**Prime Focus**

A Publication of the Kalamazoo Astronomical Society

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**February 2008**

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**This Month's KAS Events**

General Meeting:  Friday, February 1 @ 7:00 pm
*Kalamazoo Math & Science Center* - See Page 16 for Details

Observing Session:  Saturday, February 9 @ 7:00 pm
*February Freeze Out* - *Kalamazoo Nature Center*

Board Meeting:  Sunday, February 10 @ 5:00 pm
*Sunnyside Church* - 2800 Gull Road - All Members Welcome

Observing Session:  Wednesday, February 20 @ 7:00 pm
*Total Lunar Eclipse* - *Kalamazoo Nature Center* - See Page 5 for Details

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**Highlights of the February Sky...**

--- 1st ---
Dawn:  Jupiter 0.6° lower right of Venus.

--- 4th ---
The Moon passes 4° south of Jupiter, 1 a.m.
The Moon passes 4° south of Venus, 7 a.m.

--- 6th ---
New Moon

--- 9th ---
The Moon passes 3° north of Uranus, 5 a.m.

--- 13th ---
First Quarter Moon

--- 16th ---
The Moon passes 1.6° north of Mars, 3 a.m.

--- 20th ---
Full Moon

The Moon passes 0.7° south of Regulus, 7 p.m.

--- 21st ---
The Moon passes 3° south of Saturn, 7 a.m.

--- 23rd ---
Saturn at opposition

--- 25th ---
Dawn:  Mercury within 2° of Venus for next week.

--- 27th ---
Dawn:  Venus 1.1° below Mercury.

--- 28th ---
Last Quarter Moon
The Moon passes 0.6° south of Antares, 10 p.m.

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www.kasonline.org
The general meeting of the Kalamazoo Astronomical Society was brought to order by President Jack Price on Friday, January 11, 2008 at 7:18 pm. Approximately 31 members and guests were in attendance at the Kalamazoo Area Math & Science Center (KAMSC). Before the meeting officially came to order, former president Richard Bell presented the 1945 Kalamazoo Amateur Astronomical Association (KAAA) gavel to the newly-elected president.

The feature presentation of the evening was given by past president and newly-elected Vice President, Mike Sinclair. Mike continued his biographical lecture series with a talk on Simon Newcomb. Mike explained that he knew little about Newcomb until he found a copy of one of his books (Elements of Astronomy) at a used book store in Chicago.

The title of Mike’s latest talk was The Unknown Astronomer. Simon Newcomb was born on March 12, 1835 in Nova Scotia, Canada. Newcomb was home schooled until the age of 16. Newcomb then attended the Lawrence Scientific School and Harvard University, where he received a Bachelor of Science degree in 1858.

In 1861, with the advent of the American Civil War, he took a position with the U.S. Naval Observatory. His focus at that time was to accurately locate the position of planets in order to aid in navigation.

In 1878, Newcomb began an experiment to measure a more precise value for the speed of light. He was refining a method of interferometry first developed by Leon Foucault when he received a letter from Albert Michelson. He began a long collaboration with him; Michelson published his measurement in 1880 but revised his results to one closer to Newcomb’s in 1883. Michelson received the Nobel Prize for this work in 1907. Newcomb never felt any animosity toward Michelson.

In 1891, Seth Chandler discovered a 14-month variation of latitude (Chandler wobble). Newcomb explained the difference between the observed motion and predicted period of the wobble. The theory was based on a perfectly rigid body but Earth is slightly elastic. Newcomb used the variation of latitude observations to estimate the elasticity of Earth -- slightly more rigid than steel!

In 1899, Newcomb completed an exhaustive program to accurately measure stellar and planetary positions in order to calculate the motion of the planets. One of the key results was a much larger perihelion precession of Mercury than expected. This discrepancy wouldn’t be fully explained until 1916 with Albert Einstein’s General Theory of Relativity. Unfortunately, Simon Newcomb passed away on July 11, 1909. He’s buried in Arlington Cemetery in Washington, D.C.

Jack gave his very first President’s Report after the snack break. Jack outlined the two new volunteer positions he wants to create (see his column on page 4 for more details). Under observing reports, Roger Williams reported seeing ONE (1) Quadrantid meteor on January 3rd. Fortunately, this was one more than Jack Roach reported! Both Don Stilwell and Bill Nigg observed Mars during the recent opposition. Bill made his observations from the Florida Keys and endured the 70º F wind chill factor. Comet Holmes and Comet Tuttle were also discussed. Under astronomical news, the new sunspot cycle was mentioned along with the imminent flyby of Mercury by the MESSENGER spacecraft (see page 12). The meeting concluded at 9:02 pm.

The newly-elected KAS Board met on Sunday, January 13th at Sunnyside Church. President Jack Price brought the meeting to order at 5:00 pm. All of the other board members were present (Richard Bell, Jean DeMott, Dick Gillespie, Dan Morgan, Rich Mather, Mike Sinclair, and Roger Williams).

