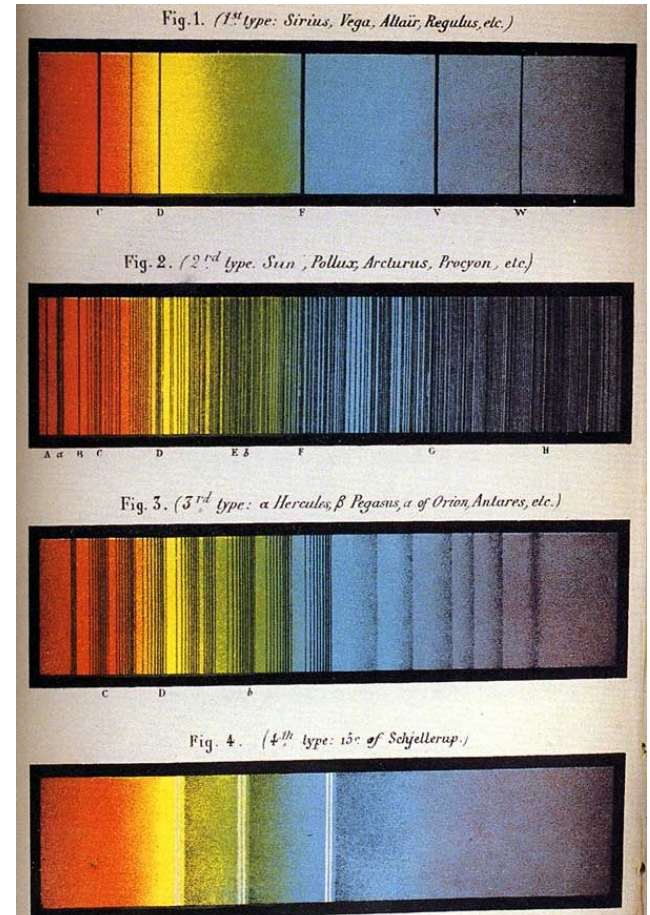
Angelo Secchi classified 4,000 stars as:

1<sup>st</sup> type: white or blue (e.g., Sirius), showing four strong dark lines (one red, one blue, and two violet-blue) identified as hydrogen; about 50% of all stars were in this group;

2<sup>nd</sup> type: yellow stars (e.g., Capella, Sun) hydrogen lines and strong metallic lines;

3<sup>rd</sup> type: red stars (e.g., Betelgeuse) with no hydrogen lines, with metallic lines;

