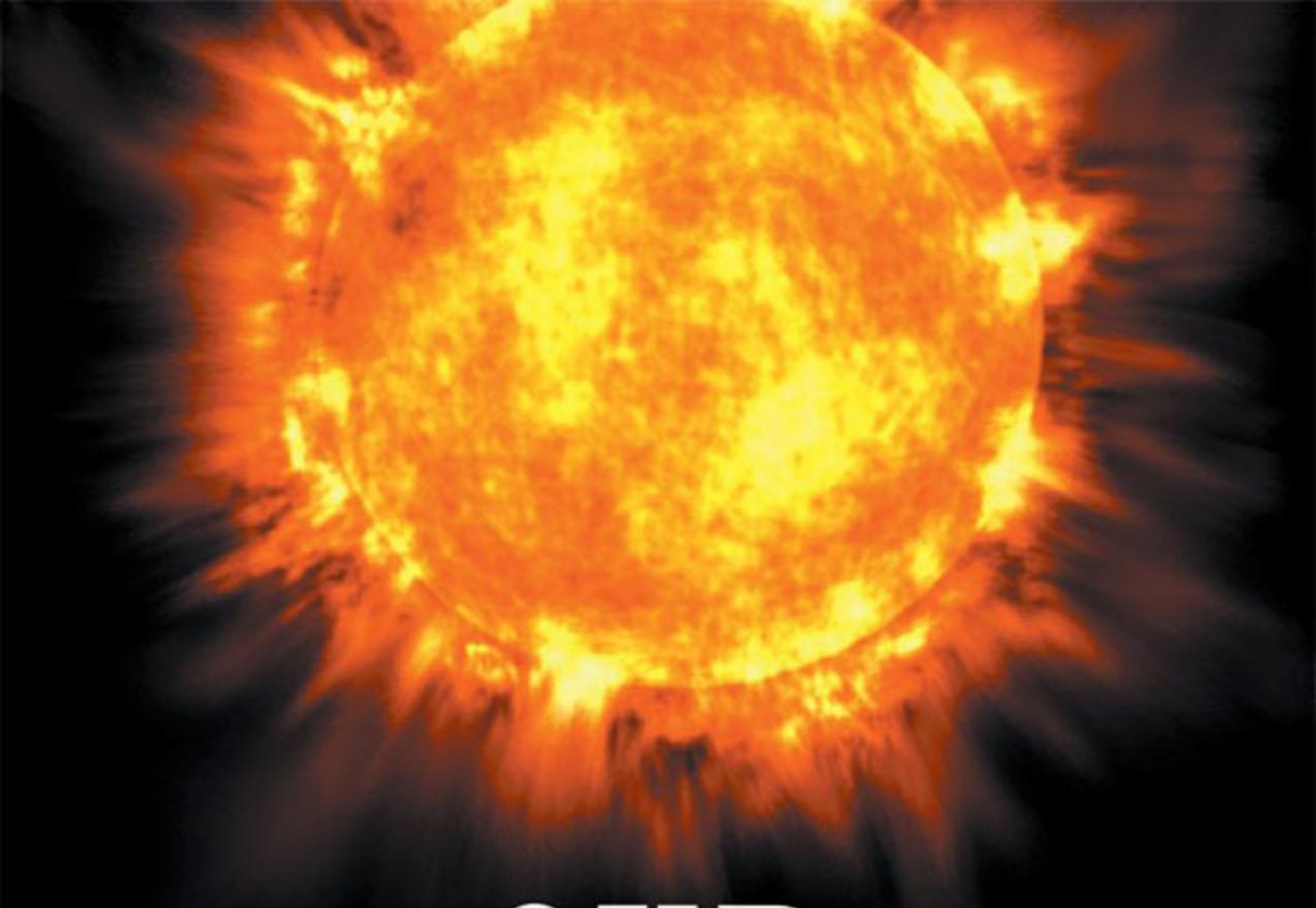

OUR NEIGHBOR STARS

INCLUDING BROWN DWARFS

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Useful Star Names, with Nebulas and Other Celestial Features

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PART 1

SO WHO IS CLOSE?

Prior to 1838 no one knew the distance to any star except the Sun. Estimates of the Sun's distance went back to Aristotle, or even earlier, and while some of those estimates were way off, by the early Nineteenth Century astronomers knew the Sun was over 80 million miles away. But for other stars all they could do was guess.

