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Publisher's version / Version de l'éditeur:

<https://doi.org/10.4224/23000151>

Skygazing: Astronomy through the seasons, 2014-06-03

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DENEK

Ken Tapping, 3 June, 2014

These evenings it is hard to miss a bright, blue-white star in the eastern sky. This star is Vega, the most conspicuous star of the three making up the Summer Triangle. Scan down towards the eastern horizon you will find the second, Altair, roughly in line with two fainter stars. Now it is easy to find Deneb, the third star. Just scan north and imagine the triangle. It does not look as bright as the other two stars, but there is nothing comparable nearby to compete with it. Although this star might not look that impressive, it is. It lies about 2,000 light years away and if it were an average star, you would not be able to see it at all. Deneb is a member of the class of stars known as supergiants. The Sun is a yellow dwarf. Deneb is extremely luminous; with an energy output around 200,000 times that of the Sun. To put that in perspective, let's start by looking at the Sun's energy output.

The Sun's total energy output has been determined many times, using measurements made by spacecraft. It is 4 followed by 26 zeroes Watts. Numbers this large are hard to wrap one's mind around. However, we can get something more manageable by using Einstein's equation "E equals mc squared", which tells us how energy and mass are related to one another. We then get the rather stunning result that this amount of energy production can be achieved by total annihilation of four million tonnes of the Sun's material every second. By comparison a large nuclear power station obtains its energy through annihilating less than a millionth of a gram per second. Moreover the Sun has enough fuel to sustain itself through a lifetime of about 10 billion years. We are now roughly halfway through that period. Now let's look at Deneb. It is producing energy at a rate 200,000 times that of the Sun, which can only be sustained by annihilating 800 billion tonnes of itself a second!

The lifetime of a star is pretty well defined by one thing: the amount of material it collects when it forms. Unless there is a nearby companion to

snack on, that initial amount of material is what dictates a star's entire life.

Increasing the initial mass of a star increases its energy output a lot. A star ten times the mass of the Sun will be 3,000 times more luminous. To be 200,000 times brighter, Deneb has a mass of around 20 times the mass of the Sun. Having only twenty times the mass of the Sun as fuel, and burning it 200,000 times faster, means Deneb's life will be short and tempestuous. It will shine for about a million years and then explode as a supernova, blowing its material off into space. If Deneb has any planets, they won't last long enough for life to evolve very far before being incinerated. However, supergiant stars like Deneb are of critical importance for the existence of planets and living creatures.

When the universe formed, just under fourteen billion years ago, it was extremely hot and compressed. As it expanded and cooled, it eventually reached a point where atoms could form and stay together. However, these first atoms were mostly hydrogen, with some helium. The elements needed to make planets and living things like us did not exist in other than minute traces. Then the first generations of stars formed, mostly giant and supergiant stars that during their short, tempestuous lives, generated as by-products from their profligate energy production most of the elements. When their lives ended in supernova explosions, all the other elements were synthesized. Finally, all this material was ejected into space where it mixed with the great hydrogen clouds, enriching them with everything needed to make our world and us. Deneb and the other supergiant stars are continuing this work.

Jupiter is low in the west at sunset, Saturn and Mars lie high in the south and Venus rises about 4 am. The Moon will reach First Quarter on the 5th.

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