RESEARCH PROJECT

A perusal of paramount attributes relating to Glitters of the Milky Way Galaxy

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Abstract

Background: A star is an astronomical object comprising a luminous spheroid of plasma held together by its gravity, which is accredited by a well-defined set of attributes, like

- Relative Luminosity
- Absolute Temperature
- Absolute Magnitude
- Relative Radius, etc

having importance of their own.

Methods: In this study, we have analyzed a well-defined dataset involving stars, having a permutation of the set of attributes mentioned in the subsection above.

Results: We have found that the dataset, we have worked on is apt, by comparing its nature to that of the Hertzsprung-Russell Diagram. We have also plotted some more plots, involving some tuples of attributes.

Conclusions: Our results provide a concrete aptness of the dataset, by making use of Data Science with apposite Machine Learning Techniques and provoked new plots, which may be contemplated for further improvement in literature.

Keywords: Suicide, Machine Learning, Statistics.

1 Introduction

Stars are the most widely recognized astronomical objects and represent the most fundamental building blocks of galaxies. The age, distribution, and composition of the stars in a galaxy trace the history, dynamics, and evolution of that galaxy. Moreover, stars are responsible for the manufacture and distribution of heavy elements such as carbon, nitrogen, and oxygen, and their characteristics are intimately tied to the characteristics of the planetary systems that may coalesce about them. Consequently, the study of the birth, life, and death of stars is central to the field of astronomy.

Stars are born within the clouds of dust and scattered throughout most galaxies. A familiar example of such a dust cloud is the Orion Nebula. Turbulence deep within these clouds gives rise to knots with sufficient mass that the gas and dust can begin to collapse under their gravitational attraction. As the cloud collapses, the material at the center begins to heat up. Known as a protostar, it is this hot core at the heart of the collapsing cloud that will one day become a star. Three-dimensional computer models of star formation predict that the spinning clouds of collapsing gas and dust may break up into two or three blobs; this would explain why the majority of the stars in the Milky Way are paired or in groups of multiple stars. As the cloud collapses, a dense, hot core forms and begins gathering dust and gas. Not all of this material ends up as part of a star — the remaining dust can become planets, asteroids, or comets or may remain as dust.

In some cases, the cloud may not collapse at a steady pace. In January 2004, an amateur astronomer, James McNeil, discovered a small nebula that appeared unexpectedly near the nebula Messier 78, in the constellation of Orion. When observers around the world pointed their instruments at McNeil's Nebula, they found something interesting — its brightness appears to vary. Observations with NASA's Chandra X-ray Observatory provided a likely explanation: the interaction between the young star's magnetic field and the surrounding gas causes episodic increases in brightness.

2 Hertzsprung–Russell diagram

The Hertzsprung–Russell diagram, abbreviated as H–R diagram, HR diagram, or HRD, is a scatter plot of stars showing the relationship between the stars' absolute magnitudes or luminosities versus their stellar classifications or effective temperatures. The diagram was created independently in 1911 by Ejnar Hertzsprung and by Henry Norris Russell in 1913 and represented a major step towards an understanding of stellar evolution.

In the nineteenth century, large-scale photographic spectroscopic surveys of stars were performed at Harvard College Observatory, producing spectral classifications for tens of thousands of stars, culminating ultimately in the Henry Draper Catalogue. In one segment of this work, Antonia Maury included divisions of the stars by the width of their spectral lines.[1] Hertzsprung noted that stars described with narrow lines tended to have smaller proper motions than the others of the same spectral classification. He took this as an indication of greater luminosity for the narrow-line stars, and computed secular parallaxes for several groups of these, allowing him to estimate their absolute magnitude.[2]

In 1910 Hans Rosenberg published a diagram plotting the apparent magnitude of stars in the Pleiades cluster against the strengths of the calcium K line and two hydrogen Balmer lines.[3] These spectral lines serve as a proxy for the temperature of the star, an early form of spectral classification. The apparent magnitude of stars in the same cluster is equivalent to their absolute magnitude and so this early diagram was effectively a plot of luminosity against temperature. The same type of diagram is still used today to show the stars in clusters without having to initially know their distance and luminosity.[4] Hertzsprung had already been working with this type of diagram, but his first publications showing it were not until 1911. This was also the form of the diagram using apparent magnitudes of a cluster of stars all at the same distance.[5]

Russell's early (1913) versions of the diagram included Maury's giant stars identified by Hertzsprung, those nearby stars with parallaxes measured at the time, stars from the Hyades (a nearby open cluster), and several moving groups, for which the moving cluster method could be used to derive distances and thereby obtain absolute magnitudes for those stars.[6].

