



South Downs Mercury



The monthly newsletter of South Downs Astronomical Society
Issue: 446 - December 2011

Next Meeting - Friday 2nd December. Lecture room of the South Downs Planetarium, Chichester, at 7.30pm.

- ⊗ "What's Up!" - guide to the month ahead by SDAS member John Whittington.
- ⊗ "Xmas Festivities" - Jan and her team will be serving minced pies, nibbles and a glass of wine to mark the start of the Xmas season. There will also be a raffle for books etc - **contributions of raffle prizes will be gratefully received.**
- ⊗ "The Lunar Imaging Record Attempt" - Ninian Boyle relates the April 2009 attempt to enter the Guinness Book of Records by creating the largest ground-based telescope mosaic image of the Moon.

In the News:

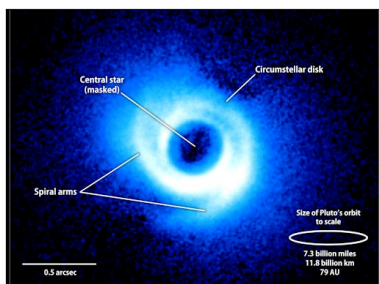
⊗ Last July the Rosetta spacecraft made photometric and spectroscopic observations of the 100km-size asteroid Lutetia as it flew by on its way to comet 67P/Churyumov-Gerasimenko. That data has now been consolidated with



information from the European Southern Observatory and NASA ground-based telescopes with the conclusion that Lutetia's properties closely match those of a rare class of meteorites, enstatite chondrites. Such meteorites (which

account for less than about 2% of all recovered meteorites on Earth) are thought to have formed in the inner Solar system and to have been a major building block in the formation of Mercury, Venus and Earth. More details can be found at: <http://www.sciencedaily.com/releases/2011/11/111111095110.htm>

⊗ By now, you might suppose that every kind of star in the Milky Way had been seen - there are dwarf stars, giant stars, dead stars, exploding stars, binary stars, etc. But, researchers using the Hawaii Subaru telescope have now discovered a star with spiral arms (SAO 206462).

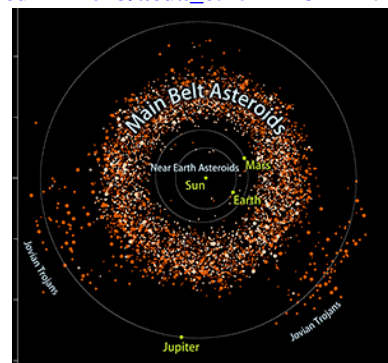


Located in the Lupus constellation, the arms extend from a circumstellar disc that is about 14 billion miles across, or about twice the size of Pluto's orbit. A possible cause of this arrangement is the presence of an exoplanet in the disc - computer-modelling show that one of the effects of a planet-sized body in such a disc is the formation of an arm. The presence of two arms would then imply at least two such bodies in the disc. More details can be found at: http://science.nasa.gov/science-news/science-at-nasa/2011/31oct_spiralarms/

⊗ It appears that the Russian attempt to send a probe to collect a soil sample from Phobos, the smallest moon of Mars, has ended in failure. Launch of the Phobos-Grunt probe into Earth orbit was successful but was followed by a failure of the probe engine to fire and a loss of the data link between the probe and mission control. If the mission does end in failure, current estimates suggest the spacecraft will re-enter Earth's atmosphere in late November/early December.

⊗ Interested in asteroids? Want to know where they are and their classification? Then the just-published AKARI database of 5120 asteroids is for you. freely available as a downloadable file at: http://www.ir.isas.jaxa.jp/AKARI/Outreach/results/AcuA111013/acua_e.html#n3 There

are many diagrams of the location of the asteroid Main Belt, but I particularly liked the version on the AKARI website, clearly showing the grouping of the Trojans in their 60° location both ahead and behind Jupiter.



