www.scienceinschool.org

A map of the stars

Historical Roots

Discovering order in the stars

More than a century ago, two astronomers – Ejnar Hertzsprung in Denmark and Henry Norris Russell in the United States – were asking the same question: Is there an underlying order in how stars live and evolve?

Working independently, they started to create a star plot, marking each star according to its brightness and colour (an indicator of temperature). To their surprise, the points did not scatter randomly. Instead, they revealed a striking pattern – a hidden order that reflected the stages of a star's life.

This discovery became the foundation of modern stellar astronomy. The Hertzsprung-Russell (H-R) diagram not only classifies stars but also traces their evolution over millions or even billions of years. In simple words, it is a fundamental tool to study stellar populations and their life cycles.

Its development was made possible thanks to extensive work at the Harvard College Observatory in the late 19th century, where astronomers conducted one of the first large-scale spectroscopic surveys, recording stellar spectra on photographic plates and classifying tens of thousands according to their light patterns. Their efforts produced the Henry Draper Catalogue[1], a major milestone in stellar astronomy.

Among the researchers, Antonia Maury introduced an important refinement: she grouped stars not only by colour and temperature but also by the width of their spectral lines, a subtle feature that indicates a star's intrinsic luminosity. Her enhanced spectral classification system became a key foundation for later breakthroughs.

From spectra to the H-R diagram

Hertzsprung's breakthrough (1908)

Building on Maury's work, Hertzsprung noticed that stars with narrow spectral lines tended to have smaller proper motions than others of the same type, meaning they were likely to be more distant yet more luminous. In 1908, he published these findings[2] estimating their absolute magnitudes and showing that stellar brightness and temperature were systematically linked. This was the first evidence of the pattern that would become the H-R diagram.

Russell's contribution (1913)

A few years later, Russell independently reached a similar conclusion. Using distances and luminosities derived from parallax measurements, he plotted stars against their spectral types. His data revealed the same structure Hertzsprung had found: a tight and continuous sequence rather than a random scatter.

Russell's work confirmed and strengthened Hertzsprung's insight, establishing that the relationship between brightness and temperature is a fundamental feature of stellar physics.

Birth of the H-R Diagram

Together, their work gave rise to the Hertzsprung-Russell diagram, one of astronomy's most powerful tool in modern stellar astrophysics.[3]

References

[1] Cannin AJ, Pickering EC (1918) The Henry Draper catalogue 0h, 1h, and 3h. *Annals of Harvard College Observatory* **91**: 1-290.

[2] Hertzsprung E (1909) Über die Sterne der Unterabteilungen c und ac nach der Spektralklassifikation von Antonia C. Maury. *Astronomische Nachrichten* **179**: 373.

[3] Introduction to the H-R diagram: https://www.cosmos.esa.int/web/cesar/the-hertzsprung-russell-diagram