WHY DO THE STARS IN ORION LOOK SO DIFFERENT FROM EACH OTHER? *OR* A COMPARATIVE VIEW OF THE STARS IN ORION

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ABSTRACT

This paper will help explain why the stars in the Orion constellation look so different from one other by comparing nine stars. The nine stars discussed in this paper were chosen primarily for their brightness, with Chi2 Ori being the exception (see Table 1*)*. It was chosen for both its distance from earth and luminosity.

The Orion constellation measures 594 square degrees of the sky and is located on the celestial equator, close to the Milky Way, between 4 hours right ascension (R.A.) and 6 hours R.A. Five stars are 1st magnitude (m_v) or brighter, with 15 brighter than 4th m_v [Facts on File Dictionary of Astronomy, The 1994].

Table 1. Nine Stars in Orion

Name	**m_v[2]**	**Temperature (K)[2]**	**Spectral Class[1]**	**Diameter (Solar radii)[2]**	**Luminosity (suns)[2]**	**Distance (ly)[2]**
Betelgeuse, α Ori	0.43	3448	M2 Iab	1515	305089	429
Rigel, β Ori	0.12	9076	B8 Iae	99	59548	777
Bellatrix, γ Ori	1.63	19245	B2 III	4.2	2161	243
Mintaka, δ Ori	2.25	15278	O9	17	14301	919
Alnilam, ε Ori	1.68	15903	B0	31	54514	1359
Alnitak, ζ Ori	1.71	17038	O9	17	20673	826
Algiebba, η Ori	3.34	20918	B1	6.2	6604	906
Meissa, λ Ori	3.37	14320	O8	13	6597	1069
Chi2 Ori	4.62	7686	B2	779	1897869	32616

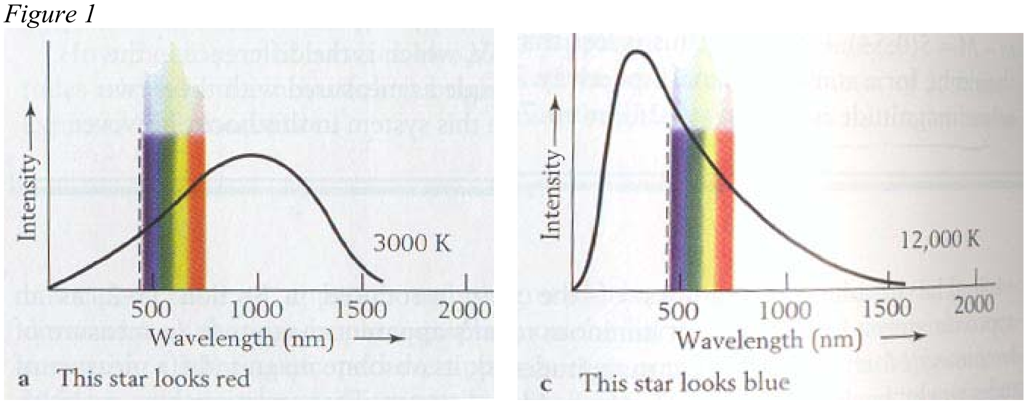
[1] *Space Explorer II Astronomy Software, V 2.1*, 1997, Meade Instruments, Corp.
[2] *Starry Night Pro* Astronomy Software, V 3.0, Sienna Software, Inc. 1991-1999.

1. COLOUR & SURFACE TEMPERATURE

Two factors determine why the stars in Orion look different to us: the stars' brightness, then, to a smaller degree, colour. First, the stars brightness is referred to as its apparent magnitude. In Table 1, apparent magnitude of a star, symbolized as m_v, is represented by a numerical value. The smaller the number, the brighter the star. The brightest star in Table 1 is Rigel, with an m_v of 0.12, which happens to also be the brightest star in the Orion constellation. The apparent magnitude is as we observe the star from earth. It is not reflective of a stars true physical character, such as its size or luminosity. More on these later.

The second stars in Orion look different are there colour. A stars' colour is directly related to its temperature: the more red a star, the cooler it is, while bluish stars are hotter. The intensity curve (Figure 1) of a cool star peaks at the longer wavelengths (reddish) and the intensity of a hot star peaks in the shorter wavelengths (bluish) [Kaufman & Freedman, Universe, Fifth Edition].