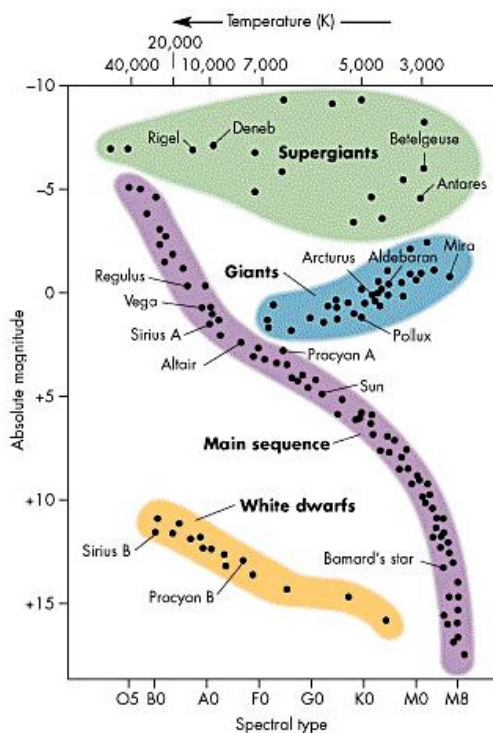
Also on the site is an animation of the planets as they move around their orbits.

YOUR SOCIETY NEEDS YOU!
The Editor will welcome suggestions for the next few articles in our newsletter. You don't have to write the article (but if you want to, that's great). Just drop me a few lines by post, or by email, or hand them in at the next meeting, outlining the subject or theme of the proposed article and we will get our troupe of trained monkeys to get typing on their keyboards.

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CLASSIFYING THE STARS

Early in the 20th Century, Ejnar Hertzsprung and Henry Russell made an extraordinary discovery when they plotted absolute luminosity (or magnitude) against temperature (or colour) for the small number of nearby stars for which they had data. Working independently, they discovered that the majority of stars in what are now known as Hertzsprung-Russell (HR) diagrams traced a band across the diagram, running diagonally from hot and bright stars down to dim and cool stars. The band (known as the Main Sequence) became more defined as more stellar distance measurements became available (enabling absolute stellar magnitude or luminosity to be calculated),



and the diagram also showed several groupings of stars to the right of the Main Sequence. Known as Red Giant and Supergiant stars, because of their reddish colour, these stars had to be larger in diameter than hotter Main Sequence stars of the same luminosity.

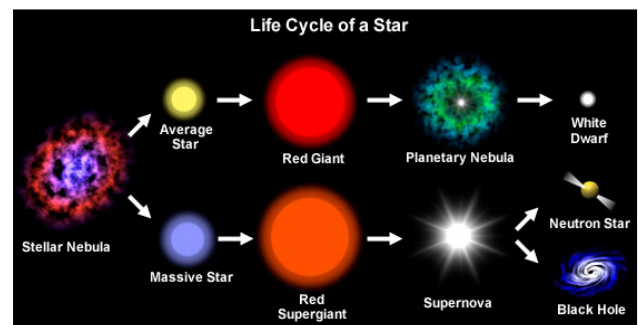
A small group of stars also located to the left of the Main Sequence - bluish-white in colour, these stars were the opposite of the giants - their low luminosity (which made them difficult to observe) meant they had to be small.

As with so many other advances in astronomy, the discovery of definite groupings of stars in the HR diagram raised more questions than answers. Presumably, the reasoning went, there had to be similar stellar processes at work throughout the diagram, so what was the linkage between Giant and Main Sequence stars? Inadequate as it was, in the early 1900's the only known mechanism able to produce anything like the energy output from a star was that due to gravitational collapse. Specifically, potential energy of the gas cloud from which a star was formed was progressively released as thermal energy as the cloud collapsed towards its centre of mass. Eventually, the reasoning went, collapse would come to a halt and the star would start to cool, becoming less luminous.

Applying this idea to the HR diagram, astronomers concluded (wrongly) that the Giants were stars in the very early stages of formation, becoming hotter as they collapsed, moving horizontally across the HR diagram towards the Main Sequence band. At that point, having reached their minimum size, no further thermal energy was available and they became cooler and less luminous, gradually moving down the Main Sequence. However, not only did their conclusions fail to explain the presence of stars well below the Main Sequence (the so-called White Dwarfs), but also failed to reconcile estimates of several tens of millions of years for gravitational collapse of a star with estimates ten times larger based on geological considerations of the age of the Earth and Sun.

The correct explanation of the relationships in the HR diagram would have to wait for the work of astronomers and physicists such as Hans Bethe and George Gamow in the 1930's and Fred Hoyle in the 1940's. Their work identified nuclear fusion in the heart of a star as the mechanism responsible for its prodigious energy release; furthermore, they were able to map out the life sequence of a star, from (initially) hydrogen fusion to helium and then on to carbon and yet heavier elements.