In the 1830s telescopes had improved to the point where professional astronomers began to hope they could actually measure the distance to nearby stars. They knew it would be difficult, so they hoped to start with nearby stars, just to make it a bit easier. But if you did not already know which stars were close to us, how could you pick out which ones to start with?

One approach was to assume (as even Aristotle had 24 centuries ago) that the brightest stars were the closest. The brightest of all stars (after the Sun) is Sirius, a star whose very name meant bright or blazing in Ancient Greek. A more technical approach said that stars are moving. This is called proper motion, and the higher the proper motion, presumably the closer the star. You can see this effect when riding in a car. Distant objects move across your field of view more slowly than do nearby ones. Of course, with stars, both the Sun and the star will be moving, but the idea seemed logical.

The fastest moving star known in the 1830s was a visible but moderately dim star called 61 Cygni, located in one of the wings of the constellation of Cygnus the swan. The German astronomer Friedrich Georg Wilhelm Bessel (1784-1846) picked it to be the first to measure. The Baltic astronomer Friedrich Struve (1793-1864) (founder of a famous dynasty of astronomers) opted for a very bright star, Vega, since Sirius, the brightest, is so far south in the sky as to be badly placed for measuring from Struve's location at Pulkovo Observatory near St. Petersburg, Russia. The second brightest star, Canopus, is so far south that it is never visible from Pulkovo. Thomas J. A. Henderson (1798-1844), the first Astronomer Royal of Scotland, had not yet reached that honor, and was working at Table Mountain Observatory in South Africa. Cleverly, he chose a star high on both lists, of fast movers and of very bright stars. This was the star known as Alpha Centauri.

Henderson completed his work first, but disbelieved his results, which showed Alpha Centauri to be slightly over 3 lightyears away. He doubted it could really be that far. So Bessel published first, coming up with a distance for 61 Cygni that was even greater, over ten lightyears. This convinced Henderson to publish. Struve followed shortly after.

Each of the three came up with figures a bit under the correct distances for their respective stars, but close enough to the modern results to prove they had in fact measured the distances within a reasonable margin of error. Possibly their consistency in being a bit low resulted from bias against believing the truly enormous distances involved.

Each used the same method, which is still used today, although most accurately by the European Space Agency's satellite Hipparcos rather than astronomers on the ground squinting through a telescope. (Actually, professional astronomers today *never* look through telescopes. In fact, it is impossible to look through modern large telescopes, they only photograph or make other records.)

So how was the measurement made? I'll start with an example. Hold your arm out straight, and raise a finger. Close one eye, and note where the finger appears against the background. Now, without moving your arm or finger, switch eyes. The finger will appear to shift its position against the background. This is due to the difference in the locations of your two eyes. It is how humans are able to judge distances. For stars, the baseline difference between your eyes is a bit inadequate for the job, but we have a much larger baseline available. Earth averages 92,955,807.27 miles (or 149,597,870.7 kilometers) from the Sun's center, a value known as the Astronomical Unit, or AU. So get the location of a star against the background, wait six months, and do it again. This gives a baseline of nearly 186 million miles or 300 million kilometers.

Even with such a large baseline the stars are all so far away that the shift is very small. In fact, observers from Aristotle (384 BC - 322 BC) to Tycho Brahe (1546 - 1601) used the fact that no shift was detectable to "prove" that the Earth stood still. The shift is known as the star's parallax, and even for the closest star is well under one second of arc, where a full circle is 360 degrees, each subdivided into 60 minutes of arc, each of which is subdivided into 60 seconds of arc. So one second of arc is just one part in 1,296,000 of a circle. I don't know how good Aristotle's eyesight was, but no one can see detail that fine!

With the introduction of photography to the problem late in the Nineteenth Century, results became easier and more accurate. Yet the angles were so small that distances could be measured only out to a few hundred lightyears, and with a generous margin of error. Quoted distances were generally accurate to only +/- 15 or 20 percent, and were essentially meaningless after about 500 lightyears. The work was slow and tedious, and by 1990 fewer than ten thousand stars had any sort of distance measured.

The European Space Agency's Hipparcos satellite changed all that. It was able to accurately measure distances to 1600 lightyears, and determined it for over 100,000 stars.

