Gemini

a publication of the Minnesota Astronomical Society

August, 1992 Volume 17 No. 4

Upcoming Events

July

23	"The Long Night"
24-25	Star party
29	New moon
31-1	Star party at Metcalf

August

4	MAS general meeting, 7:30 p.m.
12	Perseids meteor shower
13	Full moon
27	New moon
28-29	Star party at Baylor

September

1	MAS general meeting, 7:30 p.m.
11	Full moon
25-26	Star party at Metcalf
26	New moon

Paperwork Stage of Wilder Site Observatory Nears Completion

"Southern site" observatory still possibility

The saga of the Society's would-be observatories continued in mid-July, with last-minute changes to the Wilder Forest site lease, plus a new wrinkle--another possible "southern site" observatory.

President Mike Kibat met with representatives of the Wilder Foundation and resolved most of the major issues still pending at the start of the month of July. As of mid-July, the two parties to the lease were still thrashing out details of the language.

Wilder officials have expressed concern about granting the Society permission to trim trees. They are also concerned about the impact of Society activities on their attendance statistics. Wilder must pay the township an infra-structure fee based on those numbers. The Society could be forced to charge members of the public a small fee, 15 to 25 cents per person, to reimburse the Wilder Foundation for those costs.

Due to the delay in signing the Wilder lease, now scheduled for Wilder Foundation Board review at their Aug. 20, 1992, meeting, the Society must forego the opportunity to acquire the 3M buildings for the Wilder site. However, there is a possible new site near Cannon Falls where the buildings could be moved.

As of mid-July, the plan was to construct an observatory for the 16-inch Cassegrain at Wilder and remodel the garage into a classroom, as originally intended.

The new site discovered by Leanne Ronning and promoted by Tom Lindquist is southeast of Cannon Falls, approximately 13 miles south and one mile west of the Ronning property. Known as the Cherry Grove School site, it was the site of a one-room schoolhouse, now collapsed. Some of the lumber could potentially be salvaged, but the remainder of the building would have to be discarded and the site cleared of junk and debris.

The site is mostly clear of trees and has electrical and telephone lines. It is situated on a plowed road, so it is readily accessible, even in winter.

Little is yet known about sky conditions, but it can be assumed that they will be similar to those at the Ronning site. The Rochester light dome will lie to the south-southeast and rise to 10-20 degrees above that horizon.

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Observatories

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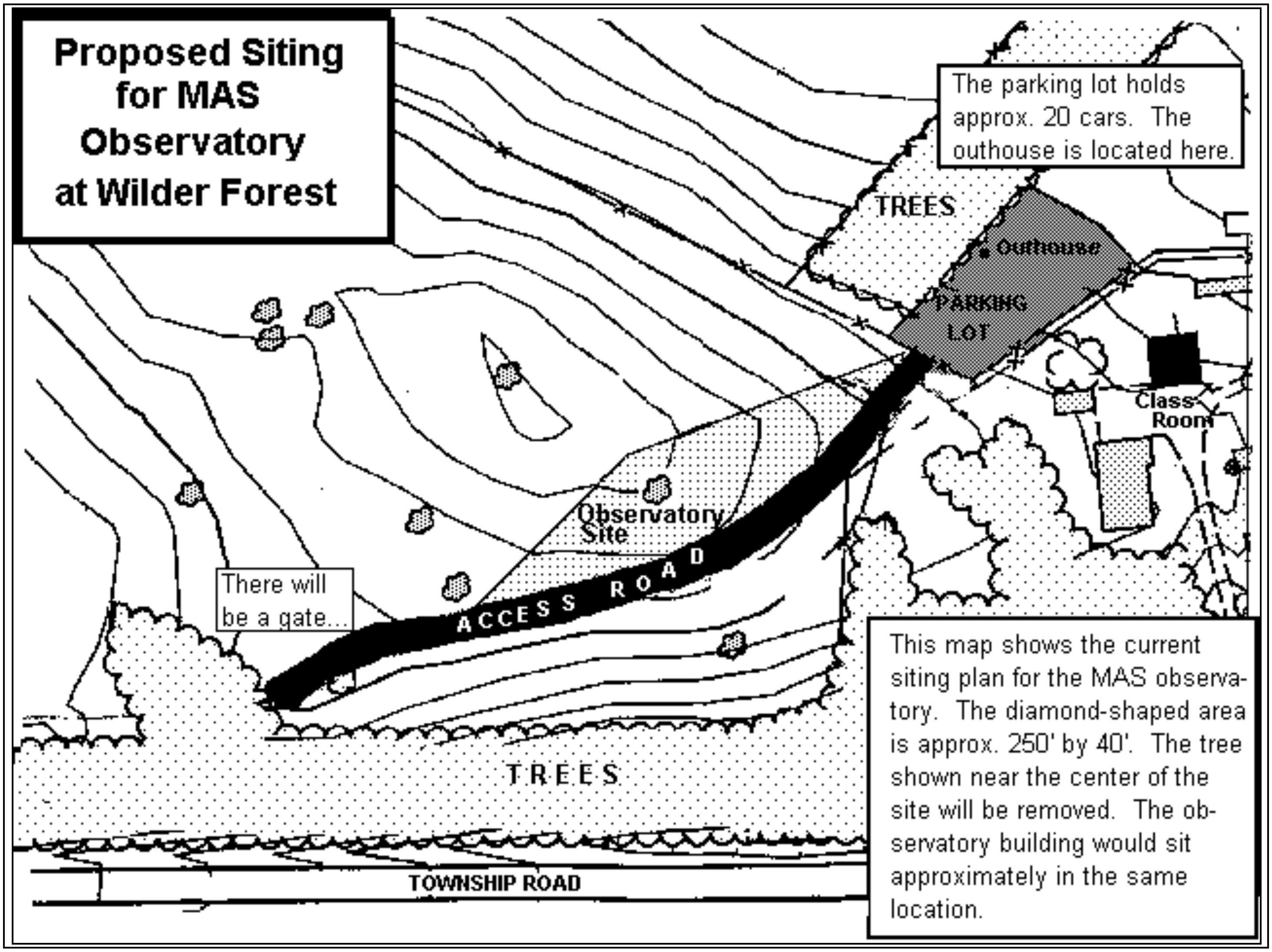
The Red Wing light dome will lie to the east-northeast and rise to 15-25 degrees. The Twin Cities light dome lies to the northwest and rises to 40-50 degrees.