Rich Mather delivered a Treasurer’s report showing a current balance of $12,885.62. The impressive increase was due primarily to grant money from Pfizer, obtained through the efforts of Jean DeMott. Gifts totaling $155 to the Owl Observatory Fund were also received during the last report period. This leaves KAS with a Land Acquisition Fund of just over $5800 and about $7000 in a checking account. After some discussion, the Board voted that the Land Acquisition Fund and $5000 of the checking account money should be invested in certificates of deposit as soon as possible, since interest rates seem likely to decline.

Planned imminent events were summarized by Jack. Besides the Full Moon Theater on January 26th and the general meeting on February 1st, the February Freeze Out is on February 9th, and Total Lunar Eclipse viewing on the 20th, both at the Kalamazoo Nature Center.

Regarding old business, Jack has obtained a first-aid kit for Owl Observatory. Roger had not yet confirmed with Miller Auditorium KAS’s appearance at the Kalamazoo Symphony Orchestra’s performance of Holst’s The Planets on April 18th. This would be done immediately, but a KAS contact person would need to be named, since Roger and Molly will be traveling on that date. Richard agreed to be the contact, and he further recommended that we acquire - before that date - a table cover with the KAS logo, for use where the banner is not practical. Richard and Jean will work on this. Since the cover will be made to fit one of the KAS portable tables, Miller
Auditorium will be informed that we will bring a six-foot table, and available space will be confirmed.

In the category of new business, Richard presented a proposed list of dates for public observing sessions in 2008. These will need to be confirmed with the Nature Center, so Richard will e-mail them to Jen Wright. He also suggested the immediate printing of a number of brochures once the schedule is final. The Board voted to authorize printing of 500 brochures for a start.

Jack has also set up a meeting with Jen Wright to get acquainted and to go over our agreement with KNC. Items suggested for him to raise include recurring damage to the observatory building from lawn mowing and issues related to behavior of other groups renting KNC facilities on the same nights (an infamous pig roast being exhibit A). Jack will also push a suggestion previously made by Richard, that KNC staff attend at least one KAS observing session during the year, so that they can know more about what actually happens there.

In other business, discussion was held on how to make all club members aware of the equipment available for borrowing and to insure that the equipment is widely circulated and used. A KAS appearance at Vicksburg Middle School was confirmed for March 12th. Richard also proposed another Full Moon Theater appearance at Vicksburg Middle School was confirmed for March 12th. Richard also proposed another Full Moon Theater presenting In the Shadow of the Moon, a video about the Apollo space program. He suggested March 22nd, which is near the Full Moon, but Jack pointed out that this date falls between Good Friday and Easter. He suggested March 15th as an alternative, but no decision was made. The issue of a topic for Astronomy Day 2008 was raised, and the Sun was the consensus choice. Richard also gave a heads-up that 2009 has been designated the as International Year of Astronomy by the United Nations, honoring the 400th anniversary of Galileo’s first telescopic observations.

The meeting was adjourned at 7:00 pm. The next meeting was set for February 10th, same time and place.

Respectfully submitted by Roger Williams

A classic fall season with beautiful weather followed by a very brief Indian Summer brought the 2007 Perpetual Plant Sale (PPS) to a close in early November. Despite a very unfortunate late start to the summer selling season, the total proceeds for this year’s sale came to $1100. Even though I was playing "catch up" all summer and struggling with a two month drought I had another great year of meeting and working with my usual diverse and interesting parade of customers.

Thanks go out again this year to my KAS plant donors: Dick and Jackie Gillespie, Bob and Barb Havira and Jack and Paula Roach. Many thanks also to my good friend Sue Hodapp and her mother Elaine Hodapp for their support and encouragement, for keeping me tipped about great plant sales and finally for their great late season donations of baskets and planters. I also need to thank Pfizer colleague Kate Scandlon not only for being a regular customer but also for all the terrific deals she has found for me on pots and planters.

A little voice told me that I should not set a sales goal for the 2007 PPS and that premonition proved to be prophetic. As some of you are aware, disaster struck just as I was preparing for my annual kick-off sale on June 18th and 19th. My family property and future site of my retirement home fell victim to a thoughtless and inconsiderate neighbor. The property invasion and ensuing damage left me with no alternative but to put all my preparation activities on hold and give immediate attention to protecting the site from further trespass and to try to start dealing with the damage. As a result I lost most of my perennial stock to the drought, had to cancel the kick-off sale and was unable to start selling until the beginning of July.

At that point I made a calculated decision (since I already had so much time and effort invested in the rest of my plant stock and preparations) to set aside my problems and focus my attention on making the plant sale as successful as possible. I am extremely disappointed that for the first time I did not break my previous year sales total, but under the circumstances I feel blessed to have closed the sale out at $1100. Good friends, lots of great customers and many days of beautiful weather saved me.

