Sunset Astronomical Society

The Sunset *Gazette*

Serving the Tri-Cities since 1975

Volume 9, Issue 4 December, 2011

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

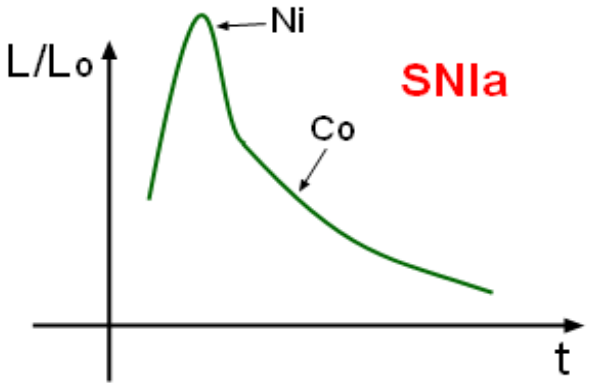
Subscription prices for "Sky and Telescope" Magazine or "Astronomy" Magazine are available at club rate with the purchase of individual or family membership. For prices please refer to the treasurer or the club's website:

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.

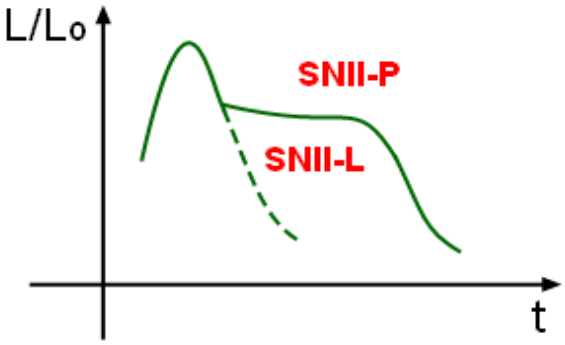
In the last issue we covered Type Ia supernovae as the most reliable standard candles when it comes to cosmological distances. We continue by talking more about their distinctive light curves which makes it relatively easy to discern them from core collapse supernovae.



This plot of luminosity (relative to the Sun, L_0) versus time shows the characteristic light curve for a Type Ia supernova. The peak is primarily due to the decay of Nickel (Ni), while the later stage is powered by Cobalt (Co). Source of pictures + text: Wikipedia

The light curve of a Type Ia supernova (left) is quite characteristic and very different from core collapse supernovae (see below). When it reaches the maximum luminosity, the spectrum of a Type Ia supernova contains lines elements from oxygen to calcium which mainly made up the outer layers of the star. Months later the spectrum is then dominated by light emitted by material which was at the center of the core of the star, these are elements like radioactive nickel, cobalt and iron synthesized during the explosion.

A common factor of all Type Ia supernovae is that they have a standard blue and visual absolute magnitude of ca -19.3 ± 0.3 and that their light curves are very similar to each other. Therefore it is not intrinsically necessary to capture the supernova directly at its peak magnitude. By comparing the shape of its light curve to a family of parameterized curves the absolute magnitude at the maximum brightness can be determined.



This graph of the luminosity as a function of time shows the characteristic shapes of the light curves for a Type II-L and II-P supernova. Source of pictures + text: Wikipedia

From that the distance of the supernova can be calculated. That makes Type Ia supernovae one of the most accurate methods for distance measurements. Given that the luminosity of a supernova explosion often rivals that of its galaxy it originated the explosions can be seen over fast distances, approximately 500 times farther away than Cepheid Variables. The method has now been refined so that the current uncertainty approaches a mere 5%, corresponding to an uncertainty of just 0.1 magnitudes.