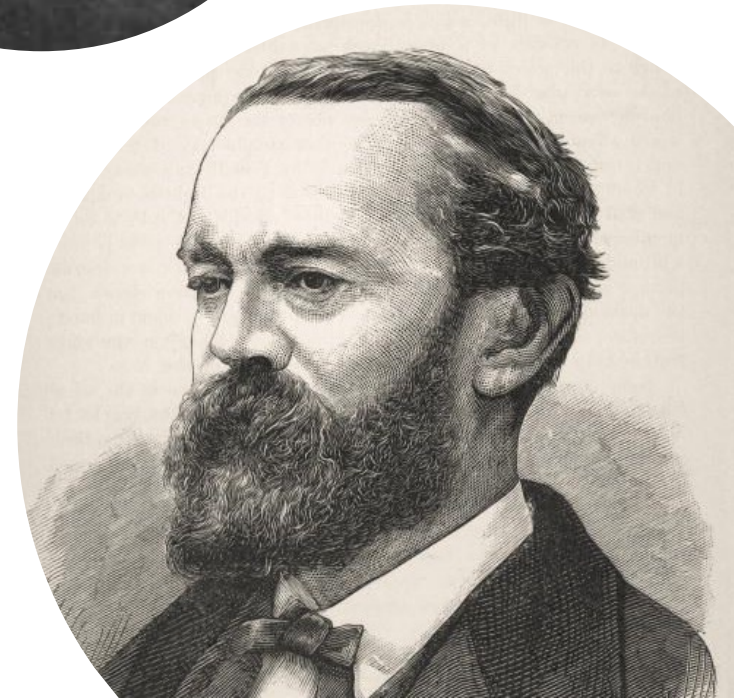
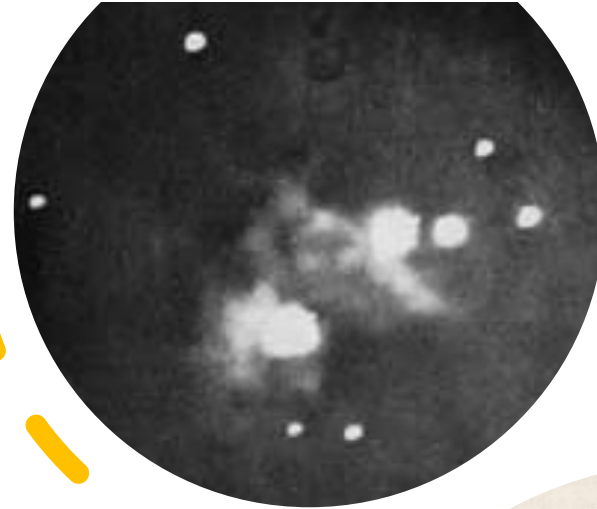
4<sup>th</sup> type faint red stars with dark bands of lines due to hydrocarbons



These tell us something about the physics of these stars!

# Henry Draper

- Photographed Orion Nebular 1880
- Made first spectra of distant stars
- Contributed to a catalog (Draper catalog) with positions, magnitudes and spectral types of stars
- Williamina Fleming performed most of the classification.





## The first ‘computer’: Williamina Fleming

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Assigned to each star a letter according to how much hydrogen could be observed in its spectra (17 total spectral ‘types’)

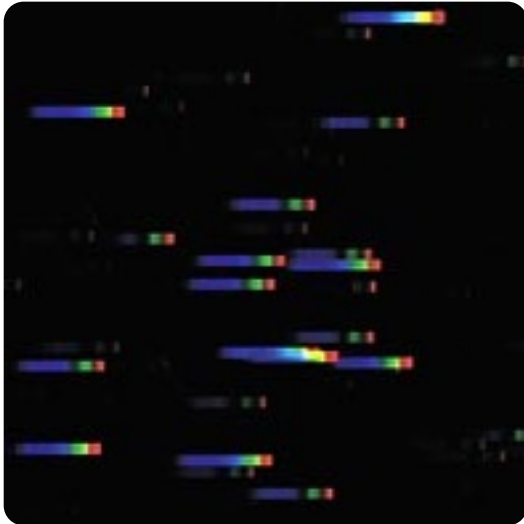
- A stars – had the most hydrogen
- B stars – next most, etc., down to type O
- P and Q spectral types were for odd-ball spectra

catalogued 10,351 stars in 9 years



## Edward Pickering 19<sup>th</sup> Century

- Collected photographic plate images of the spectra of stars
- Obtained hundreds of thousands of such spectra
- Hired 'computers' to catalog these spectra





# Annie Jump Cannon

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Realized A,B,...,Q system was inadequate

Reordered stars; eliminated redundancies in Flemings' system

Cannon's spectral types: OBAFGKM, with fractional gradations (...F0, F2, F8, G0,...)

Adopted for use in 1910

This arrangement ordered stars from hottest to coolest



Became known as the Harvard Classification Scheme



# Spectral Type Classification System

O B A F G K M (L T)

- Oh Be A Fine Girl/Guy, Kiss Me!

50,000 K ←————— 3,000 K  
Temperature

# Ejnar Hertzsprung

- 1905: counter-intuitive discovery
  - faint, red stars were close
  - bright red stars were more distant!

