Sunset Astronomical Society

The Sunset *Gazette*

Serving the Tri-Cities since 1975

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Meeting information

Meetings are generally in the theater in the Delta College Planetarium in Bay City. The meetings will usually be on the 2nd Friday of each month at 7:00 PM. Watch the newsletter for changes in dates and times. Membership is not required to participate in meetings and activities. See last Page for this month's meeting site.

Membership Information

Our club has switched to e-mailing our newsletters. For those wishing to receive a hard copy mailed an additional dues of $10.00 per year is required.

Student / Senior: (17 years & younger, 65+ years)

1 year - $15 (mailed Newsletter add $10)

2 year - $20 (mailed Newsletter add $10)

Regular: (18+ years)

1 year - $20 (mailed Newsletter add $10)

2 year - $30 (mailed Newsletter add $10)

Family:

1 year - $25 (mailed Newsletter add $10)

2 year - $40 (mailed Newsletter inclusive)

Membership includes voting privileges, the newsletter and free admission into Delta College Planetarium shows.

Treasurer's address for renewals and subscriptions:

Tom Smith, 3423 Hidden Road,

Bay City, MI 48706-1243

Subscription Information

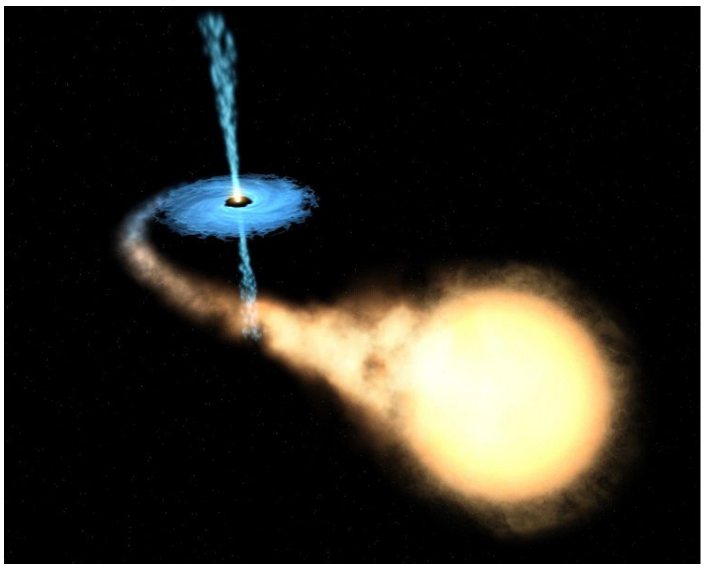
Subscription prices for "Sky and Telescope" Magazine or "Astronomy" Magazine are available at club rate with the purchase of individual or family membership. For prices please refer to the treasurer or the club's website:

http://www.sunsetastronomicalsociety.com/SASMembership.htm

Measuring Astronomical Distances Over The Centuries

This new series is about how astronomers determined and measured distances to astronomical objects over the course of more than two thousand years. The series will span from the beginnings in Greek antique to the latest development using earth and space based telescopes.

As in the last issues we will continue to talk about more about standard candles which astronomers use to measure the distance of objects on ever larger scale.



Source of picture: Wikipedia

A further method uses so called **X-ray bursters** as standard candles. These X-ray bursters are composed of two stars orbiting each other closely: one is a neutron star whereas the other one is an ordinary star. When the ordinary star expands its **Roche lobe** (more about it on the next pages) which is the region of space around a star within which orbiting material is gravitationally bound to that star, then star material can escape the gravitational pull of the star. If the star is orbited by a very compact object with a strong gravitational field the matter starts streaming towards the neutron star. The material which falls towards the neutron star is rich in hydrogen and helium because it comes form the outer layers of the star. Because of the very high gravitational field of a neutron star the material falls with a high velocity towards the neutron star. On its way it can also collide with other accreted material forming an accretion disk (see upper picture). The material then accumulates onto the surface of the neutron star as a dense layer of degenerate matter due to the extremely high gravitational field. When enough of this material accumulates on the surface of the neutron star a nuclear fusion reactions can be set of which causes a huge increase in temperature and initiates a runaway thermonuclear explosion. This sparks an intense burst of X-rays. The accretion of the material and the consequent explosion is happening periodically on a timescales ranging from hours to days. At the peak of the bust the amount of X-ray flux can be calculated once the mass of the neutron star is known: about 1.5 solar masses. This allows to determine the distance of the binary system up to extra galactic distances.