There are several forms of the Hertzsprung–Russell diagram, and the nomenclature is not very well defined. All forms share the same general layout: stars of greater luminosity are toward the top of the diagram, and stars with higher surface temperature are toward the left side of the diagram.

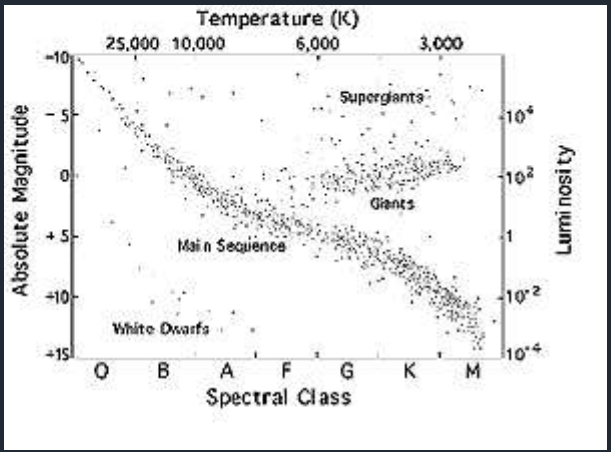

Fig. 1 The Hertzsprung-Russell (H-R) Diagram.

In general, the larger a star, the shorter its life, although all but the most massive stars live for billions of years. When a star has fused all the hydrogen in its core, nuclear reactions cease. Deprived of the energy production needed to support it, the core begins to collapse into itself and becomes much hotter. Hydrogen is still available outside the core, so hydrogen fusion continues in a shell surrounding the core. The increasingly hot core also pushes the outer layers of the star outward, causing them to expand and cool, transforming the star into a red giant.

If the star is sufficiently massive, the collapsing core may become hot enough to support more exotic nuclear reactions that consume helium and produce a variety of heavier elements up to iron. However, such reactions offer only a reprieve. Gradually, the star's internal nuclear fires become increasingly unstable - sometimes burning furiously, other times dying down. These variations cause the star to pulsate and throw off its outer layers, enshrouding itself in a cocoon of gas and dust. What happens next depends on the size of the core.

3 Main Sequence

$\sim 90\%$ of all stars occupy the diagonal band running from the upper left corner (hot, luminous stars) to the lower right corner (cool, dim stars) of the H-R diagram. Stars become main sequence stars when the process of thermonuclear fusion - hydrogen to helium - stabilizes. These stars are in hydrostatic equilibrium - the outward radiation pressure from the fusion process is balanced by the inward gravitational force. When the transition from a protostar to the main sequence star occurs, the star is called a Zero Age Main Sequence (ZAMS) star. The determining factor of where a star is located on the main sequence is mass. The Sun is a G spectral class star with an effective surface temperature of $\sim 5800K$. Since the luminosity and mass of all other stars are measured relative to the Sun, the Sun has one solar luminosity and one solar mass. The O and B stars are the hottest most massive, and the K and M stars are the coolest and least massive stars. The O and B stars are sometimes referred to as early sequence stars, and the K and M stars as late sequence stars. These terms refer to stars more massive (early sequence) than the Sun or less massive (late sequence) than the Sun. All one solar mass stars with hydrogen to helium fusion occurring within their cores, occupy the same position on the main sequence as the Sun; they stay in that location, with that specific relationship of temperature and absolute magnitude, until the hydrogen within the core becomes depleted and the fusion of hydrogen nuclei to helium nuclei stops.

The mass-luminosity relationship for main-sequence stars is defined as:

$$\frac{L}{L_{Sun}} \sim \left(\frac{M}{M_{Sun}}\right)^4$$

All main-sequence stars with a mass less than ~ 8 solar masses are sometimes referred to as dwarf stars, with the coolest, least massive stars in the lower right corner called red dwarfs. The more massive the star, the faster the rate of fusion, and the less time it remains on the main sequence.

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