We are now coming to the role Type Ia supernovae played in redefining the structure of our universe. In the beginning to mid 1990's two research teams were investigating and using Type Ia supernovae to chart the expansion of the Universe. The first team was the **High-z Supernova Search Team**, an international cosmology collaboration formed in 1994 by Brian P. Schmidt (Harvard University) and Nicholas B. Suntzeff, a staff astronomer at the Cerro Tololo Inter-American Observatory (CTIO) in Chile. The team later grew to roughly 20 astronomers located in the United States, Europe, Australia, and Chile. They used the Victor M. Blanco Telescope of CTIO for discovering Type Ia supernovae out to red-shifts of z=0.9. Confirmation and verification of the spectra were then carried at Keck Observatory, and the European Southern Observatory.

The other research team was the **Supernova Cosmology Project** which was headed by Saul Perlmutter at Lawrence Berkeley National Laboratory and consisting of a team of 31 members from Australia, Chile, France, Spain, Sweden, UK and USA.

In the late 1990's both teams published their results (High-z Team in 1998 and Supernova Cosmology Project in 1999): After observing the brightness and red-shift of 58 supernova, both teams have found that the remnants of nearly all Type Ia supernovae are at least 15 % further away than the standard model of the Universe predicted at that time. This result implied that the Universe is 'open' and will expand forever. Cosmologists often speak of the universe as being either "open" or "closed". These attributes refer to whether the curvature of the universe is negative or positive. The result also suggested that there is a bizarre quantum force at work which is affecting the expansion rate of the universe. This quantum force was named Dark Energy and is thought to be a hypothetical form of energy that permeates all of space and tends to accelerate the expansion. Currently dark energy is widely accepted to explain why the universe appears to be expanding at an accelerating rate and makes up for about 73% of the total mass energy of the universe in the standard model of cosmology. This model is known as the **ΛCDM** or **Lambda-CDM** model and is an abbreviation for the **Lambda-Cold Dark Matter** model, which includes the presence of dark matter and dark energy. This would now be a good point to take an in depth look at this model: it attempts to explain 4 major observables:

1) The existence and structure of the cosmic microwave background

2) The large scale structure of galaxy clusters

3) The current distribution of hydrogen, helium, deuterium and lithium

4) The accelerating expansion of the universe observed in the light from distant galaxies and supernovae

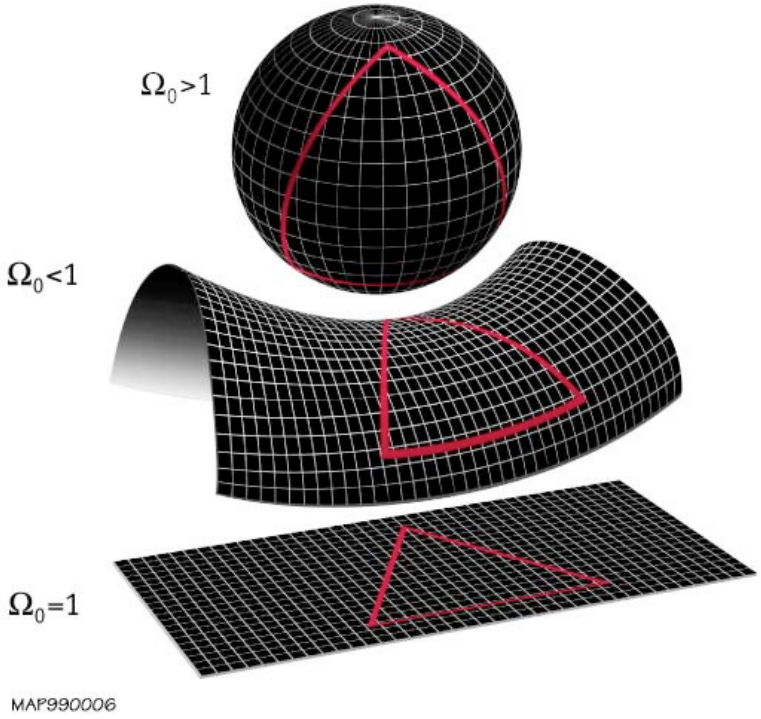
In a way it is the 'simplest' model which is still in general agreement with these observed phenomena following a long held belief in physics that overcomplicating things does not necessarily mean a model is more correct than a more simplistic one. Having said that one has to note that small but significant minority of astrophysicists does not agree with the current model. The standard model has been developed over the last decades and is based on the cosmological principle, meaning that our location as observers in the universe is in no way unusual or special and given a large enough scale the universe would look the same from every other location and in all directions. The model includes the following assumptions:

- Metric space expands (think of objects on the surface of an expanding balloon) which is well documented both as the red-shift of prominent spectral absorption or emission lines in the light from distant galaxies and as the time dilation in the light decay of supernova luminosity curves. These effects are caused by a Doppler shift in the electromagnetic radiation as it travels across expanding space. What is paradox is the fact that expanding space increases the distance between gravitationally non-bounded galaxies whereas it does not increase the size of the objects in space.

- The model assumes that the universe has a "flat" spatial geometry meaning that the interior angles of a triangle will always sum to 180° and that space is defined by straight lines. Alternatively you could think of a 'closed' universe in which the interior angles of a triangle would sum to more than 180° or a hyperbolic one in which the angles would sum to less than 180°. Currently the values of key parameters imply that the universe is either flat or slightly open, the universe will expand forever, and the expansion is accelerating. (see picture on the page 3)

- The Λ (Lambda) in the model name stands for the cosmological constant Ω_Λ. This constant is currently associated with a vacuum energy also called Dark Energy inherent in empty space. It explains the current accelerating expansion of space against the attractive (= collapsing) effects of gravity. As mentioned about 73% of the energy density of the present universe is estimated to be dark energy.

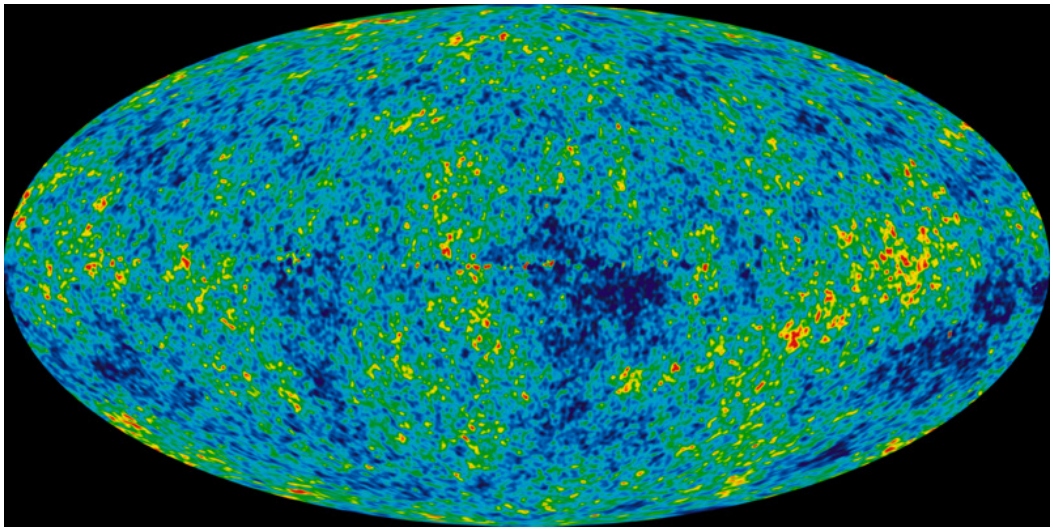
- Cold dark matter is a form of unseen matter necessary to account for gravitational effects observed in very large scale structures not be accountable for by the quantity of observed matter. It helps to explain the anomalies in the rotation of galaxies, the gravitational lensing of light by galaxy clusters and the enhanced clustering of galaxies. The current theories describe dark matter as being cold, which means its velocity is far below the speed of light and consisting of matter not made up of protons and neutrons, it is also 'dissipationless' meaning it cannot cool by radiating photons and it is 'collisionless' meaning the dark matter particles will interact with each other and other particles only through gravity. It is estimated that about 23% of the mass-energy density of the universe is made up of dark matter.