*If all red stars have same temperature ...*

*how can one red star have an intrinsic  
brightness that is much greater than that of  
another red star?*

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Evolutionary Phases!

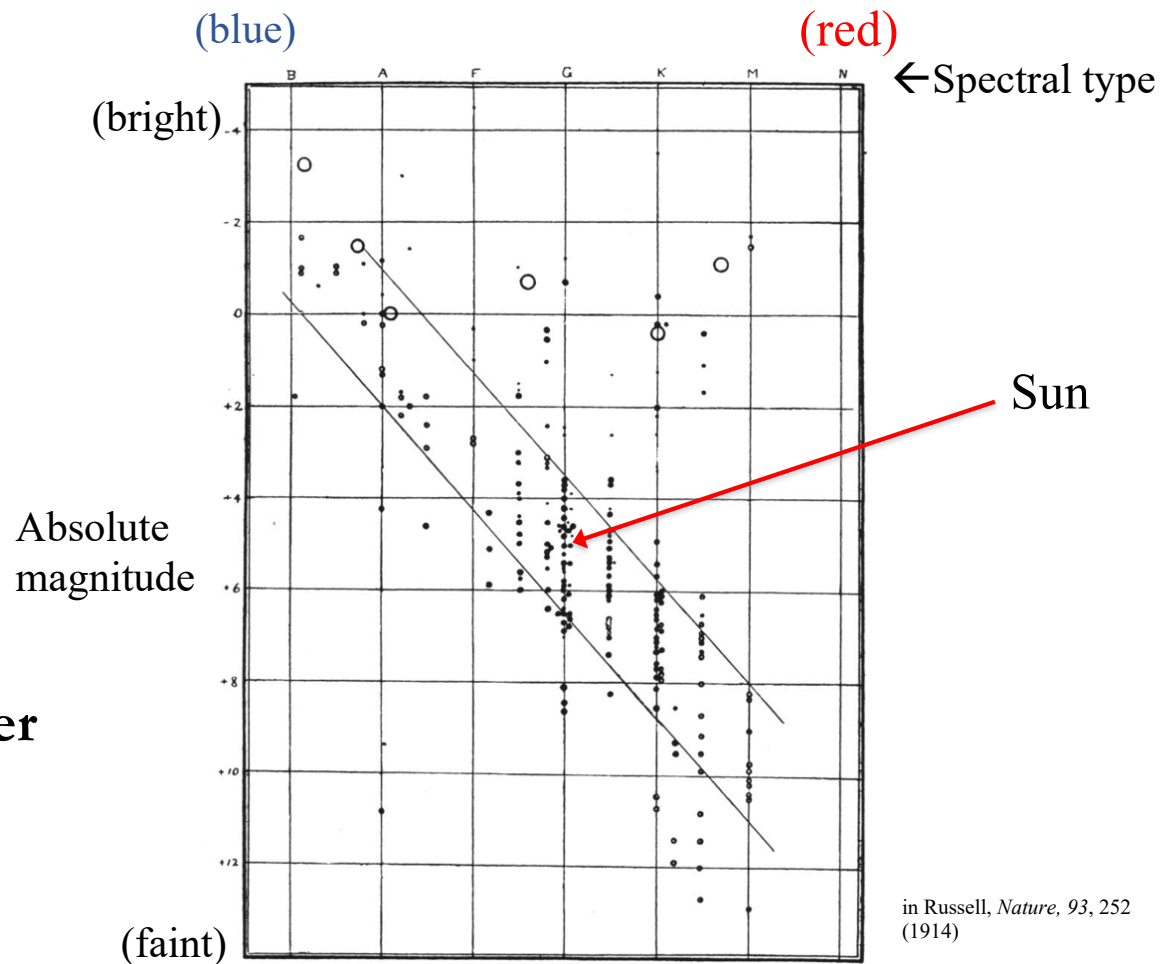
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# Henry Norris Russell