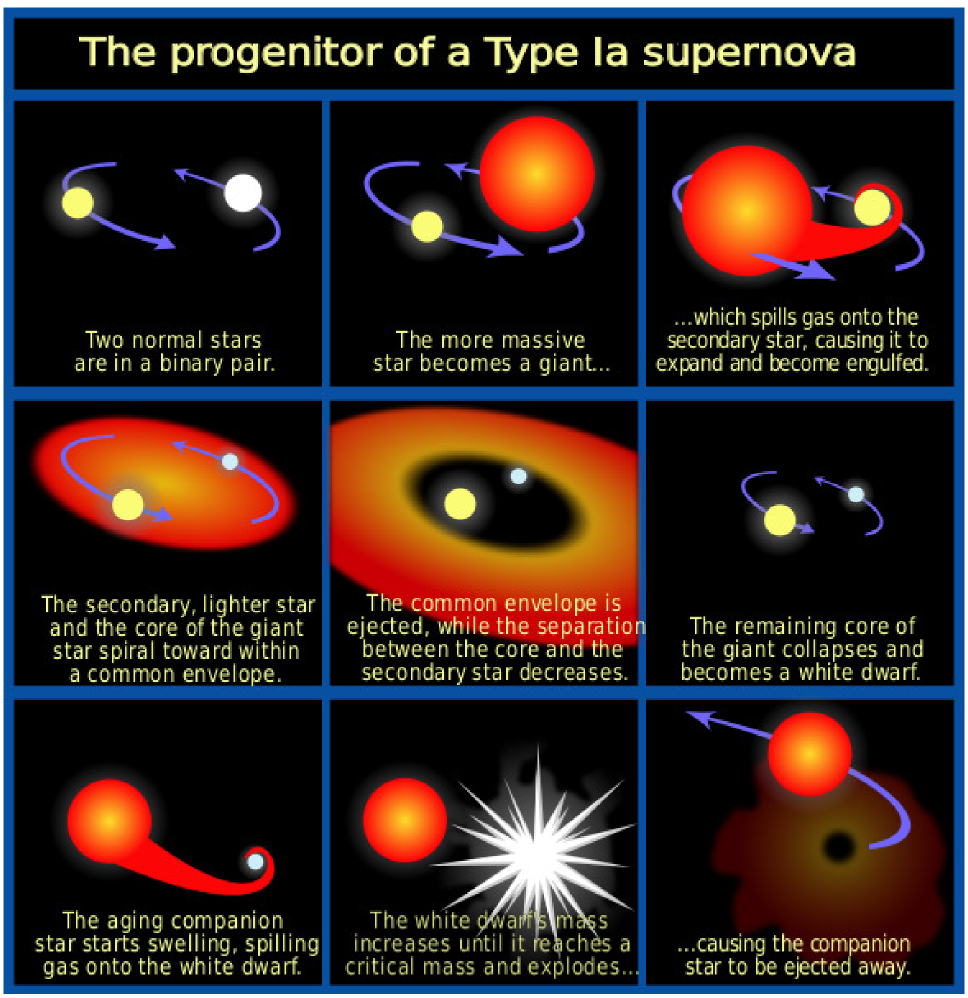
Now we come to the probably most important standard candle for long and very long distant measurements: The **Type Ia supernova.** Those of you who were present in the October SAS meeting and witnessed the excellent talk by **Dave Bailey** from the Warren Astronomical Society (Thanks again Dave!) will have already gained a very good understanding of the mechanisms of cataclysmic variables under which Type Ia supernova fall. For those who missed the talk I will give a more in depth description about the evolution and mechanism of this special class of supernovae.

