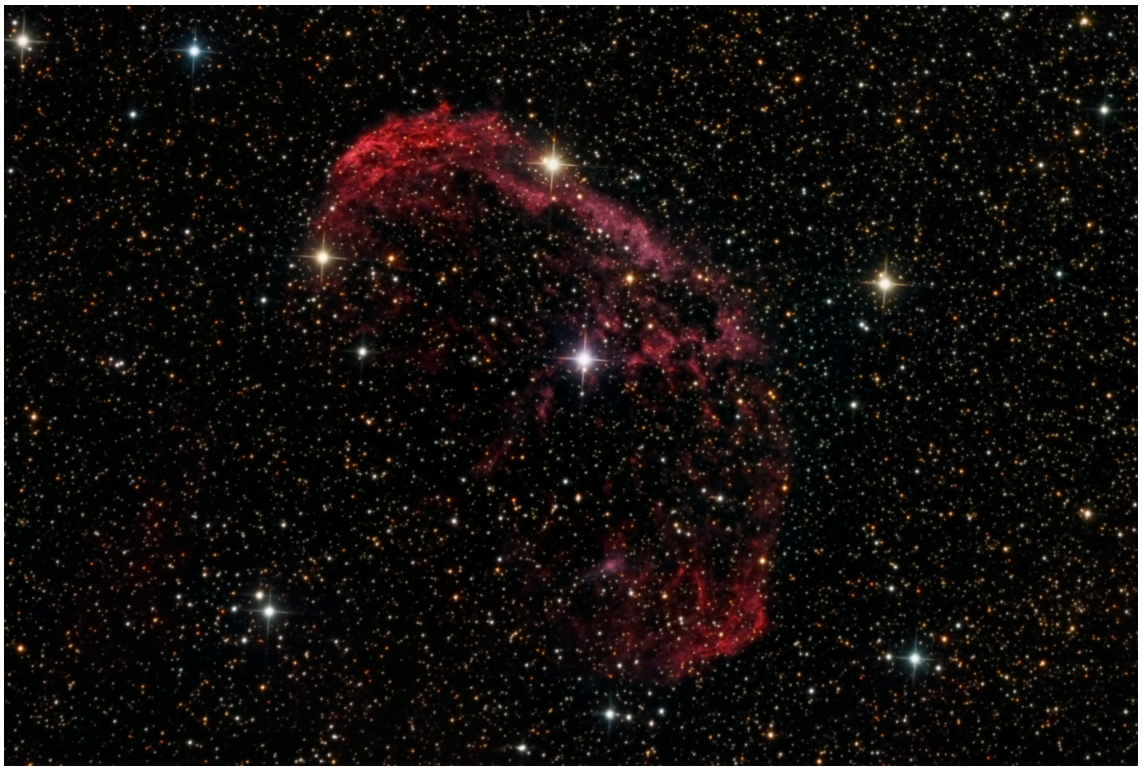
Sky WAA tch



Crescent Nebula

In late June, Olivier Prache took this image of the Crescent Nebula in Cygnus (NGC 6888) through a Hyperion 12.5" astrograph, using a Finger Lakes Instruments ML16803 camera--a 14-hour exposure (L: 33x10-min, B:15x10, G: 18x10, R: 18x10).

The Crescent is an emission nebula approximately 5000 light yrs. distant. The nebula's central star is a massive and extremely hot Wolf-Rayet star (25,000K+). It has been shedding its outer envelope providing material which collides with earlier ejecta to form the nebula.

In This Issue . . .

Events for August 2013

Upcoming Lectures

Lienhard Lecture Hall

There will be no lecture in August. Lectures will resume with the annual Member Presentations Night, where members will speak on topics of interest. Presentations Night is scheduled for September 6th. Those wishing to present should contact the WAA Speakers Coordinator.

New Members. . .

Kristina Newland - White Plains
Enzo Marino - Harrison

Renewing Members. . .

