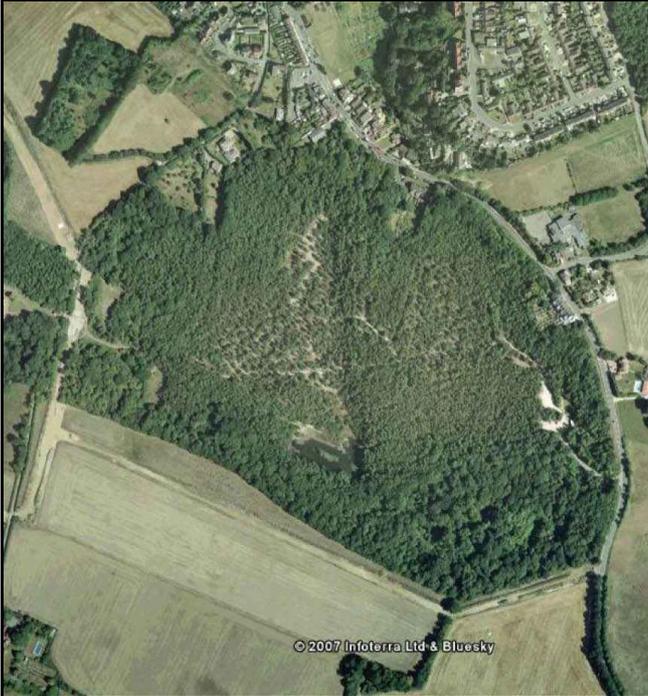


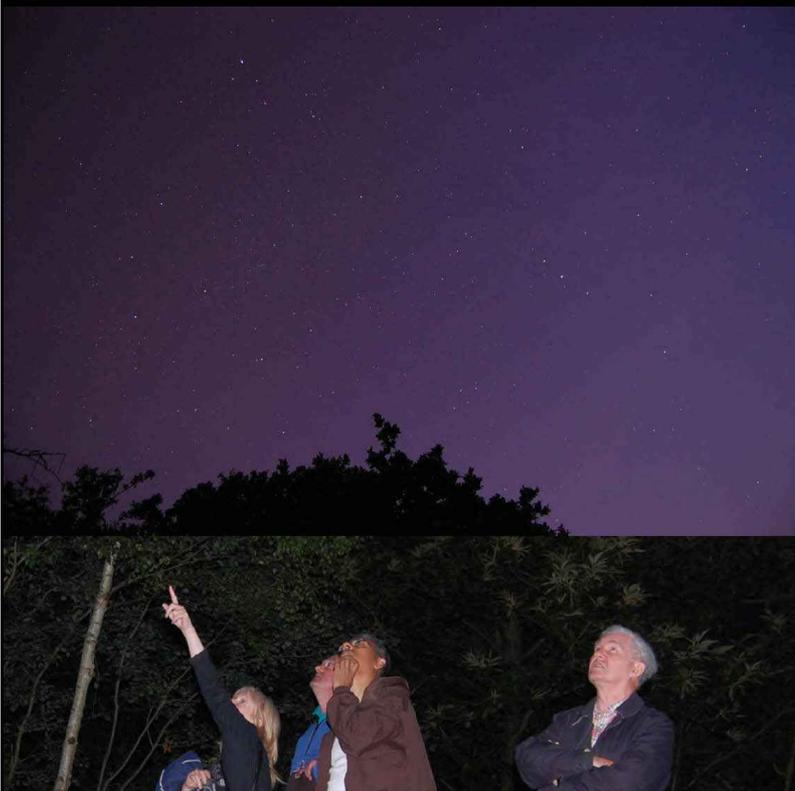
Earth & Sky: Field trip – Beacon Wood Country Park, Kent, U.K..



Beacon Wood Country Park is a 70 acre (28 ha) site listed as a Site of Nature Conservation Interest. It is named for the beacons constructed at the time of the Napoleonic Wars to provide warning of invasion. The site was used by the EC Powder Company to produce smokeless gunpowder during the late 19th Century. It was also used as a clay pit, and there are fossiliferous exposures of the Woolwich Beds.

The field trip (July 17, 2012) continued the multi-disciplinary theme of the *Earth & Sky* course, exploring the night sky and nocturnal wildlife.

Image from Google Earth; © 2007 Infoterra Ltd & Bluesky.



Discovering the Summer Triangle.

Above: Chart of the Summer Triangle. Figures give stars' visual magnitudes. Left: Participants identify the stars of the Summer Triangle. Photo has slightly different orientation to the chart.

Chart: Jim Thomas (2005) GNU General Public License. Images: M. J. Heath (July 17-July 18, 2010).