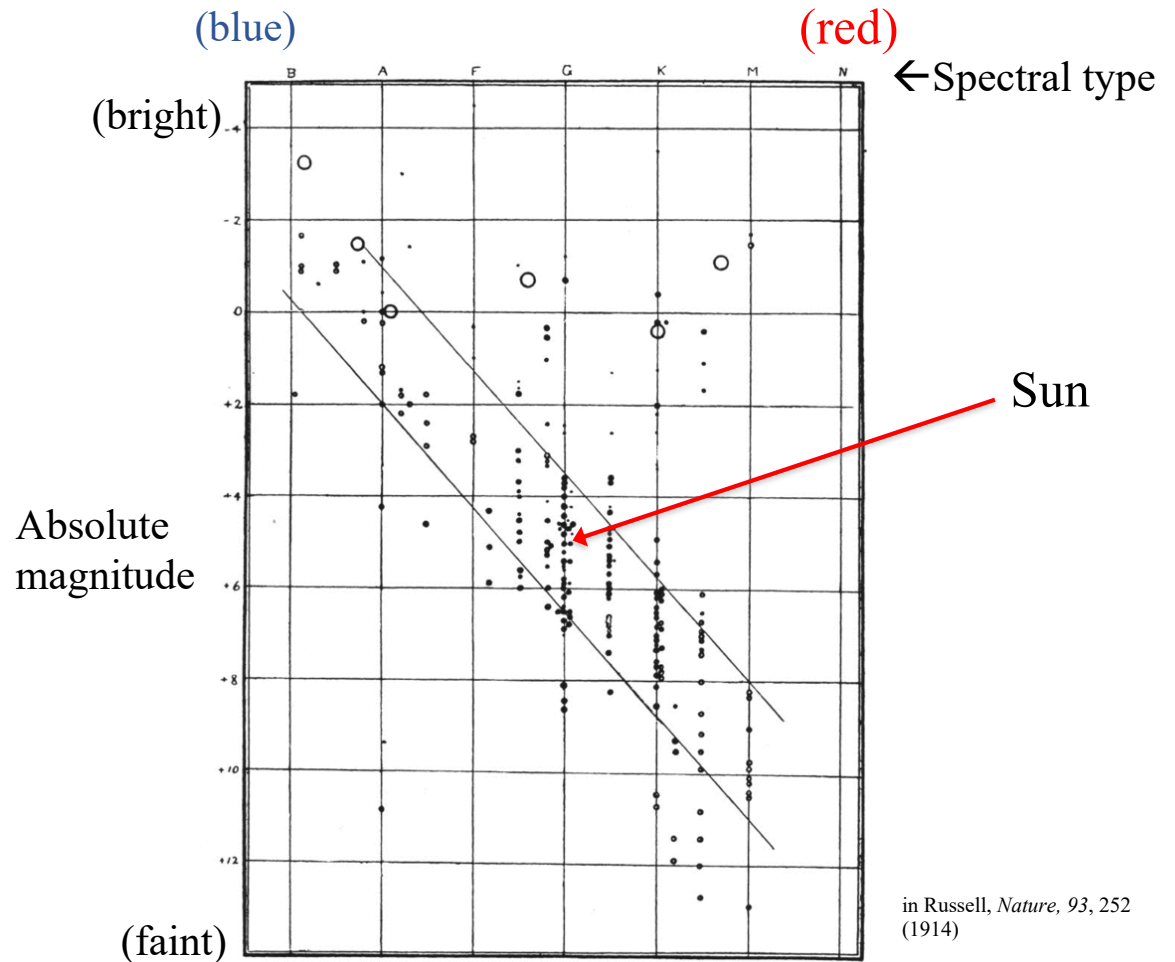
June 13, 1913 presentation  
to British Astronomical  
Society