Jose E. Castillo - Pelham Manor
Donna Cincotta - Yonkers
Jon Gumowitz - White Plains
Glen & Patricia Lalli - White Plains
Steve Petersen - Briarcliff Manor
Sushil Khanna - Katonah
Barry Feinberg - Croton on Hudson

Starway to Heaven

Saturday August 3rd, Dusk
Meadow Picnic Area,
Ward Pound Ridge Reservation,
Cross River, NY

This is our scheduled Starway to Heaven observing date for August, weather permitting. Free and open to the public. The scheduled rain/cloud date is August 10th. Participants and guests should read and abide by our General Observing Guidelines and Disclaimer.

Members Classified

As a service to members, the WAA newsletter will publish advertisements for equipment sales and other astronomy-related purposes. Ads will only be accepted from WAA members and must relate to amateur astronomy. Please keep to 100 words, include contact info and provide by the 20th of the month for inclusion in the next issue. The newsletter is subject to space limits; so ads may be held to subsequent issues. The WAA may refuse an ad at its sole discretion. In particular, price information will not be accepted. Members and parties use this classified service at their own risk. The Westchester Amateur Astronomers (WAA) and its officers accept no responsibility for the contents of any ad or for any related transaction.

Send classified ad requests to:
waa-newsletter@westchesterastronomers.org.

Call: 1-877-456-5778 (toll free) for announcements, weather cancellations, or questions. Also, don't forget to periodically visit the WAA website.

John Paladini taking solar images at the WAA Picnic
(Larry Faltz)

Solar viewing at the WAA Picnic
(Tom Boustead)

Almanac

For August 2013 by Bob Kelly

Aug 6 Aug 14 Aug 21 Aug 28

My family loves the Bronx Zoo, and the open habitats are wonderful. But my Dad points out that the open habitats seem to provide the animals with better places to hide just out of sight of their visitors. So it is with our bright planets this month; you know they're there, but they seem hard to find.

Who needs 3D glasses? Saturn, even with one eye (like that Minion in the movies) is still magnificently 3D in a telescope. Saturn is getting lower in the southwestern sky after sunset. Perhaps Saturn heard that Venus has a good hiding place, in plain sight, bright as all get out, low in the west. Venus usually gets some distance from the Sun and the horizon on each side trip from in front of and behind the Sun. But not this time – Venus extends herself from 30 to 40 degrees from the Sun over next four months, but doesn't get more than 17 degrees above the horizon after sunset, not getting out of the evening twilight at our latitude. Daytime observers will have some distance between Venus and the Sun, but with Venus being lower in celestial latitude and lower on the ecliptic, it's harder to block the Sun to spy the evening star in the afternoon.

While Venus and Saturn wonder where everybody went, Jupiter, Mars and Mercury are playing in the dawn sky. Catch all three while you can. Jupiter stands out, rising almost one-third of the way above the eastern horizon at dawn by the end of the month. Mars tags along, but can't keep up with the king. Mars struggles to get out of the twilight, lagging five degrees lower than Jupiter at the start of August and straggling 18 degrees behind Jupiter by the end of the month. Jupiter is the standout telescopically, as well, appearing ten times larger than Mars.

Mercury completes the lovely scene for those rising before the 6 to 6:30am sunrise in August, lower, but brighter than Mars and diving for cover. The innermost planet brightens like a falling firework as it falls fast back into the solar glare by mid-month.The Moon starts out the month high in the morning sky, as it shrinks to a crescent. At mid-month, the Moon will ride low in our skies, drowning the Teapot and Scorpion's star clouds. So early and late in the month is the best time to see the subtle and wonderful deep sky objects out there in the direction of the center of the Milky Way.

The favorite summer meteor shower of sleep-away camps, the Perseids, peak during daylight on the 12th, making the mornings of the 12th or 13th good times for viewing. Typically, the mornings are better for meteors as the Earth goes 'head-first' into the swarm after midnight. However, the orbit of the Perseids' parent comet Swift-Tuttle is highly inclined to the Earth's orbit, and the location they appear to come from in the sky rises well before midnight, so lucky watchers may see a few bright meteors anytime on those nights. If you go out, you can 'listen' for the meteors on your FM radio. A car radio can do as well as a portable radio. Tune the radio to an empty frequency, and listen for the sound of a distant radio station's signal to fade in and out as a meteor ionizes the atmosphere and refracts the signal from over the horizon. If you haven't heard this before, listen at http://spaceweather.com/glossary/nasameteorradar.html .