In parallel with the development of a theory of stellar nucleosynthesis, two further advances helped to unlock a correct understanding of why stars sit at a particular position in a HR diagram and how, over time, they move up and down or across the diagram. Spectroscopy enabled not only the identification of particular elements but also their concentration and other physical conditions in the outer layers of stars. And stellar astrometry of binary stars enabled the mass of a wide range of stars on the Main Sequence to be estimated.

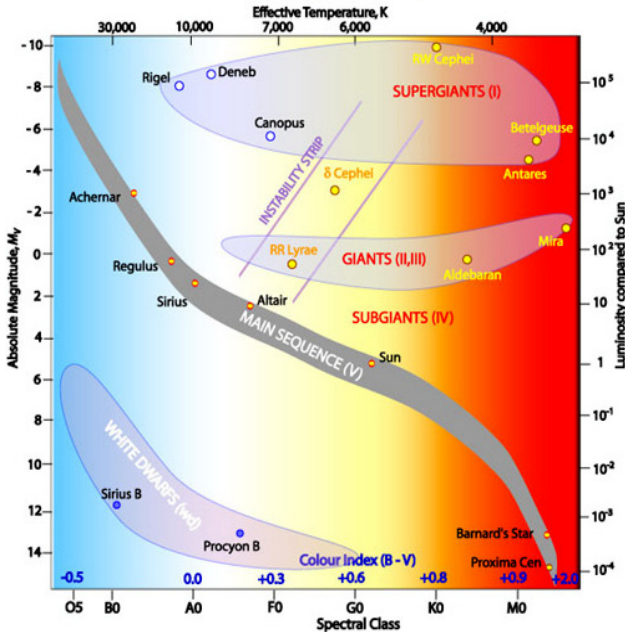


Bringing together all these advances it became clear at last how to interpret the HR diagram:

- Stars form from clouds of cold gas that gradually become hotter as they gravitationally collapse. Starting from a position low down and to the right of the Main Sequence, these protostars move horizontally left and upwards;
- the Main Sequence comprises stars in which the first stage of nucleosynthesis, hydrogen fusion, is underway. Highly luminous bluish (hot) stars towards the top of the Sequence are more massive and have a shorter life than yellowish (cool) stars lower down the sequence;
- the majority of stars spend the majority of their life on the Main Sequence, only moving away, to the right and upwards, when the hydrogen core has been fully converted to helium and helium fusion starts;

With this understanding that it is the mass of a star that governs how it ends its life, it was then possible to broadly describe and chart on a HR diagram how stars of different mass would enter into the last stage(s) of their life as they left the main Sequence:

- low mass stars such as our Sun will cool and swell to

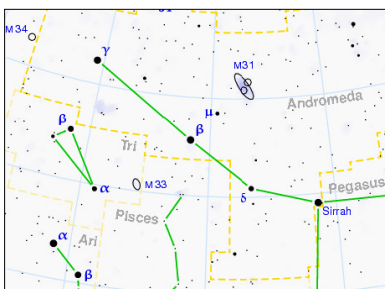


become a Red sub-Giant, moving to the right and upwards away from the Main Sequence. Depending on their mass, such stars may become unstable, passing through a variable luminosity stage (e.g as a Cepheid) as helium fusion produces carbon. As such stars continue to swell, becoming Red Giants, the core temperature will fall, eventually becoming too low to support nuclear reactions

TEN TARGETS FOR ASTRONOMERS

At our November meeting, Bob Mizon suggested **Ten Targets for Light-Polluted Astronomers** observable either with binoculars or a small telescope. If you want to accept Bob's challenge ("Get out there and have a look"), his suggested ten targets are:

1. *Open Cluster NGC 752 in Andromeda*. Located just below γ Andromedae. Easily seen with binoculars but better with a telescope which reveals about 60 stars no brighter than mag.9.



2. γ *Andromedae (Almach)*. A beautiful double star with a striking contrast of colour, golden yellow and a smaller bluish-green companion.

3. *The Wristwatch (Kemble's Cascade)* in *Camelopardus*. String of 20+ colourful mag. 5-10 stars over a distance of about five moon diameters. Open cluster NGC1502 can be found at one end.

and the star will collapse, expelling its outer layers as a planetary nebula. The residual star will then cool, moving left towards and through the Main Sequence. No further reactions take place and the star will slowly cool, moving down the HR diagram and become a White Dwarf.