Astronomers for several decades had felt that they might have an almost complete census of the stars within 16 lightyears of the Sun. That every few years another star would be added to that list suggested that they may have been somewhat optimistic. But having even a pretty good census meant that astronomers would get a feel for how common each type of star was.

STARS COME DIFFERENT TYPES?

Anyone looking at the stars on a clear night can see that they have different colors. Betelgeuse in the winter sky and Antares in the summer are distinctly reddish, a few have a blue tint. By the Nineteenth Century astronomers recognized that this meant they were different temperatures, and a Jesuit astronomer, Father Angelo Secchi (1818-1878), organized the different types according to their temperatures/colors. Hottest were the blue stars, with temperatures ranging down from there through white, yellow, orange, and red. Letters had been assigned to the different colors before Secchi, and were so embedded in the literature that he did not consider changing them. The result is that today, with the addition of several letters to cover types unknown to Secchi, in descending order of temperature star types are W, O, B, A, F, G, K, M, R, N, S, L, T, and Y. The last three are for brown dwarfs rather than real stars. Generations of students have gasped in dismay at the thought of having to remember that sequence, until learning the unforgettable mnemonic, “wow, oh be a fine girl, kiss me right now sweetheart, lovingly, tenderly”. Who said astronomers aren’t fun guys? (Don’t blame Fr. Secchi for that mnemonic, it supposedly was invented at Harvard.)

Early in the Twentieth Century the Danish astronomer Ejnar Hertzsprung (1873-1967) and American astronomer Henry Norris Russell (1877-1957) collaborated on creating a chart or graph on which they plotted stars according to their temperatures and intrinsic brightness. Of course, the apparent brightness in the night sky was easy to see, but how bright were the stars really? For that you needed the distance. Distances for a few hundred stars were known by then. Hertzsprung and Russell found that most stars on their chart fell on a curve vaguely resembling a shallow backwards N. Since this included most stars, it became known as the Main Sequence. Other stars fell on a branch that included giant stars, so it was the Giant Branch. A group of very small and hot stars comprised the white dwarfs. Today that graph is known in honor of its creators as the HR Diagram, and it provides a key to understanding the nature of individual stars.

The letters (O, B, A, etc) get subdivided by finer gradations of temperature using numbers from 0 to 9, with 9 the coolest and 0 the hottest. Thus G9 is just warmer than K0. The Sun is ranked as a G2, with a surface temperature of about 9950F, or 5800K (the interior of sunspots is cooler). Stars on the Main Sequence are indicated by the roman numeral V, so the Sun’s type is G2V. Giant Branch stars and some others have a complex set of types, with roman numerals I, II, etc. It is now known that Giant Branch stars are approaching the ends of their lives. White dwarfs are basically the burned out hulks of stars. In the very remote future the Sun will evolve into a giant red star, and then slowly deflate into a white dwarf.

Its mass will not change significantly, so its density will drop very low, and then shoot up to an amazing amount.

Perhaps somewhat contrary to expectations, the larger and more massive a star is when it forms, the shorter its lifespan. Red dwarfs with just 15% of the Sun's mass are good for 300 or 400 billion years. The Sun is already 4.35 billion years old, and is good for about 1.2 billion years before starting to swell up. A star such as Sirius, with more than twice the Sun's mass, has a total life span of little more than a billion years.

Astronomers found that the most common type of star was the red dwarf, even though with their small size and limited light output they were dim and hard to find. Bright stars are comparatively rare, and our galaxy of over 200 billion stars may have only a couple dozen stars of the W type.

Stellar types get a lot more complicated, depending on the ratio of the amounts of various elements to hydrogen, the speed of the star's rotation (this affects how well and how fast it mixes its contents, as well as its shape), the presence and distance of stellar companions, emissions, and much more. But this is a work on what stars are near us, not astrophysics, so let's lay that topic on the table.

WHAT DISTANCE?

On Earth Americans measure distance in miles, and just about everyone else on the planet measures it in kilometers. Knowing that the Sun is 93,000,000 miles, or 149,500,000 kilometers away hints that the stars' distances are going to be so far that writing it down will lead to a bad case of writers' cramp, waste of time writing, and take up too much paper and ink. Efficiency is called for.