Later in August, the possibly great-comet-to-be ISON may be spied by intrepid faint object observers as ISON moves out of the solar glare. Some interesting websites are giving their take on ISON's prospects. NASA's http://www.isoncampaign.org/ is a good place to start. For most of us, the fun will start in October, as ISON passes close to Mars and Regulus in the morning sky.

If you are feeling restless, Neptune is up all night this month, as we make our closest approach for the year on the 26th. Some of us remember staying up for "Neptune All Night" on PBS when Voyager 2 sent its photos back from Neptune and we watched them come in line-by-line live. Now Neptune can return the favor!

Uranus comes up later in the evening. Both are readily seen to be different from the background stars, although a finder chart is needed to find them.

Other solar system objects are harder to distinguish. Asteroid #3, Juno, comes to opposition on the 6th. During our closest approach, Juno brightens to magnitude +8.9. Finder chart are definitely needed since Juno looks like the adjacent stars. So pay a second or third visit to see if it moves relative to the background stars. Asteroids Vesta and Ceres (Numbers 4 and 1) spend at least part of August in the view of the solar satellite SOHO's C3 camera. Check a star plotting program to tell which dot is an asteroid. And watch for the beautiful billowing coronal mass ejections from the Sun.

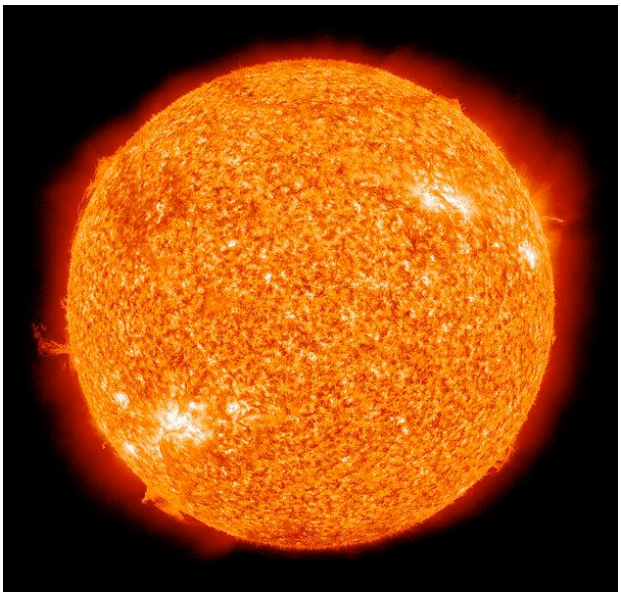
The International Space Station is visible in the mornings early this month and the evenings starting August 3rd.

The Moon is close to Jupiter on the 3rd, 4th and 31st, Mars on the 4th, Mercury on the 5th and Venus on the 9th. The Moon gets even closer to some stars – Spica on the 12th, and a 3.5 magnitude star pops out from behind the moon around 4:20am on August 1st. Look at the 1 o'clock position on the dark part of the Moon's limb. Saturn gets the Moon's attention on the 12th and the 13th.