Now I have to turn my full attention to resolving my property situation. Because I have no idea how long it will take, I have very reluctantly decided to put the PPS on hiatus. I created the PPS for the purpose of establishing and growing a land acquisition fund for the KAS, and I hate to lose even a single season of contributions. If a miracle happens I may still be able to pull off a sale in 2008 but, more realistically, I hope that at this time next year I will be busily preparing for the 2009 PPS.

So, if anybody out there has had experience with land encroachment or knows of a good real estate attorney with experience successfully representing a victimized land owner with an unwanted piece of her neighbor’s hardware permanently installed on their land, please get in touch. You could help me return to being a happy person again, merrily growing and selling plants and making money for her favorite cause.

Jean De Mott
(269) 381-1406
jeamott@hotmail.com
Hi everyone! I’m Jack Price, the new President of the KAS. Following Mike Sinclair and Richard Bell. . .boy do I have big shoes to fill.

Let me tell you a little about myself. I’ve enjoyed looking at the night sky since I was a young boy, dreaming about what was out there. Like many others I was fascinated seeing and listening to Sputnik. That excitement carried on through the 1960’s with the whole Space Race. As a Boy Scout, I learned a little bit about the constellations and even remembered some of the names. Like many young boys I wanted to be part of the space program, not so much as an astronaut but helping design and launch rockets. One of the most impressive memories is from Christmas Eve 1968 as the Apollo 8 spacecraft was orbiting the Moon looking at the craters while the astronaut read from the Bible about the creation of the Earth. I had things all planned out, college, military, space program. If you want to hear God laugh, tell Him your plans.

As things go, plans change, life happens; career, marriage, raising two sons. Then along came Comet Hyakutake in 1996. My sister, Phyllis Lubbert, happened to see some of Dave Garten’s photos. He shared a copy with her and then she showed me. He gave her information about the KAS and she passed it along to me. I visited a meeting and decided it was time to learn a little more about astronomy. I joined the KAS in late 1996 or early 1997. Then along came Comet Hale-Bopp in early 1997 and I was really hooked on astronomy as well as enjoying the fellowship of KAS members. In addition to many KAS activities, I’ve gone to several star parties; the Apollo Rendezvous in Dayton, Ohio (twice); NIAG Fest in Northern Indiana; and Starfest in Canada (twice). I strongly suggest that everyone go to a star party. There are many to choose from all over the country and Canada. Check the links on KAS Online and talk to KAS members who have attended many of them (see page 13 as well).

I’ve been on the KAS Board for several years as a Member-At-Large and Vice President and now as President. I want to see most of the KAS activities continue as they have been. I am going to create a new position in the club of Public Observing Session Host. This person will be responsible to open the gate at the Nature Center, put out the signs and open up Owl Observatory. Then close up and put things away and lock up. Members can sign up for the two sessions in the month or just one. We will have a list of the dates online and have a sign-up sheet at the general meetings. I want to do this to spread the work around to many members. I may also request several members to be available to be media resource people. When the media wants a quote or information about some upcoming event I can give them a referral.

That should be enough for this month. Keep looking up!

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**Seminar @ WMU**

College of Arts and Sciences & Department of Geosciences presents

**Mars Exploration Rover Mission**

Presented by Dr. Ray Arvidson
Washington University in St. Louis

The two rovers, Spirit and Opportunity, have been traveling across the surface and making scientific measurements for over 1200 Mars days or sols. Opportunity landed on Meridiani Planum on what we now know are ancient lake beds formed in an acid-sulfate aqueous system. Spirit landed on olivine-bearing basaltic plains and then drove to the older Columbia Hills.

The Hills are an ancient volcanic complex with extensive evidence for the interaction of water and magmatic systems, including hydrated sulfate and silica deposits. The evidence for the interaction of water and crustal materials will be discussed, along with implications for habitability and life on Mars.

**Monday, February 11 @ 4:00 p.m.**

**Rood Hall - Room 1104**
Native Americans call February’s Full Moon the Snow Moon. This month’s Full Moon, however, might be better described as the Copper Moon or even the Blood Moon! Why? A total lunar eclipse takes place on the night of February 20th.

We were clouded out for the lunar eclipse last March, which was in progress at moonrise. Skies were clear for August’s early morning eclipse, but dawn broke as the totally eclipsed Moon set in the west.

February’s total lunar eclipse takes place late in the evening and we get to see the show from start to finish! The entire event will be visible over all of South America and most of North America as well as western Europe and Africa. Only our friends in the Far East and Australia will be shut out.

The eclipse officially kicks off at 8:05 pm EST (exactly two hours after moonrise) when the Moon slips into the Earth’s penumbra, the lighter outer shadow cast by our planet. This stage of a lunar eclipse is undetectable as the shading on the outer penumbra is very slight.