Plotted spectral type (in order  
of temperature) vs. absolute  
magnitude



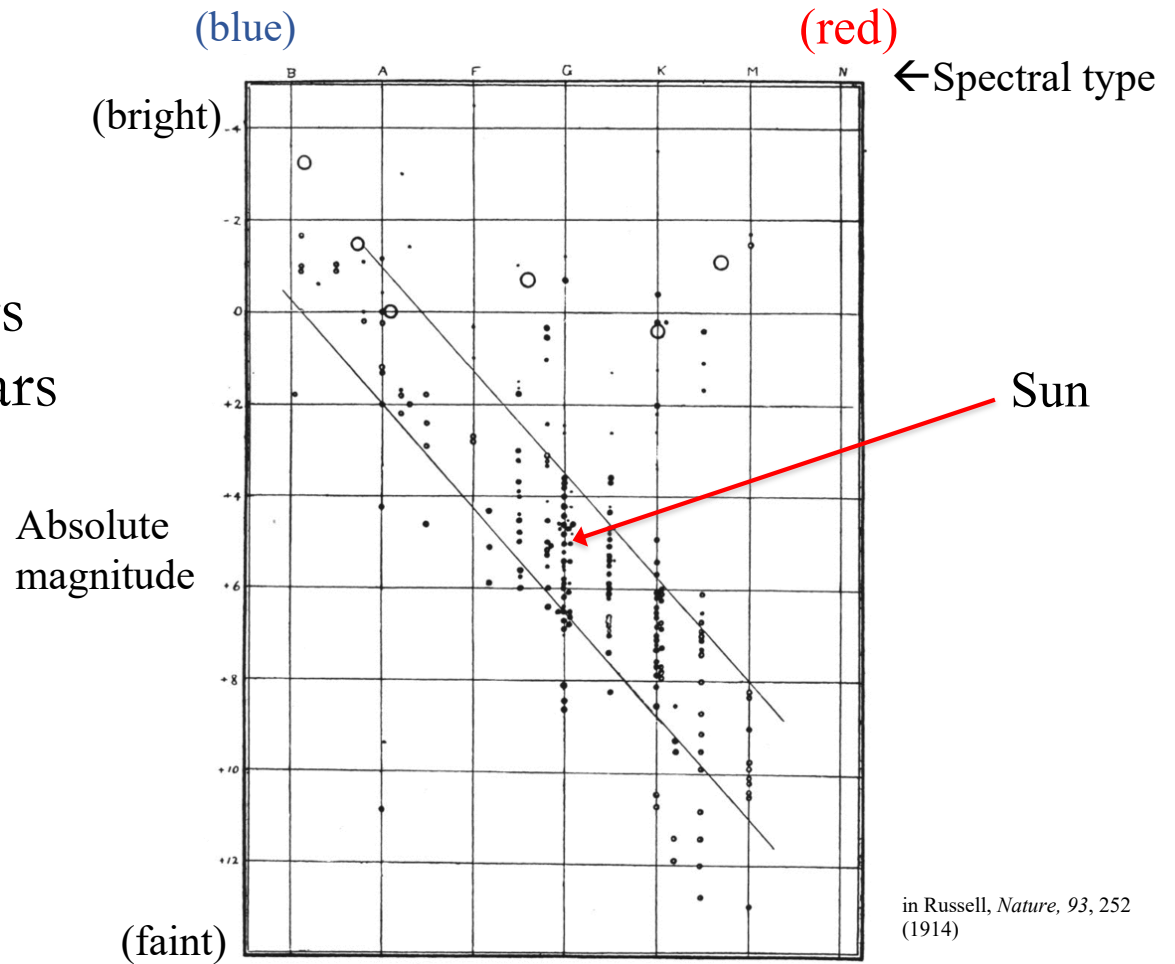
# Henry Norris Russell

Stars steadily increase from dimmest to brightness concurrently with red to blue colors