Light moves in a vacuum at its maximum possible speed, 186,282.3959 miles per second, or 299,792.458 kilometers per second. After astronomers started finding stars were an enormous distance away, they invented the lightyear, the distance light travels in one year. You could figure out the exact amount easily enough, just multiply the miles per second by the number of seconds in a year ($60\times60\times24\times365.2422$), but it has already been done for you. A lightyear is 5,878,625,373,183.608 miles, or 9,460,730,472,580.8 kilometers. Earth's distance from the Sun is called the Astronomical Unit (AU), and is usually used for distances within the Solar System. A lightyear is also 63,241.1 Astronomical Units.

MAGNITUDES

Around 160 BC the Greek astronomer Hipparchus (190 BC - 120 BC) invented the magnitude scale for discussing how bright stars are. He declared the twenty brightest stars not counting the Sun (this includes three in this list) as being the first magnitude. The dimmest stars visible were lumped together as sixth magnitude. Note that the larger the number the dimmer the star. Those in between were second, third, fourth, and fifth magnitude. This served well enough until the invention of the telescope revealed a horde of stars fainter than sixth magnitude. Things drifted with no definitive resolution until the mid Nineteenth Century, when Benjamin A. Gould (1824 - 1896) created a mathematical formula for magnitudes. Each full magnitude would be the fifth root of 100 (about 2.512 times) brighter or dimmer than the next full magnitude. The way this worked out three of Hipparchus's stars wound up with negative magnitudes. A difference of five magnitudes is exactly 100 times brighter or dimmer. And Hipparchus got the European Space Agency spacecraft Hipparcos named for him.

Apparent magnitude refers to how bright the star looks in our sky. The brightest star is the Sun, with an apparent magnitude of -27. The next brightest star is Sirius with an apparent magnitude of -1.46. A difference of exactly 25 magnitudes would mean that the Sun looks 100^5 times brighter (10,000,000,000) than Sirius appears to be. Absolute magnitude refers to how bright a star would look if placed at a standard distance. The Sun's absolute magnitude of about 4.6 makes it a very ordinary star, although few stars in this list have a brighter absolute magnitude.

ACCURACY

When I worked on the Apollo Project the engineers were extremely upset to learn that the Moon's distance was then known only to an accuracy of one mile. As the only astronomer around I heard the brunt of the complaints. My response was that if one mile made a difference when the astronauts had to go 230,000 miles, their tolerances were too tight. Today, with laser reflectors on the Moon, its distance is known within one centimeter (0.4 inch), an accuracy which has permitted verification of the theory of continental drift on Earth.

We generally do not have the distances of most other Solar System objects to an accuracy much better than a mile today, and for many minor objects such as asteroids, accuracies may be in the range of a hundred miles. Outside the Solar System the distances of the handful of stars within ten lightyears probably are accurate to the first four significant digits, but as we move further outward the accuracy drops. A star listed as 17.00 lightyears may actually be somewhere in the range of 16.85 to 17.15 lightyears. Thus the order of stars on this list may change as one is found to be slightly more distant and another slightly closer.

There is also the question of completeness. Brown dwarfs in particular are so faint as to be hard to find, and dimmer red dwarfs and white dwarfs may have been overlooked. There is a high probability that in the future from five to ten objects not yet on this list will be found to fall within a list of the closest. As evidence of this, entry #13 below was only reported discovered in August of 2011. The list of 100 stars is probably fairly complete, but the list of thirteen nearest brown dwarfs may actually triple over the next few years.

WHATCHMACALLIT?

Few stars actually have been given names. (For more on that, see my earlier work, *Useful Star Names,* Strategic Book Publishing, 2011, ISBN 978-1-61204-614-3.) Most are referred to by catalog numbers. The problem here is that there are many catalogs. Bayer started the use of Greek letters. Flamsteed used numbers, assigned going from east to west. Gliese numbered nearby stars. Members of the Struve family invented designations for variable stars. The Nineteenth Century had the Henry Draper Catalogue and the Bonner Durchmusterung, plus its annex, the Cape or Cordoba Durchmusterung. The Twentieth Century had the Smithsonian Astrophysical Observatory Catalog. Our era has the Hipparcos Catalog. And any one star can appear in all of these, plus a few more I haven't mentioned. In listing the nearest stars, I have tried to include most of the catalog designations people are likely to be using, so the stars may be found more easily. Check the alphabetical index near the end if you are seeking a particular star, as this is where I have listed a number of different designations for most stars.