The remainder of the sky--the zenith, most of the southeastern and
southern sky, and the southwestern sky down to the horizon--should be relatively dark.

A number of question were unanswered at the time of this writing, including what local lights might interfere with observing, what the potential for development is in that area, and so forth. Kibat was heading out of town and suggested Vice President Mike Conley convene a board meeting to discuss purchasing the Cherry Grove site.

The purchase price for the property will not be printed here for security reasons, but it is very reasonable and affordable.

As Gemini went to press, messages regarding both the Wilder Forest site and the Cherry Grove School site were flying back forth over the Ceres BBS. Check the BBS for the latest information.



GEMINI

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The Great Nebula in Andromeda. MAS member Dave Siskind used his 5.5-inch Celestron Schmidt camera for this 12-minute exposure of M 31 and its companions, M 32 and NGC 205 (bottom), taken Sept. 4, 1989. The image is inverted, as seen in a telescope.

Announcements

Greg Russa of the University of Minnesota, who is also a member of the Society, will lecture on supernovas at the Aug. 4 general meeting, which will be at 7:30 p.m. in the auditorium of the Science Museum of Minnesota. Non-members may attend the meeting.

The program for the September meeting of the Society is still pending.

Jeff Beddow gave the July program, which was on paleo-archeology and ancient observatories. Beddow is requesting volunteers interested in exploring possible astronomical alignments at Minnesota Indian mound sites.

The University of Massachusetts Lowell, The American Meteor Society and Science Applications International Corporation are sponsoring an international workshop on Radiometeor Science and Engineering Aug. 17-21 at that university. Few amateur astronomers are likely to attend, due to the registration fee of $250.

Jim Fox previously announced 3M has for sale an 8-inch Meade 826C which is six years old. If interested, contact Fox at (612) 436-5843.

Meteor Showering, a newsletter for serious meteor observers, premiered recently. The editor is Gregg Pasterick, P.O. Box 27, Kilbourne, OH 43032-0027. Meteor showering is relatively technical, it contains shower rates and other data.

MEMBERSHIP AND SUBSCRIPTION FEES

$33	Regular membership with subscription to S&T
$26	Student membership with subscription to S&T
$9	Student membership without subscription to S&T

COSMOLOGY FOR THE AMATEUR II: The first 10^{-24} seconds

By Ivan Policoff

The four basic forces of nature.

The interactions of everything in the universe are controlled by only four basic forces: the strong nuclear force, the electromagnetic force, the weak nuclear force, and gravity. These are listed, respectively, according to their relative strengths, from the strongest to the weakest.

