Volume 3, Issue 12

December 2008

$ 4.95

Triton Fun Company Science Newsletter December 2008

Science Newsletter December 2008

In Praise of Binary Stars

J. Parks-diFranco

Special points of interest:

- Stars as twins
- Triton Fun stuff
- Superfluous questions

We are always looking for **contributors** to the Science Newsletter. If you would like to write an article about a science subject you are excited about, or contribute a superfluous question, or if you would like to be on our **mailing list** for future newsletters, please e-mail us at:

info@tritonfun.com

What are binary stars, how do they act and how do we detect them ? Most of our stars are singles, but almost half are binaries, or multiples, revolving around their common center of gravity. We can extrapolate this because we have 59 stars in our solar neighborhood and half of those are binaries. We can also project this ratio to the distribution of matter in space. Space distances are so vast that even millions of miles are impractical as a measure (too many zeros), so they are usually measured in light years, which means not a stretch of time but of space: the distance light travels in a year. The speed of light is around 186,000 miles per second which is about 11 million miles per minute, and 6 trillion miles (12 zeros) per year; so that is what a light year amounts to in miles. Thus it take light about 8 1/2 minutes to travel from our sun to Earth, but from the nearest visible star, Alpha Centauri, it takes 4 1/3 years at the same speed. The mean distance from the sun to Earth is called an astronomical unit (A.U.). And there are 63,300 such units to the light year.

The nearest star to us is a triple star and will help us study masses of two bodies orbiting each other. Binary systems are important because mass determines how long a star will live. Because scientist Henrietta Leavitt plotted the "period-luminosity" relation of stars, subsequent scientists took her work a step further with the "mass-luminosity" relation so that scientists could deduce that the more mass, the more luminosity. These valuable observations of mass were made from binary systems.

Our observations distribute binaries into three categories. First, **visual binaries**, our eyes alone see only one star and we need to use a telescope to separate them. Only a pair of stars with large orbits can be separated visually. For example, the Albireo pair in Cygnus is separated by some 4500 A.U. and their revolution is thought to take tens of thousands of years. If the orbits are too small, the star images blend together in the telescope and we can see only one point of light. Because visual binary systems must have large orbits, they also have long orbital periods (hundreds to thousands of years to complete one orbit). Astronomers study visual binary systems by measuring the position of the two stars at the telescope over many years to map the orbits. For example, the bright star Sirius A and its white dwarf companion Sirius B have an orbital period of 50 years. Many such doubles have such long orbital time that they are impractical to map. Others are too close to be visible as separate stars.

Artist conception of a binary star system

Stars can be close together, or far away, or only detectable spectroscopically

Next, **spectroscopic binaries** as seen through the largest telescope we have still only appear as a single point, but their spectra identifies them as a binary by the signature of light. Its spectrum which is formed by the light from both stars and therefore contains the spectral lines from both, tells us there are two stars present and not one. The Doppler shifts cause their spectral lines to move back and forth across each other, perhaps shifting first towards blue and then towards red. These spectral lines moving back and forth would alert us we are observing a spectroscopic binary. If we want to see how long it takes for the spectral lines to return to their starting positions, we can find the orbital period of a spectroscopic binary system. To find the orbit velocities of the two stars we can measure the size of the

continued, pg 2 —>

Binary Stars: *continued*

Photos/Info: NASA/Far Ultraviolet Spectroscopic Explorer (FUSE) mission/Astronomy Club of the State College of Parana/CACEP

Doppler shifts. Then we can multiply velocity times orbital period to find the orbit's circumference and then the radius can be found. The mass can be calculated per the orbit's size and period. But the Doppler effect only tells us the velocity towards or away from us, and since we cannot see the individual stars, we cannot know their inclination (the angle between the plane of a planet's orbit and the ecliptic plane), so scientists cannot compute true mass, only the lower limit of the masses. If we look at Mizar, at the curve of the Big Dipper's handle, it has a faint companion. Mizar itself is a telescopic double and the brightest component is a spectroscopic double star. When the two stars are in line, the spectra coincide. When, as they revolve, one approaches us as the other moves away, the spectrum lines are doubled.

The third group, the **eclipsing binary**, occurs when the motion of their orbital plane is in our line of sight and they eclipse each other. Their spectrum shows the pattern of the eclipsing binary. As double stars revolve, one may eclipse the other, causing reduced brightness. Best known of the eclipsing double stars is Algol in Perseus. It waxes and wanes at intervals of about three days. The eclipsing stars are 13 million miles apart. Their combined magnitude ranges from 2.3 to 3.4. One star is bright, the other much darker. When the dark star gets in front of the brighter one, as seen from Earth, Algol dims down.

We cannot close a summary of binaries without mentioning *novae*, stars that gain and lose mass through mass exchanges. They range from giants and supergiants to dwarfs and subdwarfs; from stars with a diameter almost 3000 times that of the sun, large enough to occupy the solar system beyond the orbit of Saturn, to stars the size of our major planets, and some even smaller than the Earth. The smallest stars are not visible to the naked eye, although they outnumber the giants and some are only a few light years away. The surprising thing is that the smallest stars do not differ greatly in mass from the largest ones: by a factor of ten, perhaps, or a hundred at most. This means that planet-size stars are incredibly compact while the supergiants may be a thousand times thinner than air. Gravity causes a dwarf to collapse, the surface gravity being intense, and can suck mass from the giant. Theoretically gravity could squeeze a star to the point of a black hole.