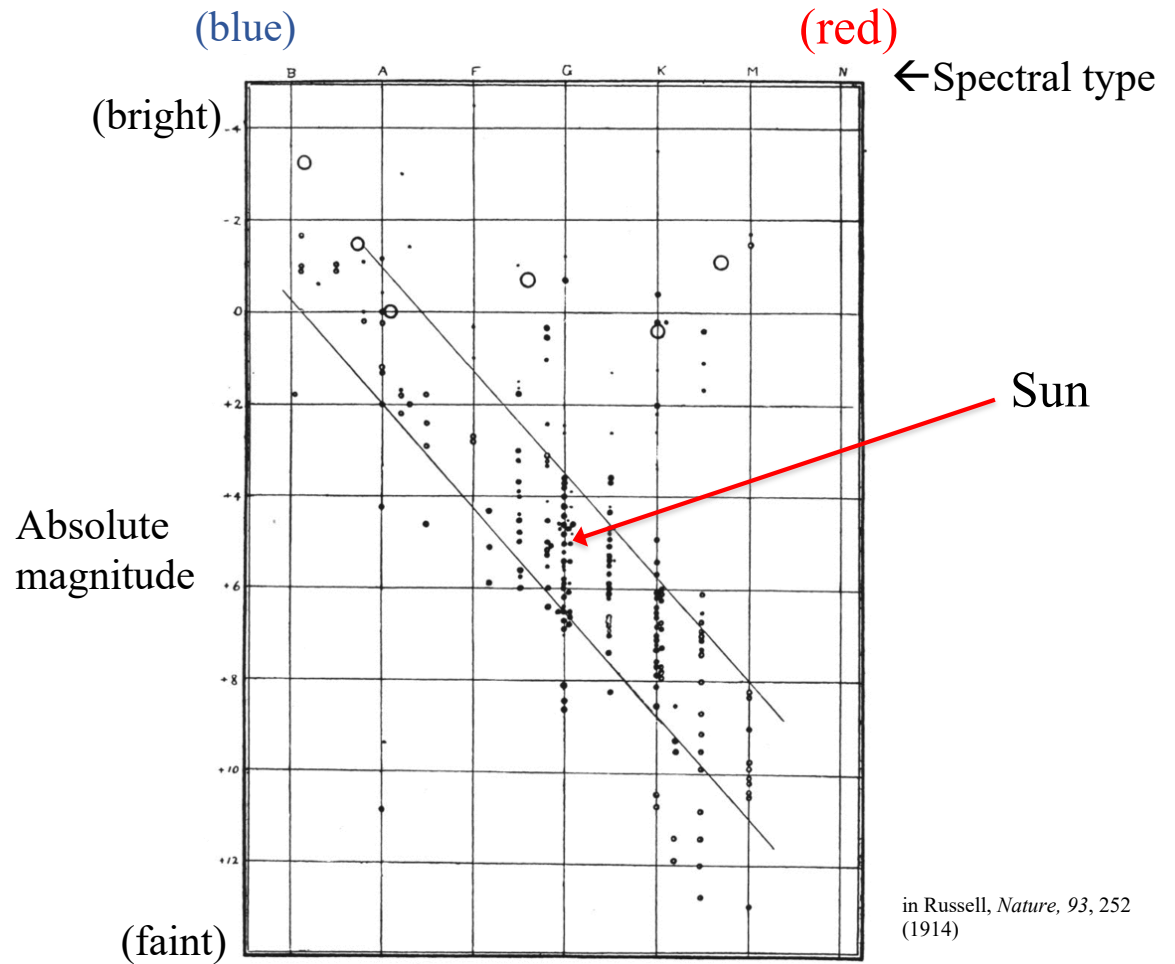
# Henry Norris Russell

Shows that blue/white stars are brighter and all faint stars are red



# Henry Norris Russell

The red stars are separated into two groups





# Henry Norris Russell

You can predict the intrinsic brightness of a star on the main sequence (a star burning hydrogen to helium) from the spectrum.