Use the penumbral stage of the eclipse to setup your gear and observe the ringed planet Saturn, located only 3º or 4º to the Moon’s northwest. Saturn reaches opposition three days after eclipse time, so it’ll be near its maximum brilliance for the year. Regulus, the heart of Leo the Lion, is only 2º or 3º to the northeast of the Moon. This bonus conjunction will fit into the field-of-view of almost any pair of binoculars.

Small bites will be taken from the Moon’s disk starting at about 8:43 pm. At this time, the Moon begins its gradual plunge into the Earth’s umbra, the darker inner shadow. Observing the Moon through a telescope with low to medium powers can be really exciting at this stage. Watching the Earth’s shadow creep across the lunar surface, covering up maria and craters, is one of the big thrills of astronomy. The objects we normally observe, such as the Moon on a regular night or deep sky objects, are static and unchanging. During a lunar eclipse, you get to watch astronomy in motion!

Crater timing is still a very important activity to perform if you’re looking for a project during the eclipse. The umbra changes shape from one eclipse to the next; therefore adding a complication to predicting the duration of lunar eclipses. The effect is clearly related to the Earth’s atmosphere, but this phenomenon is not completely understood. Generally, you pick a familiar crater like Copernicus or Tycho and record the times when the shadow touches the two opposite edges of the crater. Check out the NASA Eclipse Home Page by Fred Espenak for more information.

Totality is predicted to begin 10:01 pm, but try and see how accurately you can determine when this moment happens for yourself (and for science). The exact appearance of the totality eclipsed Moon depends on several factors. First is the Moon’s path through the umbra. As you can see in the diagram below, the Moon skims the southwestern boundary. Therefore, the Moon’s southern half should remain lighter than the northern half. Then there are various environmental factors such as the amount of cloud cover on eclipse day and how much contaminates are in the air (both naturally occurring and manmade).

Last August’s total lunar eclipse was bright with an exquisite orange and copper hue, so it’s safe to assume this month’s eclipse will follow suit. Incidentally, the coppery to blood-red appearance of the totality eclipse Moon comes from sunlight refracted through the Earth’s atmosphere. In essence, what we’re seeing are the colors of all the sunrises and sunsets around the globe. The Moon would vanish completely during totality if it wasn’t for the Earth’s prism-like atmosphere.

The French astronomer André-Louis Danjon developed a five point scale for evaluating the visual appearance and brightness of the Moon during a total lunar eclipse. Again, check out the handy NASA Eclipse Home Page for details on the Danjon Scale. Try to determine the Danjon rating for yourself and then compare your results with other amateur astronomers.

Totality lasts for a total of 50 minutes and ends at 10:51 pm. The Moon then gracefully exits the umbra entirely at 12:09 am on February 21st. At this point, you may as well pack up your gear and catch some sleep before work. Let’s just hope the weather cooperates on February 20-21, because this is our last chance to enjoy the splendors of a total lunar eclipse until December 20 - 21, 2010.
In perusing the online catalog of one of the major vendors (Oceanside Photo & Telescope), I recently noticed a listing for a new equatorial telescope mount (available only for pre-order at this point). It was said to use a harmonic drive for tracking, and some fairly impressive claims were advanced.

The smallest model had a capacity of 125 pounds, and it was said to require no counterweights, apparently because the available torque was so great. Furthermore, backlash was claimed to be essentially non-existent, and the periodic error was said to be slow and smooth.

Coincidentally, at about the same time I received a copy of the publication *Astronomy Technology Today*, which had a cover story featuring the same mount, being built under the brand name Chronos. This gave a more detailed explanation of how a harmonic drive operates, in contrast to the OPT catalog. I am attempting here to summarize the rudiments of the new drive and to assess its possible utility in future equatorial mounts.

As amateur astronomers know well, keeping a celestial object centered in a high-power telescope field requires tracking of the sidereal motion of the stars. The tracking needs to be smooth (especially for astrophotography), but slower than any electric motor can run. This means that some form of reduction gear is required, usually in the range of 6,000:1. By far the most common device used up to now is the worm gear.

As the illustration shows, at any time one tooth of the worm gear is fully engaged, while the two adjacent teeth are partially engaged. The worm is usually turned by a spur gear, driven by a smaller gear attached to the motor. Both of these gear pairs must have a small space between the sides of the teeth to prevent binding, and this leads to backlash when the direction of rotation is reversed. In addition, imperfections in the shape of the teeth lead to a periodic departure from smooth motion, typically in the shape of a sine wave, with each turn of the worm. This periodic error is usually one of the main shortcomings of a worm gear. Most modern computer-controlled drives have periodic error correction, which stores in memory the corrections required and applies them automatically.