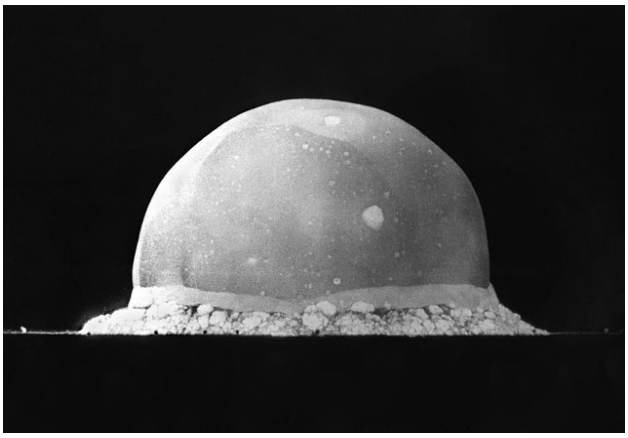
Articles and Photos

Harnessing the Power of the Stars

Larry Faltz



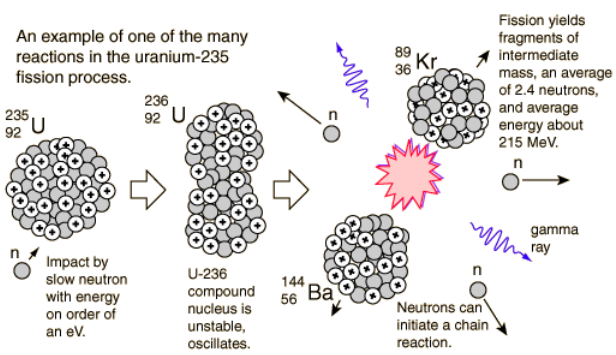
Way back in junior high school, around 1960, I was thought to be a promising science student and seemed way ahead of my classmates. But, as the early English poet George Chapman (1559-1634) wrote, "Let pride go afore, shame will follow after." We were studying the atom and radioactivity, and on the final exam, on which I was expected by the teacher, my classmates and myself to score 100%, was the question "Name a natural fusion reactor." Now, I really knew this stuff cold, and I went in to the exam dripping with confidence. I raced through the test up to that point, but suddenly I drew a complete blank. "Natural fusion reactor? Where? Where?" My brain imagined a map of the Earth and as I flew over it I came up with absolutely nothing. I must have put down an answer (those were the days before multiple choice questions, so there was merely a blank line to accept the answer and nothing to jog the memory) but I knew I was going to get it wrong. I had simply been earthbound and forgotten the sun. My final score of 99% was considered a dreadful failure and met with derision. The teacher couldn't resist pointing out my utter idiocy in public. Even 53 years later, I think of that stupid omission and cringe with humiliation. "There is not a fiercer hell than the failure in a great object." (John Keats) Only later, studying the Iliad and Greek plays in college, did I learn about hubris, the price one pays for challenging the gods for the sin of excessive pride.



Trinity, 16 milliseconds after detonation.

The Atomic Age had dawned not that many years before my fateful gaffe. Generally, its beginning is

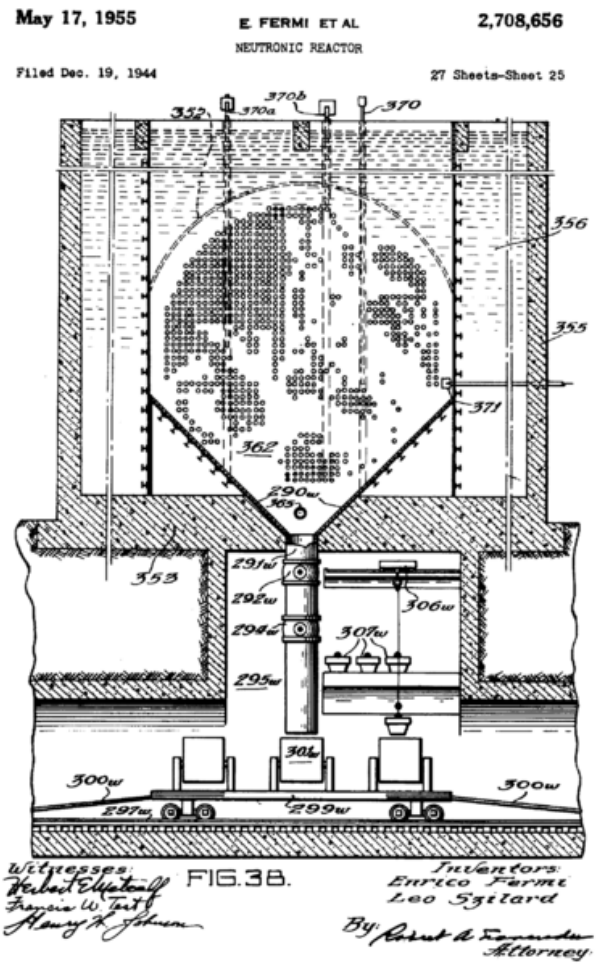
dated to one of two events: the first self-sustaining chain reaction under Chicago's Stagg Field on December 1, 1942 by a team led by Enrico Fermi, or, more dramatically, the Trinity plutonium bomb test on July 17, 1945 in New Mexico, the successful product of the Manhattan Project, led by J. Robert Oppenheimer. Academic purists could go as far back as the discovery of radioactivity in 1896 by Henri Becquerel, or cite any of the many intervening contributors: Thomson, Rutherford, Einstein or the Curies among others. A seminal intellectual breakthrough was made by Leo Szilard, physicist, Hungarian refugee, conceiver of technology (electron microscope, linear accelerator and cyclotron, although they were built by others), science fiction writer (The Voice of the Dolphins) and sometime President of the University of Chicago, who recalled the exact moment that he imagined the nuclear fission chain reaction. It was on December 12, 1933 while he was waiting to cross the street at a stoplight on Russell Square in London's Bloomsbury neighborhood, near the British Museum. The neutron had just been discovered, by Chadwick in 1932, and several physicists had realized that its absence of electric charge might permit it to slip past the electron barrier surrounding an atom and alter the nucleus. If the products of the reaction had slightly less mass than the reactants, an enormous amount of energy would