Type Ia supernovae are a sub-category of cataclysmic variable stars which go supernova when a white dwarf star explodes. A white dwarf is the remains of a star which has completed its life cycle and has stopped nuclear fusion. If the white dwarf is of the common carbon-oxygen variety it will be capable of further fusion reactions if the temperatures rise high enough. A white dwarf cannot exceed a certain mass, which is given by the Chandrasekhar limit and is about 1.4 solar masses for a white dwarf which speed of rotation is low. A high speed rotating white dwarf could exceed this mass limit. Only up to this limit can the star be supported by electron degeneracy pressure. For those who want a short quantum mechanical explanation: the Pauli Exclusion Principle disallows two half integer spin particles (in this case electrons) from occupying the same quantum state at a given time. This results in a repulsive force which itself manifests as a pressure against further compression: it stabilizes the star up to certain mass which is the Chandrasekhar limit. If the mass is exceeded the star would further collapse into a neutron star.

It is this mass limit which makes the Type Ia supernovae a near perfect standard candle. Because the mass of the star is known the explosion will always release the same amount of energy and therefore the absolute brightness of the supernova will always be the same. Given the high brightness of a type Ia supernovae with a typical visual absolute magnitude of $M_v = -19.3$ (about 5 billion times brighter than the Sun) they can be detected over very large distances.

There are two different mechanism for Type 1a supernovae currently discussed albeit both of them involve the explosions of white dwarfs:

<u>**Close binaries where one star is a white dwarf, the other an ordinary star; mechanism 1**</u>: This theory was first developed by Rudolph Minkowski and Fritz Zwicky. The mechanism of this supernova theory is similar to that of a nova: In a binary star system consisting of two main-sequence stars with the primary having a greater mass than the secondary star, the primary will evolve faster onto the asymptotic giant branch where its hull expands considerably. The primary star degenerates then into a white dwarf and the secondary star later evolves into a red giant. At this stage the red giant can loose material to the white dwarf if the star exceeds its **Roche lobe**. In a binary system the Roche lobe is the region of space around a star within orbiting material is gravitationally bound to that star. If the star expands its hull past its Roche lobe, then the material can escape the



Source of picture: Wikipedia

gravitational pull of the star. The material can then be transferred into the other object's (here the white dwarf) Roche lobe via the first Lagrangian point. The matter can form an accretion disc before it is accumulating onto the surface of the white dwarf. In the case of a nova the white dwarf is of lower mass (0.5 - 0.6 sun masses) and the in-falling matter causes repeated hydrogen fusion surface explosions (also called repeating novas) that does not destroy the star. But each explosion may not consume all of the accreted mass so the white dwarf slowly increases in mass. If it is a higher mass white dwarf to start with the white dwarf may eventually approach the Chandrasekhar limit. Beyond the Chandrasekhar limit of about 1.4 solar masses it would no longer be able to support its weight through electron degeneracy pressure and would begin to collapse. In the case of a white dwarf primarily composed of heavier elements like magnesium, neon and oxygen the collapse would form a neutron star, but if the white dwarf consists of carbon-oxygen nuclear fusion can still take place and the resulting reaction leads to the explosion. In the current model astronomers think that the Chandrasekhar limit is actually never breached, and the collapse is never initiated. Instead, the accreting material from the binary star leads to an increase in pressure and density which in turn increases the temperature of the core of the white dwarf. When the white dwarf approaches to within about 1% of the Chandrasekhar limit a 1000 year lasting period of convection takes place. The details of the ignitions are still unclear but at one or several locations an ignition flame (= nuclear fusion) appears and burns its way through the star. Once the fusion reaction has started, the temperature of the white dwarf begins to rise. An ordinary main sequence star would expand and cool in order to counter-balance an increase in thermal energy and pressure. However in a white dwarf the star is kept in balance against the gravitational collapse by degeneracy pressure which is independent of temperature. The white dwarf is therefore unable to regulate the burning process like normal stars do and is vulnerable to a runaway fusion reaction. The flame now accelerates and a substantial fraction of the carbon and oxygen in the white dwarf is burned into heavier elements within a period of only a few seconds which in turn raises the temperature to billions of degrees. The energy released is of the order of $1\text{-}2\times10^{44}$ J which is more than enough to overcome the binding forces which holds the star together. The explosion ejects matter with speeds on the order of 5,000 - 20,000 km/s, or roughly up to 6% of the speed of light. The matter does not contain great amounts of hydrogen like in core collapse supernovae and the light curve is also very characteristic making it easy to discern if the supernovae precursor was a white dwarf.