The drive designed by Chronos came out of a project to replace the mount control system of the equatorial fork mount at Stony Ridge Observatory. It is based on harmonic drives, which are available off-the-shelf from a number of manufacturers. They are apparently used widely in robotics and in pointing satellite dishes. The principal behind the drives is well illustrated on the web site of one of these manufacturers, from which the following figures were taken.

The wave generator is made up of a rigid, elliptical cam into which is machined the inside raceway of a set of ball bearings. The outside raceway is subject to elastic deformation, such that the bearings conform to the elliptical shape of the cam. The wave generator is usually attached to the input shaft of a servo motor. The flexspline is a thin, cup-shaped metal rim with external teeth, which is deformed into an elliptical shape by the ball bearings. The output shaft is attached to the bottom of the cup. The circular spline is a rigid element with internal teeth, usually fixed to a casing so that it cannot move. The flexspline teeth contact the circular spline only at the ends of the long axis of the ellipse.

The key to the design is that the flexspline has two fewer teeth than the circular spline (in the cited example). The result is that as the wave generator turns and changes the orientation of the ellipse, the external teeth of the flexspline are forced into contact with different teeth of the circular spline. As shown by the illustration below, the disparity in number of teeth causes the flexspline to rotate by one tooth when the wave generator has turned 180° and by two teeth in 360°, in the direction opposite to the rotation of the wave generator.
means influences of tooth pitch errors and accumulated pitch errors on rotational accuracy are equalized to assure high positional/rotational accuracy.

4. Small numbers of components and ease of assembly

Effective speed reduction ratios are possible with only three basic components, and since all three components are co-axially aligned, the Harmonic Drive can be easily built into component-assembled products, allowing for simple configurations.

5. Small-sized and lightweight

Machinery/equipment can be made smaller and lighter because the Harmonic Drive provides the same levels of torque and speed reduction ratios as conventional gearing mechanisms, while being less than 1/3 the size of conventional products in terms of capacity and less than 1/2 the weight.

6. High torque capacity

The flexspline is made of special steel with a higher resistance to fatigue. Different from the typical driving force transmission apparatus, every tooth is subjected to very little force yet provides a high torque capacity. Because 1) the number of simultaneously mating teeth in the flexspline accounts for some 30% of the total number of teeth, and 2) these teeth come into contact with one another face to face, every tooth is subjected to a minimum of force while providing a maximum of torque.

7. High efficiency

The mating portion of each tooth is subjected to very little slide motion. Therefore, motion loss due to friction is reduced substantially, enabling the Harmonic Drive to maintain a high level of efficiency, and allowing driving motors to be made smaller.

8. Quiet, vibration-free operation

With the Harmonic Drive, quiet and vibration-free operations are possible because the teeth do not come into rolling contact with one another, and as the circumferential speed of each tooth is low, the teeth provide a well-balanced force.
So along the lines of the original question it is now fair to ask, where did the initial mix of hydrogen and helium, the initial building blocks of the first stars and galaxies, come from?

First, imagine a universe quite different from the one we live in today, which is presently extremely cold, mostly empty, with much of the matter condensed (via gravity) into tiny stars, planets and the galaxies that contain them.

Imagine instead a universe that is filled with the following: individual protons (hydrogen nuclei), an equal number of electrons, a nearly equal number of neutrons, plus photons and neutrinos - with a mix of photons in ratio to \( \text{protons + neutrons} \) in proportion of 2 billion to one.

This is the same mix of elementary particles as we find in our universe right now, but in the case we’re imagining the density of this matter is similar to that of the air you are breathing right now, and thus far greater than the mean matter density in the present universe.

Now imagine that such a universe with these contents is uniform in temperature at \( T = 1 \) billion K and therefore uniform in matter/energy density, to 1 part in 100,000. Under these conditions the photons take on a spectrum of a nearly perfectly isothermal (single temperature) blackbody radiation field, in near perfect thermodynamic equilibrium.

At such high temperatures, matter exists in the state of fundamental particles previously described - not as atoms and molecules. This is a much simpler universe than the one we inhabit at the present time.

2) Next, imagine that space-time of this universe with the above matter/energy contents is uniformly expanding and therefore cooling and becoming more diffuse with time. Under these conditions it can be demonstrated to undergraduates that in approximately 1000 seconds nearly all of the free neutrons will fuse with the protons to become helium with the 3:1 H to He ratio (75%:25%) with a leftover deuteron/proton ratio of 30 parts per million, just as observed in the oldest stars and intergalactic gas clouds isolated from stellar processing/heavy element pollution. Deuterons are hydrogen nuclei with an extra neutron attached (\(^2\text{H}\)), a stable yet rare isotope of hydrogen.