- larger mass stars, up to about eight times the mass of the Sun, will support carbon fusion to produce oxygen, but thereafter core temperatures will be too low to support further reactions. The star will then follow a track similar to its low-mass counterpart, puffing off its outer layers and also ending life as a White Dwarf;

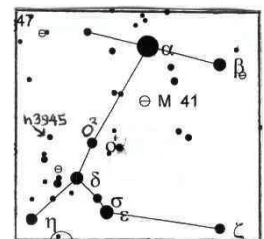
- very large-mass stars support nuclear reactions beyond oxygen, producing progressively heavier elements up to iron. By this time the star will (like its lower mass counterparts) have expanded through the Giant stage to become a Red Supergiant. Fusion processes beyond iron are not possible and the star, no longer able to support its outer layers, will catastrophically collapse as a supernova, ejecting virtually all its mass into space;

- if then the mass of the residual star is less than about three times that of our Sun the result will be a very small diameter (of the order of tens of kilometres) and very hot Neutron Star, located below the White Dwarfs at the extreme left (hot) side of the HR diagram. Above this residual mass the supernova will result in a black hole.

The stimulus that the HR diagram had on the development of theories of stellar evolution in the first half of the twentieth century cannot be overstated. Advances in observational astronomy and particularly the present-day emphasis on observations outside our Galaxy may now have somewhat relegated such diagrams to the sidelines, but without the original work of Hertzsprung and Russell the world of astronomy would be a much poorer place.

4. *Y Canum Venaticorum (La Superba)*. In Canes Venatici, well-known for its strikingly red appearance.

5. *h3945 Canis Majoris*. Arguably, the finest colour contrast double star in the winter sky.



6. *NGC 457 Cassiopeia (Owl Cluster)*. A rich field of about 150 stars of mag. 12-15.

7. *R and T Coronae Borealis* nicknamed the *Blaze Star* is a recurring nova. Normally about mag.10 it has been seen to outburst twice, reaching mag.2 and 3.



8. Σ 2398 *Draconis*. Double star with a noticeable relative movement over several years.

9. *Stock 4 Perseus Open cluster*

10. *NGC 7331 Pegasus galaxy*. A delicate spiral flanked by other more distant galaxies (NGC 7335-7 and 7340). Stephan's Quintet is about 1/2 degree SE.

DECEMBER SKY DIARY

Chart for Chichester, mid-month, 21:00 p.m.

(Contributed by Peter Littlejohns)

Mercury: rises in the dawn twilight and is at greatest elongation on the 23rd shining at mag. 0.0.

Venus: sets over 2 hours after the Sun by month's end, shining at mag. -3.9. The phase has decreased to 84% but the apparent diameter has increased to 13 arc seconds.

Earth: winter solstice occurs on the 22nd giving us the shortest daylight hours of the year.

Mars: rises around 22:45 in Leo, improving in brightness from mag. +0.7 to +0.2.

Jupiter: at mag. -2.5 now sets around 03:15 in Pisces and crosses the meridian at 20:30 mid-month.

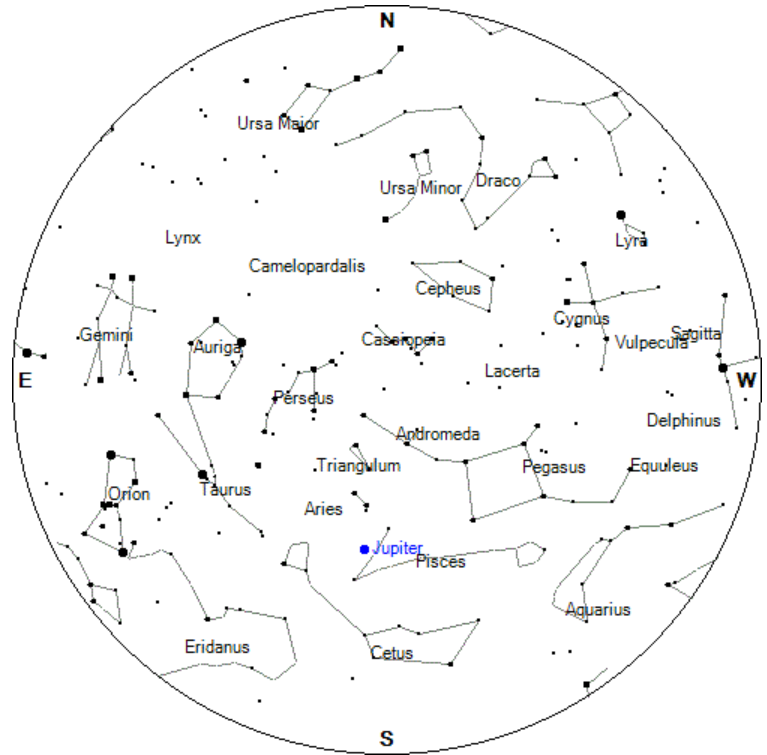
Saturn: at mag. +1.0 rises around 03:00 in Virgo.

