How to observe… Double stars

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Where my interest began

One of the most terrifying concepts for me as a child was being told by my father that when we looked at the sky at night it was empty and one could never see the end. This posed numerous problems. A chip packet was empty when I had eaten everything yet I could see the end. My new soccer boots box was empty but it had boundaries. The sky is vacant and it had no end.

This questioning led me to an interest in Astronomy and through it to my fascination with double stars.

What possible rewards for the amateur

We all have the same rewards. Freezing cold nights, humping heavier and heavier equipment around and of course an insatiable quest to acquire more toys. My friends comment that I reap more reward from the toys than I do from the study of the stars!

1. Locating the prey
2. Differentiating and defining the colours
3. Differentiating and defining the magnitudes
4. Defining the pairs

In 1844 Fredrich Wilhelm Bessel (director Konigsberg Observatory) discovered that Sirius moved very slightly in the sky and concluded that it must have a companion. It was only in 1862 that an American lens maker Alvan Clark discovered a barely visible star nearby. Their movement has provides information about them. They complete an orbit around their barycentre every 49.9 years. Sirius A is 2.3 times the mass of the sun and Sirius B about the same as the sun. B has a radius one hundredth that of the sun so its density is almost a million times more. It is a white dwarf.

Binaries in general

Binary stars are pairs of stars revolving around common centres of mass (barycentres) under mutual gravitational attraction. In most cases the stars are moving in elliptical orbits described by Kepler's Laws.

Astrometric binary: Is a pair of stars where one star is too faint to be observed directly and its presence is inferred from perturbations in the movement of the visible component. These doubles will of course not form part of our observations.

Spectroscopic doubles: At Harvard in 1887 EC Pickering discovered that changes in the spectrum of the bright star Mizar in Ursa major were due to the presence of a second star. In spectroscopic doubles the two stars are so close together that they invariably appear as one, but when one of the stars moves towards us in its orbit around the common centre of gravity the Doppler effect reveals the duality of the system. These doubles will of course not form part of our observations!

Eclipsing variables: Sometimes one of the stars in a pair moves in front of the other and effectively "dims" the light. When one is behind the other they appear as a single point. These stars are known as eclipsing variables.

In the 1930s a supergiant was observed more precisely than ever before. The star Zeta Aurigae was known to be a binary even though the components could not be split. Two German astronomers, Schneller and Hopmann, confirmed that the star was an eclipsing variable using photometers. This yielded a wealth of information about the system such as surface temperatures, sizes and masses in relation to the sun.

Optical doubles: These are stars that look as if they are associated with one another but are merely in almost the same direction as seen by us.

Detached or semi-detached systems: Stars in a close binary are often pulled into distorted shapes by mutual tidal forces. If the two stars are physically separate they are referred to as detached whilst those called semi-detached are stars whose gas is being transferred from one to the other. These objects are the subject of my research project but fall outside of our present "doubles" objectives.

Multiple star systems: These are systems where three or more stars move under their mutual gravitational attraction. In the vicinity of our sun 35% of the stars are single whilst more than 50% are physical doubles.

Locating doubles without digital equipment

By far the most time consuming exercise for any astronomer is locating the prey. Unfortunately there is no quick fix for many of us. If you are fortunate to have digital setting circles or computerized telescopes your viewing time is substantially increased.

For those without, all I can say is practice. The more familiar you are with the sky and the constellations the easier your search becomes. Being familiar with your telescope or binoculars is also a great plus. If you are mentally able to divide your field of view according to the field size the star charts are much easier to follow.

From experience I have found that it is more rewarding to do thorough planning of your intended nights viewing. Locate your targets from sky charts or Internet pages and stick religiously to those preparations on a nights viewing. With this method you become familiar with selected areas.

Choose the brightest star in the constellation and then hop from one star to the other to find the prey. Spend time determining the separation, magnitude and then lastly the colours. It takes a long time for your eyes to differentiate colours. The doubles posted on the ASSA website are relatively easy to find and your observations are meant to be fun and challenging. We cannot do any science with the observations unless a micrometer is used and this under the present circumstances is not necessary. The objective is to look, make notes and enjoy.

Cognitive theory on how doubles formed

The astronomers and mathematicians Laplace and Kant suspected that the sun and planets originated from a rotating nebula.

Interestingly enough the theory of binary formation came from interactive processes using computer models. Research undertaken by Bodenheimer and Tscharnuter in a computer simulation that was attempting to re-create planetary matter resulted in the formation of two dense clouds (coalesced from one) that revolve around empty space. Magnetic and gravitational forces over time increase the densities of these clouds, turning them into binary stars.

Rewards for science from binaries

Mass of Stars: Arthur Eddington in 1924 announced that the brightness of a star was directly related to its mass. This work was stimulated by the observation of binaries.

Cepheids: Harlow Shapley (1885 – 1972) established that Cepheid variables are not eclipsing binaries. This discovery, made before the First World War, was enormously beneficial to research in the late 1920's when Edwin Hubble used Cepheids to determine the distances to other galaxies.

X Ray sources: The first X-ray sources discovered were spinning neutron stars accreting gas from their binary partners. X-ray emissions are vital in the search for the confirmation of the existence of Black Holes. The faint component of the binary Sco X-1 is a neutron star. A black hole has been identified in Cygnus X-1 by studying its partner.

Checking Einstein's Theory: Predictions made according to Newtonian gravitational theory are inaccurate when bodies are in an orbit that is smaller and tighter than planets in the solar system. By studying a binary pulsar, Taylor and Hulse have been able to confirm the theory of Gravitational Radiation. (Loss of energy = mass by change of gravity.) This effect, far too small to be detected in our solar system, shows up clearly in the binary pulsar.

Novae: Novae are a class of cataclysmic variables. They occur in close binary systems and amount to sudden and unpredictable increases in the brightness of one of the stars. They can be "semi-detached" systems where one of the stars is a white dwarf collecting gas from a main sequence companion. The collection of gas leads to a massive flare up in magnitude.

Further reading

1. *100 Billion Suns*
Kippenhahn
2. *Astronomy and Cosmology*
Fred Hoyle
3. *The facts on file of Astronomy*
Illingworth and Clark
4. A most valuable addition to my library was the purchase of *The Night Sky Observers Guide* volume 1 & 2. Authored by Kepple and Sanner. Published by Willmann-Bell Inc. Volume 3 is ready for release soon. ☆