Widely separated galaxies are observed to be moving away from our Galaxy and from each other - in other words, the universe is expanding (apparently uniformly on large distance scales), following “Hubble’s Law” under the space-time paradigm of Einstein’s theory of General Relativity (see box below for an explanation of Hubble’s Law). We are bathed from every direction in space by blackbody (thermal) radiation, that is a perfect single temperature blackbody spectrum to 1 part in 100,000, but drastically reduced in temperature and corresponding intensity due to the universe having expanded immensely over the past 14 billion years.

It is important to understand that perfect blackbody radiation requires the matter emitting it to be dense and opaque and at the same temperature everywhere. The universe and its contents are presently nowhere near to being in this state, but it apparently was in the distant past.

The expansion of space (with time) on large spatial scales and

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**THE HUBBLE LAW**

In 1929, the American astronomer Edwin Hubble published a graph that plotted the apparent velocity of recession versus distance for a number of galaxies. The points on the graph fell along a straight line:

This relation between apparent velocity of recession and distance is known as Hubble’s Law and is expressed mathematically by the following equation:

\[ V_r = H d \]

Where \( V_r \) is the apparent velocity of recession in kilometers per second is equal to the Hubble constant \( H \), multiplied by the distance to the galaxy, \( d \), in megaparsecs.

Astronomers use this as a way to estimate distance from a galaxy’s apparent velocity of recession.
The following two web pages briefly outline the present evidence for our universe once having been as described above:

http://www.astro.ucla.edu/~wright/cosmology_faq.html
http://www.astronomycafe.net/qadir/q2561.html

Finally, it might then be fair to ask, where did those first protons, neutrons, electrons and neutrinos come from?

In particle accelerators physicists routinely create matter out of pure energy. There are uncountable numbers of protons, neutrons, electrons, neutrinos, their anti-particles (yes, anti-matter does exist), plus short-lived particles and even elements that have been created out of energy via $E = mc^2$, that never before existed. Nature also does this all by herself (e.g., in the collisions of cosmic rays with atoms in Earth’s atmosphere).

Briefly speaking, the kinetic energy of a collision between particles is converted into matter - the greater the collision energy, the more massive are the particles created. Matter should really be considered the frozen (condensed) state of energy, just as water vapor and snowflakes are different states of the same thing.

If we continue winding up the universe to ever hotter and denser states, at temperatures above 10 billion K electrons as we know them do not exist in equilibrium “material form”; above 10 trillion K or so the protons and neutrons don’t either and instead are manifested in a state known as a “quark-gluon gravitational collapse of matter on smaller spatial scales, the latter forming galaxies and the stars and planets within them, have since drastically altered our universe from its initial hot, dense, nearly perfectly uniform state.

Astronomers have measured the present expansion rate of the universe and the average density of matter, and when these measurements are coupled with General Relativity and the other laws of physics we can predict the conditions in this early, hot, dense universe (described in points 1 & 2 above) which has left behind “fossil” signatures in the present universe to test the “big bang” theory.

If the observed expansion rate or average matter density or the photon/matter ratio or any number of other observables were different than we measure, the predicted relative abundances of the lightest elements produced in the early hot-dense universe would be different. The big bang theory also predicts the present intensity and temperature of this radiation field and that it must be nearly a perfect single temperature blackbody.

Of course, nature needn’t cooperate with our explanatory ideas, but thus far it has confirmed them. By itself, this theory needn’t account for why the universe was once in such a homogeneous hot-dense state or what caused the initial expansion in space-time (i.e., “what banged”), although there are scientific hypotheses and models that have been put forth awaiting observational tests.
plasma” (protons and neutrons are each made of 3 quarks of two types, and gluons are the force carriers of the strong nuclear force that hold nuclei together). Both of these postulates have been tested in our largest particle colliders, although the latter needs further tests of confirmation.

Also to be tested at CERN’s Large Hadron Collider accelerator beginning in 2008 is the following prediction: above a temperature of about $10^{15}$ (1 quadrillion) K, the weak nuclear force and electromagnetic force cease to exist as we know them, and are expected to merge into a unified “electroweak” force, resulting in matter losing its inertia. At still higher energies (temperatures), we can at present only extrapolate from our present understanding of the laws of nature.

Nevertheless, the message is clear: The universe becomes ever simpler at ever higher energies, matter naturally condenses from energy, and as the energy per unit volume in a system drops, the state of matter changes. At sufficiently low energy a quark-gluon plasma will condense into protons and neutrons, which at still lower energies form atomic nuclei, which at much lower energies will combine with electrons to form atoms, which at still lower energies will “condense” into molecules, which at still lower energies will “condense” into complex molecular clusters, and so on.

Returning again to our snowflake analogy: randomly distributed and moving molecules of water, a simple system with a high degree of symmetry, will at sufficiently low temperatures (far below the melting point of ice) suddenly find themselves condensing to form crystalline snowflakes, a complex system with much lower symmetry. This re-arrangement of matter due to the sudden appearance of a lower potential energy state at low temperature does not happen purely at random.