Figure 1



A star's actual colour should not be confused with their colour shift in the spectrum used to determine distance. A star moving away will appear to be red-shifted and a star moving toward us will be blue-shifted, regardless of the actual colour we see. Sensitive instruments are necessary to detect the shift in the spectrum due the star's apparent slow velocity.

2. SPECTRAL CLASSES AND COLOUR

In Table 1, there is a column labeled *Spectral Class.* Without going into detail, stars are grouped into classes according to their spectra, which is similar to a rainbow of colours, each class varying slightly based on chemical composition. There are seven spectral classes of stars- *O, B, A, F, G, K* and *M* -each with a different temperature range. *O*-class is the hottest blue-violet stars, while *M*-class stars are the red-orange supergiants and are the coolest. You will note in Table 1 that all the stars listed are at the upper temperature range in spectral class, with the exception of Betelgeuse, an *M*-class star [The Facts on File Dictionary of Astronomy 1994, Kaufman & Freedman, Universe, Fifth Edition]. Hence, this is why Betelgeuse appears reddish, and the other eight appear blue to blue-white.

3. MORE ABOUT LUMINOSITY AND SIZE…

Remember that we said the apparent magnitude of a star is as we observe it from earth and that it is not reflective of a stars true physical character. We can understand more about a stars' brightness by understanding the relationship of a stars' luminosity and size. Luminosity shows the relationship of stars' radii and surface temperature. Each of the stars in Table 1 is many times more luminous than our sun, and emits enormous amounts of energy. Luminosity is related to a stars surface area and temperature. Two stars having the same temperature and size will be the same magnitude if both are equi-distance. But if one star is considerably larger, it will be brighter. In the same respect, if the much larger star is farther away, then it is possible for the two stars to appear to have the same brightness [The Facts on File Dictionary of Astronomy 1994]. To me luminosity is a standard which can be applied to any star and compared to our own sun.

4. …AND DISTANCE

The apparent magnitude of a star (as we view it from earth) gives no indication of the stars luminosity. In astronomy the luminosity of a star is as if one were viewing it from a distance of 10 parsecs. For example, Algiebba viewed from 10 pc is 6,604 times more luminous than our sun, or can be expressed as having a luminosity of 6,604 suns. For the average laymen, when he/she speaks of how luminous an object is, that person is usually referring to how bright the object appears from their viewing position. This is partially correct. Betelgeuse, with an apparent magnitude of 0.43, is considerably *brighter* than Chi2 Ori with an apparent magnitude of 4.62. But, Chi2 Ori is over six times *more luminous* than Betelgeuse, and almost 2 million times *more luminous* than our sun. As mentioned earlier, physical characteristics being the same for two stars, the distance from the observer would determine the apparent magnitude, or brightness.

5. OBSERVATIONS

To the observer, Betelgeuse is a reddish colour which is the result, as mentioned earlier, of its cooler temperature[i]. Its brightness comes from its shear size and a luminosity of over 300,000 times that of our sun. Betelgeuse is, in fact, the largest star in Orion.

The other eight stars mentioned in Table 1 – Rigel, Bellatrix, Mitaka, Alnilam, Alnitak, Algiebba, Meissa and Chi2 Ori - are bluish to blue/white to the observer[1].

It should be noted that the human eye evolved for daylight operations, and functions fairly well in the yellow light of the sun. The eyes' poor performance at night, due to the lack of rod cells and other physiological factors, results in the eyes inability to distinguish color very well at low light levels [U.S. Army publication Tactical Night Operations &

[1] Direct observations made by the author on March 24, 2001.

Night Vision Goggles]. Sensitive photographic film does an excellent job in bringing out the colour of stars.

6. CONCLUSION

The two reasons why the stars in the Orion constellation appear different to us on earth are colour and brightness. The colour of a star is dependent on the star's surface temperature. Since eight of the nine stars listed in Table 1 are blue to blue-white in colour, then why do they appear different? The answer to that is a combination of size, temperature and distance. Rigel is brighter than Bellatrix, 10,000K cooler and three times farther. But, Rigel is also 95 solar radii larger and over 57,000 times more luminous.

While it is interesting to note that all the stars listed in Table 1 are much larger and many times more luminous than our sun, our sun is an average star.

7. REFERENCES

Facts on File Dictionary of Astronomy, The 1994, Third Edition.
Kaufman & Freedman, *Universe,* Fifth Edition, page 466, *498, 754*.
U.S. Army publication *Tactical Night Operations & Night Vision Goggles.*

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