It is now well accepted that protons and neutrons are held together in the nuclei of atoms by the strong force. This force is a short-range attractive force and is sufficiently strong to overcome the coulomb repulsion of protons. It is also fairly well established that protons, neutrons, and pions are made up of quarks, and that the strong force also binds these together.

The electromagnetic force is a long-range force that can be either positive or negative. It serves a very important function in terms of keeping the electrons of the atoms organized according to different discrete energy levels. The positive charge of the nucleus attracts the negatively charged electrons.

Overall, there is as much positive charge in the universe as there is negative charge; therefore, we do not generally see long range effects of the electromagnetic force. This force also governs the interaction of magnetic N and S poles. Overall these latter interactions tend to cancel out. The weak nuclear force is involved in certain radioactive decay reactions. For example, when a neutron decays into proton with the release of an electron and an antineutrino. This is also a short-range force.

Finally, the force of gravity affects the large-scale structure of the universe, because it is only an attractive force. Assuming the conventional Big Bang model gravity appears to be most significant in terms of determining the fate of our universe.

GUT and super GUT

In recent times the Cosmic Background Explorer (COBE) has established conclusively the existence of a 2.7 K background radiation that is generally accepted as strong evidence to support the Big Bang Theory. According to this theory, the universe was extremely hot in the beginning.

Over a period of about 15 to 16 billion years it has cooled to its present temperature. The concept of temperature is closely related to energy. This is easy to understand when we think of particles, because the kinetic energy of motion of particles is a manifestation of the temperature. In a hot gas, for example, the individual atoms or molecules are moving faster than in a cooler gas.

The same thing applies to photons. The more energetic the photons, the greater their temperature. The following formula expresses the relationship between the energy (E) of a photon and its temperature.

$$E = kT$$

E is the energy in electron volts, T is the temperature in Kelvin's, and k is Boltzmann's constant. This constant has the following value:

$$k = 8.6 \times 10^{-5} \text{ eV/K}$$

One electron volt (1 eV) of energy is the energy the electron acquires when accelerated across a potential difference of one volt.

The graph shown below shows how the temperature possibly decreased with the passage of time as the universe expanded.

Along the vertical axis are shown temperatures and energy values in units of GeV, where 1 GeV = 10^{9} eV. This graph presupposes a linear decrease in temperature with time, which probably is not true during the inflationary epoch from 10^{-35} s to 10^{-24} s. More will be said about this epoch later.

Cosmologists believe that the higher the temperature is, the more similar the fundamental forces become. They also believe that at a temperature in excess of 10^{32} K (10^{19} GeV), all of these forces become unified into one super force.

At lower temperatures these forces "separate out". S. Glashow and H. Georgi worked out a Grand Unification Theory (GUT) in the 1970s which would unify the electromagnetic force, the weak nuclear force, and the strong nuclear force.

So far there is no experimental confirmation of GUT. However, recently the unification of the electromagnetic and the weak nuclear forces has been established. A super Grand Unification Theory (super GUT) which would unify all of the forces has not yet been worked out.

To verify directly these theories, it is necessary to cause high energy beams of particles to collide. Existing particle accelerators are capable of producing particle beams having an energy of 100 GeV, which are sufficient to verify the unifica

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tion of the electromagnetic and weak nuclear forces.

Verification of GUT and super GUT in the laboratory may never be possible because of the high energies that are required. Eventually astronomers and physicists may indirectly verify these theories, since shortly after the Big Bang the temperature of the universe must have been high enough to unify all of the forces.

Perhaps there is evidence still existing of these extreme conditions that can be used to support these theories.

The First 10^-43 seconds

The General Theory of Relativity applies the concepts of classical physics to our basic understanding of the universe at large; however, when we go backward in time very close to when the Big Bang presumably occurred, we find that relativity theory no longer applies.

It is possible to determine the critical time when relativity or any of our laws of physics are no longer valid. This time is called Planck's time and its value is approximately 10^-43 s; consequently, we completely lose our understanding of the concepts of space and time from 0 to 10^-43 s after the Big Bang.

It is believed that during this time interval all four of the fundamental forces were unified into one superforce.

From 10^-43 seconds to 10^-12 seconds

Referring to our graph of temperature versus time, we see that at 10^-43s the universe had cooled to a temperature of 10^32 K, which corresponds to a particle or photon energy of 10^19 GeV. To simulate this condition in the laboratory it would be necessary to cause particles to collide with this energy.

As stated before such an experiment is not feasible. At this time there was a sudden symmetry-breaking process, and gravity as one of the fundamental forces became separated from the unified superforce.