The local geometry of the universe is determined by whether Omega is less than, equal to or greater than 1. From top to bottom: a spherical universe, a hyperbolic universe, and a flat universe. (Wikipedia)

- This leaves only 5%! of the universe comprised of matter and energy we currently can observe: stars, galaxies, light, planets = the stuff everything around us is made off.

- The standard model also includes a single originating event, the "Big Bang" or initial singularity, which is not an explosion but the abrupt appearance of expanding space-time. It was followed by an exponential expansion of space known as cosmic inflation. For several hundred thousand years the universe stayed hot (above 10,000 K) which is now detectable as a residual cosmic microwave background or CMB, a very low energy radiation emanating from all parts of the sky. The "Big Bang" scenario is currently the only model consistent with the observed continuing expansion of space, the observed distribution of lighter elements in the universe and the spatial texture of minute irregularities (anisotropies) in the CMB radiation.



The **Wilkinson Microwave Anisotropy Probe** (**WMAP**) — also known as the **Microwave Anisotropy Probe** (**MAP**), and **Explorer 80** — is a spacecraft which measures differences in the temperature of the Big Bang's remnant radiant heat — the Cosmic Microwave Background Radiation — across the full sky. Wikipedia) WMAP image of the CMB temperature anisotropy (Wikipedia)

SUNSET ASTRONOMICAL SOCIETY
THE SUNSET GAZETTE
SERVING THE TRI- CITIES SINCE 1975

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2. Vice President, Mohammed Khan khan001@charter.net

Treasurer, Thomas Smith tom55net@att.net

Secretary, Newsletter Editor, Martin Grasmann
martin.grasmann@sbcglobal.net

This issue can be accessed in color on the website of the SAS!!!
http://sunsetastronomicalsociety.com

SAS Meeting

Start: 7:00 PM

Friday, Dec 9th, 2011

Delta Planetarium

Welcome members and guest

New and old business

Club Business

Treasure report

Exploring SAS Website

Refreshments Break

Presentation:

Planetarium Show:

SEASON OF LIGHT

If Clear we will observe on the planetarium Observing deck.

What's up in the Sky

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.

Dec 14-28 *Dawn*: Mercury visible high in the southeast, ca 8 to 10 deg above the horizon 45 min before sunrise.

Dec 17: Last Quarter Moon.

Dec 19, 20 *Dawn* : The waning crescent Moon can be seen to the upper right of Saturn and Spica on the 19th abd blow both of them on the 20th.

Dec 21-22 The longest night of the year.

Dec 22 *Dawn*: The crescent Moon can be seen to the upper right of Mercury low in the southeast 45 min before sunrise.

Dec 23: The very thin crescent Moon well below and to the left of Mercury.

Dec 24: New Moon.

Dec 26 *Dusk*: Venus shines to the left of a very thin crescent Moon

Dec 27-28 *Night*: Algol at minimum brightness for roughly two hours centered around 1:41 am EST.

Dec 30 *Evening*: Algol at minimum brightness for roughly two hours centered around 10:30 pm EST.

Jan 1: First Quarter Moon.

Jan 2 *Evening*: Jupiter ca 5 deg below or lower left of the Moon. Algol at minimum brightness for roughly two hours centered around 7:19 pm EST.

Jan 3 *Predawn*: Watch out for a brief but intense Quadrantid meteor shower between moonset and Dawn.

Jan 4, 5 *Evening*: Waxing gibbous Moon near the Pleiades on the 4th and between the Pleiades and Hyades on the 5th.

Jan 9: Full Moon.

UPCOMING EVENTS

2011 – 2012 SAS PROGRAM

December 9 2011 Planetarium Show: SEASON OF LIGHT

January 13 2012 Joint SAS, AU Christmas Party, potluck. Show and tell.

February 10 2012 Presentation by Timothy J Ross on the Slingshot effect and libration points.

March 9 2012 TBD

April 13 2012 TBD

May 11 2012 Election and swap meet.

June 8 2012 ?

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