Uranus: at mag. +5.8 also in Pisces sets around 00:30.

Neptune: in Aquarius sets at 21:30 at a dim mag. +7.9.

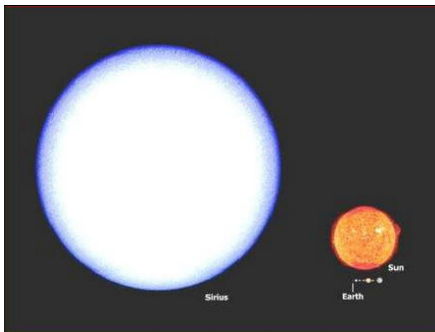
Meteors: Geminid shower peaks on the 12th but the bright Moon will interfere with all but the brightest of the predicted 100 an hour rate.

The peak of the Ursids is on the 24th with a rate of 10 to 15 an hour.



Last Month's (November) Meeting

☉ A short talk on the **Relative size of planets and stars** in our galaxy noted that our Sun is an average size star. 1.4 million km in diameter, and that light takes about 5 seconds to cross its disc, from one limb to the other, and about 8.3 minutes to reach us. In contrast, the diameter of the largest known star, Canis Majoris, is between 1800 and 2100 times the diameter of our sun (equal to about 9 times the distance from Sun to



Earth) and light takes 75 minutes to cross its disc. With a mass some 30-40 times that of the Sun, even this Red Supergiant is dwarfed in mass by star R136a1, a blue hypergiant in the Large Magellanic Cloud with a mass about 265 times that of the Sun.

Sitting between these extremes mention was made of Sirius (the brightest star in the sky) and Arcturus (only 26

times the diameter of the Sun and incidentally the light from which was used to open the 1933 Chicago World's Fair), Rigel (78 times the diameter of the Sun) in the Orion constellation, and Monocerotis (about 1600 times).

☉ Bob Mizon was on stage before his main talk (reported overleaf) with an up-to-date account of the work of the **Campaign for Dark Skies**. Bob related some of the recent success stories - encouraging several councils to change to higher efficiency lighting in streets and a distribution centre where a simple realignment of floodlights gave better ground illumination without producing a sky glare. But the battle to increase awareness of light pollution appears almost never-ending; unlike noise air, dust, vibration etc which are strictly controlled by legislation, there is no protection against light pollution. The only recourse seems to be to engage with the light polluter, explaining how they are wasting energy, and money, and encourage them to re-direct their lighting to better effect or, even better, install better-designed light fittings that only direct light downwards, not into the sky.

Thank you Bob for your talk and perhaps soon there will be progress on legislation to control light pollution.

Planetarium Shows in December

Fri. 9th 7:30 p.m. The Night Sky this Christmas
 Sun. 11th 3:30 p.m. The Hunt for New Planets and Life
 Sun. 18th 3:30 p.m. The Night Sky this Christmas
 Thur. 22nd 3:30 p.m. The Star of Bethlehem
 Thur. 22nd 5:30 p.m. The Star of Bethlehem
 Fri. 23rd 7:30 p.m. The Star of Bethlehem
 Sat. 24th 1:30 p.m. The Star of Bethlehem

Sat. 24th 3:30 p.m. The Star of Bethlehem
 Tues. 27th 3:30 p.m. Seven Wonders of Solar System
 Wed. 28th 3:30 p.m. Hubble's Glorious Universe
 Thur. 29th 3:30 p.m. All Aboard - A Tour of the Planets!
 Fri. 30th 7:30 p.m. The New Year Night Sky

Do remember - a discounted ticket price of only £5 is available for SDAS members attending these shows.

Booking by telephone: 01243 774 400 or 07818 297 292