The electrical forces and shape of the H$_2$O molecule, the latter determined by quantum rules and electrical forces between the hydrogen and oxygen atoms, dictate the snowflake’s construction and what sorts of shapes are possible or impossible. The overall entropy (roughly speaking “disorder”) of the universe increases with the formation of structure (snowflake) from simplicity (water vapor), as driven by spatial gradients in matter and energy. No laws are broken and no magic is required.

And so it goes with nature on all scales, from atom and molecule formation to the actions of folding proteins to living cell formation to star and galaxy formation. The universe was apparently at one time in an initially “wound up” - extraordinarily high energy, relatively low entropy - state, and has been “unwinding” for approximately 14 billion years as it expands and cools. There is quite a bit more to the story, even without completely extrapolating from what we presently know and can test, but I suspect that this has been more than enough.

With Best Regards,

Kirk Korista

P.S. Astronomers have thus far concluded from their observational census of the cosmos that the net total negative gravitational potential energy of all sources exactly cancels out the net positive sources of energy (matter and radiation plus kinetic energy of expansion of space-time). That’s right, the net energy content in the universe is 0 (zero)! Now there’s something else to ponder.
Imagine someday taking a driving tour of the surface of Mars. You trail-blaze across a dusty valley floor, looking in amaze-ment at the rocky, orange-brown hillsides and mountains all around. With each passing meter, you spy bizarre-looking rocks that no human has ever seen, and may never see again. Are they meteorites or bits of Martian crust? They beg to be photographed.

But on this tour, you can't whip out your camera and take on-the-spot close-ups of an especially interesting-looking rock. You have to wait for orders from headquarters back on Earth, and those orders won't arrive until tomorrow. By then, you probably will have passed the rock by. How frustrating!

That's essentially the predicament of the Spirit and Opportunity rovers, which are currently in their fourth year of exploring Mars. Mission scientists must wait overnight for the day's data to download from the rovers, and the rovers can't take high-res pictures of interesting rocks without explicit instructions to do so.

However, artificial intelligence software developed at JPL could soon turn the rovers into more-autonomous shutterbugs.

This software, called Autonomous Exploration for Gathering Increased Science (AEGIS), would search for interesting or unusual rocks using the rovers' low-resolution, black-and-white navigational cameras. Then, without waiting for instructions from Earth, AEGIS could direct the rovers' high-resolution cameras, spectrometers, and thermal imagers to gather data about the rocks of interest.

"Using AEGIS, the rovers could get science data that they would otherwise miss," says Rebecca Castaño, leader of the AEGIS project at JPL. The software builds on artificial intelligence technologies pioneered by NASA's Earth Observing-1 satellite (EO-1), one of a series of technology-testbed satellites developed by NASA's New Millennium Program.

AEGIS identifies a rock as being interesting in one of two ways. Mission scientists can program AEGIS to look for rocks with certain traits, such as smoothness or roughness, bright or dark surfaces, or shapes that are rounded or flat.

In addition, AEGIS can single out rocks simply because they look unusual, which often means the rocks could tell scientists something new about Mars's present and past.

The software has been thoroughly tested, Castaño says, and now it must be integrated and tested with other flight software, then uploaded to the rovers on Mars. Once installed, she hopes, Spirit and Opportunity will leave no good Mars rock unturned.

Check out other ways that the Mars Rovers have been upgraded with artificial intelligence software at:

http://nmp.nasa.gov/TECHNOLOGY/infusion.html#sciencecraft

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.
When Mariner 10 flew past Mercury three times in 1974 and 1975, the same hemisphere was in sunlight during each encounter. As a consequence, Mariner 10 was able to image less than half the planet. Planetary scientists have wondered for more than 30 years about what spacecraft images might reveal about the hemisphere of Mercury that Mariner 10 never viewed.

On January 14, 2008, the MESSENGER spacecraft observed about half of the hemisphere missed by Mariner 10. The image seen below was snapped by the Wide Angle Camera, part of the Mercury Dual Imaging System (MDIS) instrument, about 80 minutes after MESSENGER’s closest approach to Mercury (2:04 pm EST), when the spacecraft was at a distance of about 27,000 kilometers (about 17,000 miles). The image shows features as small as 10 kilometers (6 miles) in size. This image was taken through a filter sensitive to light near the red end of the visible spectrum (750 nm), one of a sequence of images taken through each of MDIS’s 11 filters.

Like the previously mapped portion of Mercury, this hemisphere appears heavily cratered. It also reveals some unique and distinctive features. On the upper right is the giant Caloris Basin, including its western portions never before seen by spacecraft. Formed by the impact of a large asteroid or comet, Caloris is one of the largest, and perhaps one of the youngest, basins in the Solar System. The new image shows the complete basin interior and reveals that it is brighter than the surrounding regions and may therefore have a different composition. Darker smooth plains completely surround Caloris, and many unusual dark-rimmed craters are observed inside the basin. Several other multi-ringed basins are seen in this image for the first time. Prominent fault scarps (large ridges) lace the newly viewed region.