With the passage of time the temperature cooled. The time interval from 10^-35 s to 10^-24 s is particularly interesting because this is the inflationary epoch. A Stanford University professor, Allan Guth, first proposed that following the Big Bang there was a period of rapid expansion of the universe, whereby the universe expanded by a factor of 10^50. This resulted in material that originally was very close to us being very rapidly pushed to regions beyond our visible universe today.

It is appropriate at this time to explain the meaning of the term "visible universe." Astronomers know that the universe is expanding, and they also believe that the density of its matter and energy is decreasing with time. It has been possible to calculate that the Big Bang occurred about 20 billion years ago by determining the velocity of recession and distances of clusters of galaxies.

This is assuming a constant rate of expansion; however, due to the mutual attraction of all the matter in the universe, the expansion must be slowing down, This means that the actual age of our universe must be less than 20 billion years. Current estimates run from about 13 to 18 billion years.

You will recall that the speed of light is finite (300,000 km/s) and that the light year is defined as the distance that light travels in one year (9.46 x 10^12 km). This means that if the age of the universe is 20 billion years, we are not able to see more than 20 billion light years out into space.

This is true since, for anything farther than that, light would not have time to reach us yet. The universe could extend beyond 20 billion light years. In fact, it could be infinite.

Returning to the idea that there was a very rapid expansion of space shortly after the Big Bang, the question arises as to where the energy came from to accomplish this.

Cosmologists say that a vacuum is not what we ordinarily think of as complete emptiness, but rather that it is a mishmash of all kinds of virtual particles (see *Cosmology for the Amateur*, Gemini, April, 1992). It has been suggested that the repulsive force that caused a sudden expansion of space came from the universe changing from a false vacuum state to a real vacuum state.

This is another one of those strange concepts. Presumably the false vacuum would have a higher energy level than the real vacuum state, although it would look the same! We can assume that if virtual particles can exist in a vacuum, there is a certain amount of energy associated with them,

The concept of an inflationary epoch is a very convenient one, because it solves a couple of problems cosmologists

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Cosmology

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have been worrying about for some time. One of these problems has to do with the uniformity (isotropy) of the 2.7 K microwave background radiation.

If we compare the temperature on both sides of the observable universe, a distance of about 40 billion light years, we find that the temperature is the same. Why is this so?. Since the universe is no older than 20 billion years and light can only travel 20 billion light years in this time, how can the effect of the temperature at one side of the universe be translated to the other side of the universe in less than 20 billion years.

The very rapid expansion of the universe early in its history offers an explanation. Shortly after the Big Bang, points that were close together and which had the same temperature were suddenly pushed beyond the limit of our visible universe. This does not mean that matter traveled at speeds greater than the speed of light during the inflationary epoch.

Cosmologists make a distinction between the motion of one object relative to another, which according to the special theory of relativity cannot exceed the speed of light, and the expansion of space which in this case moved matter beyond the range of our visible universe.

The rapid expansion of the universe early in its history also solves another problem for cosmologists. The fate of our universe seems to be determined very critically right after the Big Bang

If the density of matter was too great in comparison to the velocity of expansion, the expansion would have stopped relatively soon after the Big Bang and have collapsed into a Big Crunch. On the other hand, if the density was too small, the universe would have expanded very rapidly to become very empty.

Because of the mutual gravitational attraction of all matter, the rate of expansion of the universe is slowing down, and there is a critical density for which the expansion stops when the universe becomes infinite. Observational evidence shows that the density of matter and energy in the universe is approximately equal to the critical value.

Also, calculations show that shortly after the big bang this density would have to be equal to the critical value to within 50 decimal places! Otherwise the deviations would grow, and the density today would not be nearly equal to the critical value.

This does not seem to be very probable. Assuming the "inflationary epoch" hypothesis helps to solve this problem. Cosmologists tell us that if the density of matter and energy are too large, space has a "positive curvature". Also, if this density is too small, space has a "negative curvature".

Furthermore, if this density equals the critical value, space is flat. It is conceivable that over the visible universe the universe is very flat, but due to the inflation, curvature of the universe exists outside the visible universe. It is difficult to understand how space can be curved!

This concept was first introduced by Albert Einstein with his General Theory of Relativity. According to this theory, wherever there is matter there is curvature of space; the greater the mass is, the greater is the curvature of space.

For example, the Sun is a massive object, and the space around it is curved. It is this curved space that determines how the planets move around the Sun. A more detailed explanation of this subject is given in most new introductory astronomy texts.

