

*A Brief Column for the Beginning Stargazer Introducing a New Astronomical Term Each Month*

**A**stronomy is rich with terminology. This column will help beginning stargazers ease into the world of astronomy by *briefly introducing* a new but *basic astronomical term* (word, acronym or abbreviation) each month. This list, which began January 1999 with the letter *a*, is alphabetical but uses successive letters for each month's entry. (We will return to the letter *a* after twenty-six months.)

**Word of the Month for July 2000**

Note: The unusual length of this month's column is due to the importance of this month's term.

**spectral class (type)** The categorization or classification of stars according to the appearance or properties of their spectra (appearance of spectral lines).

Stars are ordered into **main spectral classes** designated by the capital letters **O, B, A, F, G, K and M**.

Main classes may be further subdivided into additional classes by the numbers 0 to 9. (Examples: B8, B9, A0, A1, A2, etc.) Not all subdivisions are used and some classes are further subdivided such as O9.5 or B1.5.

**The spectral sequence is primarily a sequence of decreasing surface temperature (O hottest, M coolest) and NOT chemical composition.**

Extra classes include **S** and **C** (formerly **R** and **N**) that roughly parallel G4 through M. This allowed classifying stars with unusual abundances of certain elements such as zirconium or carbon (**S** and **C** type stars).

Later developments added a *luminosity class*. Additional information about the star's spectrum may also be indicated by other symbols (appearance of emission lines, unusual abundances, peculiarities, etc.).

Astronomers currently use the *Morgan-Keenan (MK) System* introduced in 1940s by W.W. Morgan, P.C.

Keenan and Edith Kellman. The MK System is based on a revision of an earlier system developed at Harvard College Observatory during the late nineteenth and early twentieth centuries. (The Harvard system was financed through the estate of Henry Draper, a wealthy American spectroscopist, who took the first photograph of a star's spectrum.)

The *Harvard System* was subsequently developed by Annie J. Cannon and others (including Williamina Fleming and Antonia Caetana de Paiva Pereira Maury), under the direction of the observatory director, E.C. Pickering. This "HD System" was eventually published as the *Henry Draper Catalog* (1918–24), which included spectral classes of 225,300 stars. (Later extensions, including stars in the southern sky, added 133,000 additional stars to this system.)

The following table gives principal MK features of the *blue spectral region* and approximate corresponding temperature values (H = hydrogen, He = helium).

**Table 1.** Key Spectral Class Features

Class	Key Spectral Line Features	Temp. (Kelvins)
<b>O</b>	Weak H, ionized He, highly ionized metals,	> 25,000 K
<b>B</b>	H stronger, neutral He, highly ionized metals	11,000–25,000 K
<b>A</b>	Very strong H, ionized metals, some neutral metals	7,500–11,000 K
<b>F</b>	H weaker, neutral metals stronger	6,000–7,500 K
<b>G</b>	Weak H, very strong ionized calcium, neutral metals, weak molecular bands	5,000–6,000 K
<b>K</b>	Very weak H, many neutral metals, molecular bands	3,500–5,000 K
<b>M</b>	Very weak H, strong neutral metals & molecular bands	< 3,500 K

**early (type) and late (type) stars** Terms now used to refer to the hottest and coolest type stars respectively. This designation arises from an old, mistaken idea that stars evolve (age) from being hot, young objects to cool, old stars. Despite being wrong, the terms *early* and *late* continue to be used to mean “hot” and “cool.”

Difficulty in learning the **O, B, A, F, G, K, M** sequence (including **R, N, S**) was historically lessened by learning a *mnemonic* (memory aid). One of the earliest and most famous is due to Henry Norris Russell: “Oh be a fine girl, kiss me right now smack.” (A permissible substitution for “guy” is “girl.”)

**luminosity class** Besides spectral sequence designations (O, B, A, F, G, K, M), Morgan, Keenan and Kellman (1943) defined *luminosity class criteria*. Stars with the same spectral class (e.g., K4) may have similar spectral lines but the spectral lines may have different strengths. This effect is primarily due to differences in their *atmospheric pressures*. Luminosity class is assigned by looking at luminosity sensitive spectral lines. Table 2 lists luminosity classes, which are usually designated by the **Roman numerals I through VII**.

These Roman numerals appear *after* the letter/number indicating spectral type (e.g., A1 V, G8 V, K4 III, M2 I). Such a designation is now generally regarded as “the spectral class” of the star.

**The Sun’s spectral class is G2 V.** This indicates the Sun is a moderately cool (or *late*) star (hotter than G3 but cooler than G1) belonging to the *main sequence*. (The measured surface temperature of the Sun is about 5,800 K or 10,000 F.)

The term “dwarf” for luminosity class V (main sequence) is no longer commonly used.

The last two luminosity classes (VI and VII) are rarely used. Instead, astronomers designate white dwarfs by a capital “D” (*degenerate*) preceding an uppercase letter designating the dominant element (or ion) in its spectrum. Subsequent symbols may be used to indicate secondary ions or elements present in the spectrum.

Example White Dwarfs: **DA** (strong hydrogen spectral lines), **DB** (strong neutral hydrogen lines), **DO** (strong

ionized helium), **DZ** (metal lines dominate), etc.

**Table 2.** MK Luminosity Classes

MK Luminosity	Type of Object
I	Supergiants (sometimes subdivided into Ia, Iab and Ib corresponding to most luminous, normal and less luminous)
II	Bright Giants
III	(Normal) Giants
IV	Subgiants
V	Main Sequence (“dwarfs”)
VI	Subdwarfs
VII	White Dwarfs

Various *suffixes* are also used to give additional information. Table 3 gives some common examples.

**Table 3.** Additional Spectral Class Notation

Symbol	Characteristic
e	emission lines (eg., Be)
f	certain O type emission lines
k	interstellar lines present
m	strong metallic lines
n	nebulous lines
p	peculiar spectrum
s	sharp lines

Historically, several *prefixes* have also been used but have now been largely replaced by luminosity classes. These include **d** (dwarf), **g** (giant) and **s** (sharp line—a supergiant). Example: Originally the Sun was designated dG2 (now it is G2 V).

**Examples:** **O9.5 Ib** (*Alnitak*), **B8 Ia** (*Rigel*), **A1 V** (*Sirius A*), **A2 Ia** (*Deneb*), **F5–8 Ib** (*Polaris*), **G2 V** (*Rigel Kentaurus*), **K1.5 III** (*Arcturus*), **M2 Ib** (*Betelgeuse*), **M4 Ve** (*Wolf 498*), **DA2** (*Sirius B*). ✨

References. J. Mitton 1991, *Concise Dictionary of Astronomy* (Oxford Univ. Press); I. Ridpath 1997, *A Dictionary of Astronomy* (Oxford Univ. Press).