Merger of two white dwarfs; mechanism 2 (much less likely): A lone white dwarf would therefore a be pretty stable object - to explode into a supernova it needs to be in a close binary system with another star. This star could also be another white dwarf and over time the two orbiting stars would get closer and closer by loosing energy via gravitational waves. Finally the two stars will merge and when the combined masses of both white dwarfs exceed the Chandrasekhar limit the fusion of both stars will spark a runaway fusion reaction releasing enough energy to explode into a supernova explosion. There is still a lot of debate amongst astronomers how rare this event is. The discussion is important because the exploding mass of two merging white dwarfs could exceed the 1.4 solar masses and has the potential to release more energy and therefore being of a higher visual absolute magnitude than a standard Type Ia supernovae. This could lead to false assumption of the distance of the supernovae . Given the enormous importance of Type Ia supernova in the cosmological debate one has to make sure that the supernova is indeed a standard Type Ia supernova. The merger of two white dwarfs is one of several explanations proposed for the anomalously massive (2 solar mass) progenitor of the supernova SN 2003fg, however, the light curve characteristics of SN 2003fg were such that it would never have been mistaken for an ordinary high-redshift Type Ia supernova.

In the next issue we will hear more about Type Ia supernova light curves and the on the impact of Type Ia supernova on the history and future of the universe. Stay tuned!

October 14, 2011 SAS minutes

14 Members present and one guest. Second Vice President Mohammed Khan showed his pictures from the Veen Observatory field trip and the latest visit to Garry Beckstrom's Observatory. SAS president Timothy Ross presented copies about up coming SAS meetings, and encouraged members to come up with ideas for future activities. Guest speaker Dave Bailey from the Warren Astronomical Society gave a very engaging presentation on Non-Spherical Spherical Stars lasting over 2 hours.

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This issue can be accessed in color on the website of the SAS!!!

http://sunsetastronomicalsociety.com

SAS Meeting

Start: 7:00 PM

Friday, Nov 11th, 2011

Delta Planetarium

Welcome members and guest

New and old business

Club Business

Dobzilla workshop

Treasure report

Refreshments Break

What's up in the Sky

Nov 6: Daylight saving time ends!

Nov 9 *Dusk*: Venus, Mercury and Antares can be seen in a short near straight line very low in the west-southwest a half hour after sunset. Low in the east Jupiter can be found 6 deg right of the Moon.

Nov 9-12 *Dawn*: Moon passes 1.5 deg above Regulus in the morning.

Nov 10: Full Moon.

Nov 10 *Morning*: The Venus-Mercury-Antares line is now more vertical.

Nov 11 *Evening*: Pleiades are above the bright Moon (binoculars!). The Hyades and Aldebaran are under the Moon.

Nov 18 *Morning*: In the hours of dawn the Leonid meteor shower will peak, but the glow from the Moon will hide the faintest meteors.

Nov 18: Last Quarter Moon.

Nov 22 *Dawn*: Saturn, Spica and the waning thin Moon form a line over the horizon in the southeast.

Nov 18: New Moon.

Nov 26 *Dusk*: A very thin crescent Moon ca 3 to 5 deg to the right of Venus visible low in the southwest ca 1/2 to 1 hour after sunset.

Dec 2: First Quarter Moon.

Dec 6 *Evening*: Jupiter can be seen right pr lower right of the waxing Moon.

Dec 10: Full Moon.

Dec 10 *Predawn and Dawn*: Total lunar eclipse visible in western North America.

Dec 13, 14 *Night*: Gemini meteor shower due to peak around 1 p.m. EST on the 14th, but the Moon will hide all but the brightest meteors.

UPCOMING EVENTS

2011 – 2012 SAS PROGRAM

- December 9 2011 TBD
- January 13 2012 SAS Christmas Party, potluck
- February 10 2012 TBD
- March 9 2012 TBD
- April 13 2012 TBD
- May 11 2012 Election and swap meet.
- June 8 2012 TBD?

Contact Timothy Ross, Phone (989)-777-2824 or tjrastronomy@hotmail.com