Referring to our graph of temperature versus time, we see that at 10^-35s the universe had cooled to a temperature of 10^27 K, which corresponds to a particle or photon energy of 10^14 GeV. At that time there was a second symmetry-breaking process; the strong nuclear force became separated from the weak and electromagnetic forces.

(TO BE CONTINUED)

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Vacant

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Minnesota Starwatch (U of M)	(612) 624-2001

Writers and Photographers Urgently Needed

Only a very few of the 180 or so MAS members--fewer than 5 percent--contribute to Gemini each edition..

If Gemini is to survive, more members must write or take astrophotos. The deadline for the next edition--the October issue--is Sept. 10. If you have an interest in any aspect of astronomy, please write an article or column about it. The editorial staff of Gemini will be happy to assist you with suggestions, or by editing your copy (which we do anyway).

The current issue is 10 pages, but could have been as large as 24 pages if more members had contributed. Thanks to those who did.

The members of other astronomical societies in the region are especially encouraged to send their articles to Gemini, P.O. Box 26522, St. Louis Park, MN 55426-0522.

If you have access to a computer, please send your article on either an IBM or Macintosh disk. MS Word and WordPerfect files are acceptable; otherwise, please convert your file to text format.

Texas Star Party

By Dave Tosteson

It is said all good things in life are worth waiting for. The eclipse in Hawaii one year ago this weekend was in that category, and the Texas Star Party of 1992 held at the Prude Ranch near Ft. Davis, Texas, certainly was.

You see, although this was my second TSP, the first, in '89, allowed me only a taste of what clear, dark skies could offer. In '89 my 'scope had only recently arrived and, in fact, could not be used properly after hauling it over 1,500 miles in a trailer. Now looking through other people's 20 and 25-inch 'scopes was great, but we had poor weather: murky skies and giant millipedes in our room that could not be killed.

1992 was another story. Monday through Thursday offered us four completely clear nights, with over 36 hours of viewing. Tuesday of that week was easily the driest, clearest night I have ever experienced, allowing me and over 600 other mesmerized amateurs to push our 'scopes to the limit.

Showpiece galaxies, such as M 51, riveted us for minutes. Visually impossible objects, like Palomar 5, an extremely low-surface-brightness, 15th magnitude globular, was seen as a disc with direct vision in a 15-inch 'scope. We only glimpsed it with averted vision in a 20-incher the night before.

A nearby group was buzzing with excitement around Ed Boutwell's 25-inch Obsession. I walked over only to have Stephen O'Meara show me his hand-drawn finder for QO957 + 561 A and B, the famous Double-Quasar in Ursa Major, a gravitationally-lensed 17th magnitude object first seen visually at TSP '91. (See *Sky and Telescope*, Oct., 1991, p. 433.) At the eyepiece, the Y-shaped asterism was easily visible, with the quasar a steady but faint pair of pinpoints! Wow!

I've viewed the Trifid Nebula dozens of times, but the view at TSP with a 9mm Nagler on my 18-inch Dobsonian took my breath away. I actually had to roust Tom Lindquist out of his tent to see it. The contrast was stunning, with multiple dark lanes and features, but for the first time, I appreciated its color. Half of it was a ruddy dark brownish-red, subtle, but unmistakable.

Tim Parsons lent me his O-III filter to use on the Omega Nebula, M17, and again photographs could not do the subtle dark features justice. The next day I bought that filter.

I would rattle on further about the sights in the heavens, but those were only half the entertainment. The 'scopes (over 200) were fascinating: 20-inch binoculars, 17½-inch binoculars, and 8-inch motorized, reclining binocular chair, solar 'scopes with H-Alpha filters...when was a man to sleep?

Then there were the talks, 22 of them. Most were fascinating, all were well done. There was certainly a feeling of being overwhelmed, if not being able to see and do everything. Most of all, there was the hospitality, both on the part of our hosts, the Prude Ranch, and the Southwest Region of the Astronomical League, and the participants. I believe I was turned down only once when requesting a view, and that gentleman was on a viewing program.

Computers, too, were in abundance. Next to me was Tom Arnold from Texas. He had a C-14 with a CCD, several monitors and software for immediate data reduction of the 18th and 19th magnitude galaxies they would capture in five minutes. I felt like an Edsel.

Emil Bananno from the Houston group has incorporated the Hubble Guide Star Catalog into a petite 46 megabyte program to instantly give up to 15th magnitude finder charts at the telescope on your laptop!