Clearings in Beacon Wood offer darker skies than nearby South London, although light pollution remains all too evident. The evening followed the astronomical lectures with an opportunity to put our own Sun in context amongst the other stars. Prominent stars included examples that were on the main sequence (MS), obtaining their energy by burning hydrogen to helium in their cores, and more evolved stars which have moved away from the MS. The Summer Triangle consists of bright three stars, each the brightest in their own constellation. Two, Altair (α Aquilae) and Vega (α Lyrae), are nearby MS stars, whilst the third, Deneb (α Cygni) is an evolved supergiant at a great distance. [Abbreviations: M_{\odot} = solar mass; R_{\odot} = solar radius; L_{\odot} = solar luminosity]

All three stars are of spectral class A. The faintest and most southerly, Altair (A7V), with mass of $1.79 M_{\odot}$ and total luminosity $10.6 L_{\odot}$, lies only 16.8 light years away. It rotates in just 9 hours, (90% of its break-up speed) so that (as confirmed by long-baseline interferometry; Peterson, D. M. *et al.*, 2006. *Ap. J.* **636**: 1,087-1,097) it is oblate. Its equatorial radius is $2.03 R_{\odot}$ and its polar radius is $1.63 R_{\odot}$. The effective temperature of its photosphere ranges from 6900 K at the equator to 8500K at the pole. The brightest star of the Summer Triangle is Vega, a star of spectral class A0V, which lies 25 light years away. It has a mass of $2.14 M_{\odot}$ and luminosity of $37 L_{\odot}$. At 10150 K, it has a noticeably blue tinge. Vega also rotates rapidly, in just 12.5 hours (at 93% of break-up velocity), and it is also oblate with equatorial and polar radii of $2.78 R_{\odot}$ and $2.26 R_{\odot}$. We are seeing Vega pole-on, and its poles are around 2250 K hotter than its equator (see model by Aufdenberg, J. P. *et al.*, 2006. *Ap. J.* **645**: 664-675). An excess of radiation at IR wavelengths has been explained by a disk of dust particles, probably resulting from a collision of bodies of asteroidal or cometary dimensions. Its inner edge appears to lie near 80 AU, whilst at a wavelength of $160 \mu\text{m}$ it has been traced out to over 800 AU. A giant planet has been hypothesised as the cause of a clumping of dust near 70 AU, and an inner dust band exists near 8 AU.

Vega and Altair illustrate how luminosity rises sharply with increasing stellar mass. MS lifetimes plummet with rising mass and may be estimated roughly from the relation: $(M^*/M_{\odot}) / (L^*/L_{\odot}) \times 10^{10}$ years [asterisk denotes values for star in question].

Deneb (A2Ia) is a huge supergiant star, whose distance has been derived by re-analysis of parallax measurements from the Hipparcos satellite as $\sim 1,420$ light years (Apellániz, J. M. *et al.*, 2007. *Poster at IAU Symposium 250*). It has an effective temperature of 8525 K, and a radius over a hundred times larger than the Sun. Its mass may be $\sim 20 M_{\odot}$, and it would have enjoyed a very brief MS lifespan as a brilliant blue star, before evolving into its present state, burning hydrogen in a shell around the core. Deneb's white colour will be short-lived, as it continues to cool and expand into a red supergiant. Its present luminosity exceeds $50,000 L_{\odot}$.



Left: Estimated relative sizes of the Sun and the stars of the Summer Triangle (modified after several sources). Below: A panorama into the southern sky from the woodland margins. The reddish star visible above and to the right of the centre is Antares (α Scorpii). This red (3500 K) supergiant, 600 light years away, illustrates the eventual fate of Deneb. With a mass exceeding 15 to 18 M_{\odot} and radius 800 R_{\odot} , it dwarfs a blue MS companion star some 550 AU distant.

Image: M. J. Heath. July 18, 2010.



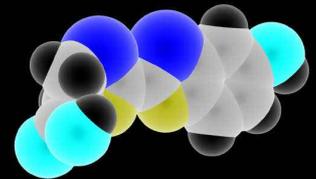
Natural history.

The wildlife of Beacon Wood reminds us that whilst massive stars such as Antares and the stars of the Summer Triangle are brilliant but short-lived, more modest stars such as our own Sun (which will remain on the MS for $> 10^{10}$ yr) may allow sufficient time for complex biology to evolve on suitable planets because they grow in brightness at a much more leisurely pace.

Top left: A female glow-worm (*Lampyris noctiluca*; a beetle) displays beside a path in Beacon Wood. The greenish light is produced by reaction between O_2 and a substance known as luciferin contained in translucent membranes on the last three body segments. The reaction is catalysed by the enzyme luciferase. Females display for up to 10 days, unless fertilisation of eggs occurs sooner, and die after reproduction. They glow to attract the smaller, flying males, which have a more typical beetle appearance.

Right: A model of the luciferin molecule; blue = S, turquoise = O, yellow = N, grey = C and black = H.

Image: Modified after Ben Mills Gallery. Public domain.



Centre and bottom : A typical wingless and larviform adult female is inspected by a visitor before being returned carefully to its display perch. The longest part of the life cycle of *L. noctiluca* is spent as a larva, during which they feed by injecting slugs and snails with digestive juices.

Images: M. J. Heath. July 17 – July 18, 2010.

A clearing for a shallow lake, with beds of reeds (*Phragmites australis*), offered views of the sky as well as an opportunity to watch numerous bats as they foraged in the twilight for flying insects.