Thus binary stars could give us indirect evidence of black holes if we observe a star revolving around something we cannot see. The black hole would pull material from its companion, accelerate rotation, and the waning star would emit x-rays as it become part of the black hole as the hole pulls in matter and light.

In fact, in 2008, stars orbiting the black hole in the center of the Milky Way galaxy have been observed by ground-based and space-based telescopes. The stars revolve around an unseen center with velocities very high at perigee and slowest at apogee (i.e., the stars whip around the black hole quickest when closest in and slow down when they are farthest out). Thus, the black hole manifests itself by the motions of nearby objects, though it itself remains *invisible*.

Aside from the cosmic romance, doubles/binaries give us invaluable astronomical clues into the puzzles of the universe.

============

References

Rey, H.A. *The Stars*, 1997
Kuhn, K., *In quest of the universe*, 1998
Seeds, M., *Horizons*, Brooks/Cole, 2000
Zim, H., *Stars*, Golden Press, 1956
Ghez, A.M. et al., *Astrophys. J.* **689**,1044 (2008)

Our Sun may be one star in a binary system ! See the Triton Fun Science Newsletter for February 2008: "Two to Tango?" This article describes the Sun's twin.

Albireo: a double star system

This binary star system, Albireo, is interesting because each star is in a different class. **Albireo A** is a yellow star of magnitude 3.1 and **Albireo B**, its bluish companion, is of magnitude 5.1. (Albireo A is actually a binary star itself with a cooler K star and another B star that are not resolvable) while Albireo B is actually a B star which is quite hot relative to Albireo A. It is 11000 K while Albireo A (the K star) is only 4000 K. So, Albireo is actually a triple. Albireo is also known as *β Cygni.*

Note different colors
(for different temperatures)

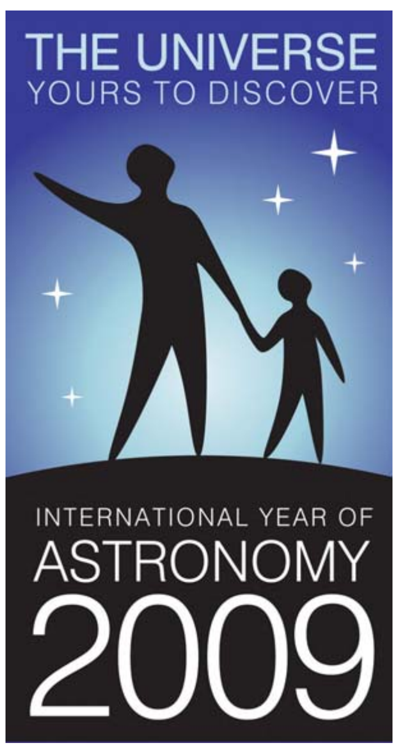
TRITON FUN PRODUCTS

2009 has been declared the "International Year of Astronomy". Events and activities to further the excitement of astronomy are being planned by IYA committees in over 100 countries. The logo for the IYA2009 is shown below. For more info on upcoming IYA2009 events, go to: http://www.astronomy2009.org

Triton Fun is an authorized distributor of T-shirts, sweatshirts and long-sleeve tees sporting this new logo. Part of the proceeds from the sale of these shirts will go to support astronomy clubs and astronomy activities connected with IYA2009 in California.

Get yours today ! These shirts can be ordered online on our website:
http://www.tritonfun.com

Or, order by phone (toll-free) : 800-778-0560



http://www.tritonfun.com

Mailing Address:

Triton Fun Company
P.O. Box 1522
La Canada Flintridge, California 91012

Phone: 800-778-0560
E-mail: info@tritonfun.com
Website: http://www.tritonfun.com

Triton Fun Company

Science and Astronomy-related products for the whole family

See our online catalog for great gift ideas !

All back-issues of our Science Newsletter are available in our "Newsletter Archive" at: http://www.tritonfun.com

We're on the Web !

http://www.tritonfun.com

** Send us your superfluous questions for a future issue ! They can be on any subject. The funnier, the better. M.D., our editor, appreciates the help and will send you a free Triton Fun coffee mug as compensation for your question. Or write an article for us and be read by professional and amateur astronomers and scientists in the U.S. and Canada ! **

Superfluous Questions:

1) In the TV show *The Odd Couple*, Oscar cooked up a dish called *what* ?

a) Crackers Concoction b) Goop Melange c) Beer Bash d) Meatloaf City

2) In the movie *White Christmas,* where in Vermont was the general's ski lodge ?

a) Montpelier b) Concord c) Pine Tree d) Burlington

3) Which one of these is **not** a *Multi-Purpose Logistics Module* for the International Space Station ?

a) Leonardo b) Columbus c) Raffaello d) Donatello

4) What is a squark ?

a) Australian desert mammal b) lunch item in Nepal c) theoretical elementary particle d) aviation tool

—> ANSWERS in next months issue of the Science Newsletter ! <——-

** ANSWERS to November's Superfluous Questions: 1. c) Silver 2. c) spoke to an alien 3. c) Tom Sawyer 4. b) 2015