Ron Scheldrup from Opta-Data had his Starport computer atlas connected to a beautiful 15-inch Textron 'scope. In the course of five minutes, we took in Pluto, the supernova in NGC 5472, seven or eight random galaxies, and found both NGC 2997 in Antlia and Abell 1060, the galaxy cluster in southern Hydra. I had spent 15 minutes futility attempting to star-hop in these deep southern-horizon, star-empty regions and, with the touch of a few buttons, there they were.

My only regret is that I was spoiled. I've observed several times since returning, but I've got the bug now. This may have to become an annual trip and, let's see, there's the Okie-Tex in October, the Ultimate in November, winter in the Keys.

Astronomy in Review

By Patrick J. Thibault
Willmar Astronomy Club

Nuclear fusion in a protostar is different from nuclear fusion in a main sequence star. A stable, main-sequence star uses hydrogen (the most abundant element); however, the core temperature in the protostar is not hot enough to fuse hydrogen.

Yet, the protostar can fuse deuterium, which has a nucleus of one proton and one neutron. Deuterium is present in the inter-stellar medium; it occurs in about 2 out of 100,000 hydrogen nuclei.

Deuterium can fuse at a temperature of 1 million K., as compared to 10 million K. for hydrogen. Due in part to the contracting force of gravity, a temperature of 1 million K. can be attained in the core of the protostar.

The energy created by the fusion of deuterium cannot be radiated outward due to the opacity of the stellar matter; however, a convective process develops in which gas bubbles rise to the surface, and cool gas falls to the core. The cool gas carries deuterium which has accumulated on the surface of the protostar.

The convection process functions at specific masses. If the protostar exceeds two solar masses, it begins to use radiative transfer.

A thin shell of gas in the interior of the protostar begins to transfer heat through radiation. As a result, the sinking gas and rising gas are unable to penetrate this shell. This leads to an increase in deuterium consumption in the core. The deuterium on the surface is no longer brought to the core by convection, but it burns on the surface as the heat from the core ignites it.

The deuterium forms a shell around the core with compressed layers, and as the deuterium burns, hot bubbles rise up to the top layer and cool gas falls; a convection process forms on the shell.

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Astronomy in Review

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The deuterium burning leads to an increase in the size of the protostar. If the protostar is one solar mass, its radius will be five times that of the Sun. Of course, the size it attains is related to its mass, and in general, a protostar contain more mass than product it makes. So a mechanism is required to reduce the mass of the protostar in preparation for fusing hydrogen.

The current theory plausits the stellar wind as the mass reducing mechanism. The wind dissipates the dense core and blows the incoming gas back. This mechanism is not fully understood, but is based on observational data. Specifically, gas streams or molecules were detected moving away from infra-red source of radiation (protostars).

Once the dense core dissipates, the protostar is now visible, and is called a pre-main-sequence star. The pre-main-sequence star is highly luminous, like the protostar, and this is attributed to gravity, not nuclear fusion..

The high pressure in the core prevents collapsing , and the heat maintaining this temperature is radiated to the surface. This causes the star to shine brightly. Gradually, the star's luminosity will decrease, and it will become more compact. This process is related to convection stability.

The convection process operates over a wide temperature gradient. The energy radiated off quickly cools the surface, and the core temperature remains elevated due to the outer layers insulating it.

As the star ages, its convection process will stabilize, and the star will become compact, with the internal temperature rising. At some point, the temperature will rise to 10 million K., and hydrogen fusion can begin. The star has entered the main sequence.

In the final article, I'll discuss the various routes a star can take to the main sequence.

MAS Software Catalog

MAS software is available to members of the Society, who may download it from the Ceres BBS (612-884-7812) evenings after 6 p.m. and weekends, or may request it from Mike Kibat, the software coordinator (612-884-0039).