Just 21 minutes after MESSENGER’s closest approach to Mercury, the Narrow Angle Camera (NAC) took the picture seen above showing a variety of intriguing surface features, including craters as small as about 300 meters (about 300 yards) across. This is one of a set of 68 NAC images showing landscapes near Mercury’s equator on the side of the planet never before imaged by spacecraft. From such highly detailed close-ups, planetary geologists can study the processes that have shaped Mercury’s surface over the past 4 billion years. One of the highest and longest scarps (cliffs) yet seen on Mercury curves from the top center down across the right side of this image. (The Sun is shining low from the left, so the scarp casts a wide shadow.) Great forces in Mercury’s crust have thrust the terrain occupying the left two-thirds of the picture up and over the terrain to the right. An impact crater has subsequently destroyed a small part of the scarp near the top of the image.

This image was taken from a distance of only 5,800 kilometers (3,600 miles) from surface of the planet and shows a region about 170 kilometers (about 100 miles) across.

Images courtesy of NASA, Johns Hopkins University Applied Physics Laboratory, and Carnegie Institution of Washington. For the latest images and information please visit:

http://messenger.jhuapl.edu/
Pack your bags, collimate your scope, and clean those eyepieces! It’s time to hit the road and attend a star party (or two). Listed below are all the major star parties (that we know of) that have already announced their dates for 2008. Registration deadlines for each star party may be different (or even passed), so please visit their web sites for the latest information.

If you plan to attend any of the events listed (or not listed) here then let us know. Maybe other KAS members would like to attend. Plus, if you do attend any star parties this year, please write a report for Prime Focus. Clear Skies!

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<th>Star Parties in 2008</th>
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<td>Northeast Astronomy Forum &amp; Telescope Show (NEAF)</td>
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<td>Cherry Springs Star Party</td>
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<td><a href="http://www.astrohbg.org/s4/">http://www.astrohbg.org/s4/</a></td>
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<td>RTMC Astronomy Expo</td>
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<td>Stellafane</td>
<td>July 31 – August 3</td>
<td><a href="http://www.okie-tex.com/">http://www.okie-tex.com/</a></td>
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The Venus-Jupiter conjunction from last month continues on Feb. 1st. The brilliant pair will be separated by a mere 0.6º low in the southeastern sky at dawn. Be sure to catch the Waning Crescent Moon near Antares in the SSE on the 1st as well.

A total lunar eclipse takes place on Feb. 20-21. Partial phases of the eclipse start at 8:43 pm, while totality kicks off at 10:01 pm. See page 5 for more details.

Saturn reaches opposition on February 23-24. It’ll be at its maximum brightness for the year and rise at sunset and set and sunrise.

Mercury will be within 2º of Venus for the remainder of the month starting on the morning of Feb. 25th. On Feb. 27th, they’ll only be 1.1º apart!
February Freeze Out

Winter nights can be ideal for observing. When it’s actually clear during a winter night in Michigan, the sky can be unbelievably transparent. So, why don’t amateur astronomers turn out in droves to winter observing sessions? It’s because it gets REALLY, REALLY COLD on a clear winter night! Now comes the time of year when the hardcore members of the KAS brave the frigid temperatures to enjoy the deep sky delights that most people probably miss because of the frigid conditions.

Saturday, February 9 @ 7:00 pm
Kalamazoo Nature Center

Planetarium admission is $3.00 per person. The Kalamazoo Valley Museum is located at 230 North Rose Street in downtown Kalamazoo. For more information please call (269) 373-7990 or visit us on the web at www.kalamazoomuseum.org

KAS SkyCaps
Available in Black & Khaki

Make sure you’re wearing one of our new SkyCaps next time you attend an observing session or travel to star parties across the country. Plus, for reasons not totally understood, these fully adjustable caps actually make stars look brighter! Reserve yours today by sending a message to kas@kasonline.org.

Only $12.00!
Pluto has been a mystery from its discovery as the ninth "planet". A flood of data from Pluto and the realm of the outer Solar System over the past 30 years led an international body of astronomers in 2006 to redesignate Pluto as one of many "minor planets". Astronomers caught a lot of flack for this "renaming" of Pluto's status, some of it from surprising places. Dr. Korista, Associate Professor of Astronomy at WMU, will present a brief overview of Pluto, provide a clear rationale behind the IAU's decision, and in doing so discuss briefly some of the recent advances in our understanding of the history of our Solar System. He'll conclude with some commentary on "What's in a Name?" from science's point of view.

Friday, February 1 @ 7:00 pm
Kalamazoo Area Math & Science Center
600 West Vine, Suite 400 • Use Dutton St. Entrance