IBM Compatible Programs

RONCHI.ZIP	112,733	07-09-92	Draws a simulated Ronchi Test Pattern
MOONTOOL.ZIP	50,724	07-09-92	Displays information about the moon (Windows)
ACLOCK.ZIP	71,999	07-09-92	Astronomical clock (Windows)
DS3D.ZIP	1229,493	07-08-92	Comet/planet ephemeris, star charts
CSHOW.ZIP	196,191	07-08-92	Graphics viewer (.GIF and others)
STARRY.ZIP	704,157	06-28-92	Starry Nights - Planetarium Program
VIEW.ZIP	67,368	04-20-92	AstroView-Simple planetarium program CGA
TIMESET.EXES	145,746	04-20-92	Set PC internal clock to NIBT/Naval Observatory
STARVIEW.ZIP	315,186	04-20-92	V1.0.09 planetarium program
SOLAR.ZIP	281,417	04-20-92	Solar eclipse prediction program
SATSORT.ZIP	52,510	04-20-92	Sort utility for TRAKSAT file output
SACEXIBM.ZIP	96,923	04-20-92	Extract program for SAC 5.2 (text)
PKUNZIP.EXE	23,528	04-20-92	Required to extract .ZIP files
MRORBIT.ZIP	254,813	04-20-92	Satellite prediction program
MOON.ZIP	153,821	04-20-92	Display of lunar features, terminator
JUPE.ZIP	154,616	04-20-92	Facts and information about Jupiter
GEOCLOCK.ZIP	258,874	04-20-92	Geographic clock program
ECU.ZIP	540,558	04-20-92	Earth-Centered Universe - Windows
CS25P.ZIP	255,615	04-20-92	Database of stars w/i 25 parsecs of sun
CCD.ZIP	339,565	04-20-92	Control/display program for the SBIG ST4 CCD
ASTROEGA.ZIP	79,423	04-20-92	General purpose astronomy program (EGA)
AST.ZIP	48,245	04-20-92	Simple planetarium, ephemeris program (CGA)
TRAKSAT.ZIP	795,636	11-23-91	V2.75, Excellent Satellite Tracking Program
TONITE.ZIP	152,808	11-23-91	Good sun/moon rise/set calculator
WDS.ZIP	3200,842	05-07-91	Washington Double Star Catalog
SKYGLOBE.ZIP	304,426	05-07-91	Planetarium program
SACDBL.ZIP	4082,879	05-07-91	V2.1 of Saguaro Astronomy Club double star data
NGP.ZIP	1745,613	05-07-91	New General Program non-stellar objects database
ICE.ZIP	1178,709	05-07-91	Interactive Computerized Ephemeris (ICE)
ACE.ZIP	664,842	10-02-90	AstroSoft Computerized Ephemeris
NSLITO.ZIP	265,591	06-28-90	Planetarium program
SUNTI2.ZIP	75,322	04-19-90	Astronomical clocks
STARSC.ZIP	177,886	04-19-90	Planetarium program (CGA)
SACTXT.ZIP	2475,107	04-19-90	SAC 5.2 deep-sky data base (Text)
SAC.ZIP	3208,998	04-19-90	V5.2 of Saguaro Astro Club deep-sky data base.

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Software Catalog

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PLANETS.ZIP	149,652	04-19-90	Computes information related to solar system
NBSCOM.ZIP	56,107	04-19-90	Set PC internal clock to NIBT clock
EQTOHO.ZIP	6,134	04-19-90	R.A./Dec conversion to alt/az (Basic)
COMETVIW.ZIP	96,751	04-19-90	Determines best time/location for comet

Windows Programs

MOONTOOL.ZIP	50,724	07-09-92	Displays information about the moon (Windows)
ACLOCK.ZIP	71,999	07-09-92	Astronomical clock (Windows)

ECU.ZIP	540,558	04-20-92	Earth-Centered Universe - Windows

GIF Format Images

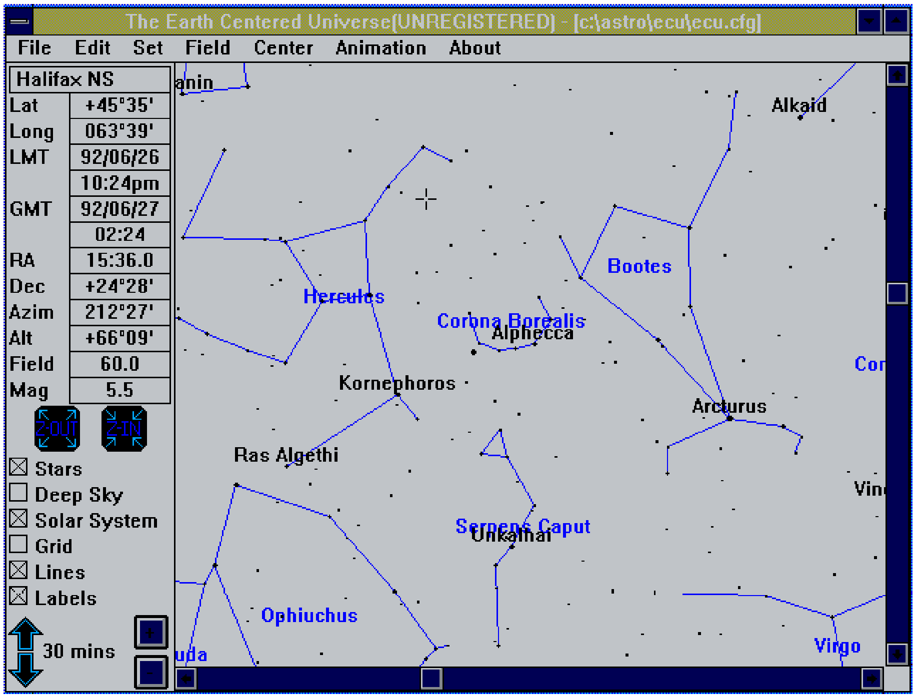
HST-4.GIF	235,708	07-09-92	HST image - possible black hole in M51
VENUS-1.GIF	16,912	07-08-92	Venus - Ultraviolet light
TRITON-1.GIF	69,688	07-08-92	Triton Image from Voyager (B&W)
TRAPEZ.GIF	1,950	07-08-92	Chart of Trapezium component stars
SATURN-1.GIF	41,472	07-08-92	Saturn - HST image (Beautiful!)
PHOBOS-5.GIF	18,432	07-08-92	Phobos
PHOBOS-4.GIF	17,408	07-08-92	Phobos
PHOBOS-3.GIF	13,312	07-08-92	Phobos
PHOBOS-2.GIF	11,264	07-08-92	Phobos
PHOBOS-1.GIF	17,408	07-08-92	Phobos
OCCULT88.GIF	8,200	07-08-92	Results of '88 occulation of 28 Sag
NEP-2.GIF	60,962	07-08-92	Neptune - Voyager image (Nice!)
NEP-1.GIF	170,005	07-08-92	Neptune - Raw Voyager image of rings
N1499.GIF	15,360	07-08-92	NGC 1499 (California Nebula)
MOON-2.GIF	57,943	07-08-92	Moon - CCD image of "sea" and crater
MOON-1.GIF	58,290	07-08-92	Moon - Dithered B&W image of full moon
M57.GIF	18,176	07-08-92	M57 (Ring Nebula) - B&W CCD image
M51-2.GIF	117,843	07-08-92	M51 (Whirlpool Galaxy) - B&W CCD (Nice!)
M51-1.GIF	13,718	07-08-92	M51 (Whirlpool Galaxy) - B&W CCD image
M101.GIF	37,376	07-08-92	M101 - False-color image
M1.GIF	10,673	07-08-92	M1 (Crab Nebula) - False color image
LMXRB.GIF	15,523	07-08-92	Description of low-mass xray binary star
JUPE-2.GIF	56,780	07-08-92	Jupiter - Voyager image (Beautiful!)
JUPE-1.GIF	36,096	07-08-92	Jupiter - B&W Voyager image (!)
JULY1991.GIF	7,777	07-08-92	Chart showing great eclipse of '91
HST-3.GIF	98,304	07-08-92	HST image - central region of M42
HST-2.GIF	50,368	07-08-92	Historic second image from HST
HST-1.GIF	34,827	07-08-92	Historic First Image from HST
APOLLO-2.GIF	36,074	07-08-92	Close-up of APOLLO-1.GIF
APOLLO-1.GIF	118,327	07-08-92	Apollo 10 w/Moon in Background (!)
9PUP.GIF	3,487	07-08-92	Position Chart for Double Star 9 Pup
85PEG.GIF	3,524	07-08-92	Position Chart for Double Star 85 Peg

Text-Based Computer Files

SAT0621.TXT	44,795	07-09-92	Satellite elements, NASA 2-line 6/21/92
DIR_LIST.TXT	2,979	07-09-92	Short listing of all files
DIR_FULL.TXT	24,236	07-09-92	Long listing of all files
SPACLINK.TXT	7,386	03-18-92	Overview of NASA's Space Link BBS
SCALESOL.TXT	1,807	03-18-92	Hands-on Demo of Solar System Size

Earth-Centered Universe (ECU)

ECU is one of the Windows programs currently available from MAS, either via the MnAC sub-menu of the Ceres bulletin board, or from Mike Kibat, the MAS software coordinator. The software is shareware from David J. Lane of Halifax, Nova Scotia, who should be commended for the features and utility of the program.



Note the several pull-down menus at the top. The Field menu allows the user to set the magnitude limit of the display, as well as the display of deep-sky objects by category, and the display of planets. It also allows toggling grid lines, constellation lines and a variety of other lines and points on and off. Another feature is a zoom in/zoom out.

The Center menu allows the user to center on a variety of objects, or on celestial coordinates, or on a point on the horizon. The complex Animation menu allows motion display in either right ascension, declination or in alt-azimuth. The animation feature incorporates a step control, forward or reverse animation and other features.

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