Nuclear fission

be liberated, based on Einstein's famous $E=mc^2$. Szilard's realization, as the light turned green and he stepped off the curb, was that if a nucleus could be found that absorbed one neutron but emitted two, "in certain circumstances," he later wrote, "it might be possible to set up a nuclear chain reaction, liberate energy on an industrial scale, and construct atomic bombs." Szilard was an enterprising individual. Even before knowing whether there were any two-neutron-emitting nuclei, he filed a patent for a nuclear reactor the following year, and for secrecy reasons he assigned it to the British Admiralty. He and Enrico Fermi patented the nuclear reactor, as we know it today, in 1944 (US Patent 2708656).

The real import of Szilard's enlightened idea had to await the actual discovery of fission itself. That occurred in 1938 when German scientists Lise Meitner, Otto Hahn and Otto Frish discovered that uranium sometimes decayed by fission. Although U^{238}, the most common isotope, can undergo fission, it can't sustain a chain reaction because it scatters too many of the neutrons. Isotope U^{235}, about 0.7% of natural uranium, can sustain; so to make weapons-grade uranium the fraction of U^{235} has to be substantially increased, a process called "enrichment". Fermi discovered neutron multiplication in uranium in 1939, prompting the famous letter from Albert Einstein (co-written by Szilard, Edward Teller and Eugene Wigner but signed by Einstein to give it

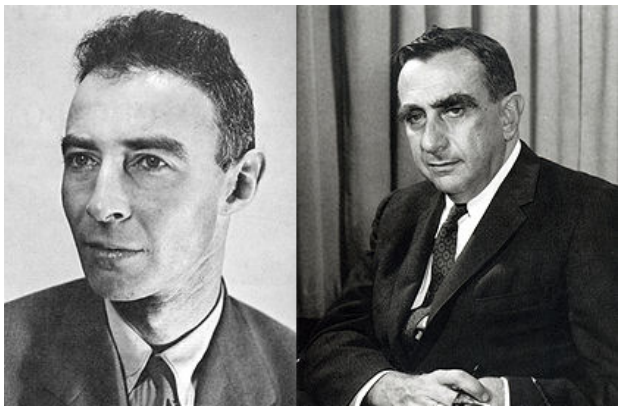


A drawing from the Fermi-Szilard nuclear reactor patent application.

gravitas) to President Roosevelt on August 2, 1939, warning of the possible development of the atomic bomb and the need to beat Germany to the punch.

The production of the atomic bomb by scientists and engineers of the Manhattan Project is the subject of Richard Rhodes spectacular history *The Making of The Atomic Bomb* (1986), winner of the Pulitzer Prize, the National Book Award, and the National Book Critics Circle Award. Everything you need to know is in this masterful work, including the science, the history, the personalities and the incredible tension leading up to the Trinity test in the Arizona desert and the Hiroshima explosion.

One of the sub-themes in the book is the monomaniacal drive of physicist Edward Teller to develop the "Super", a fusion bomb, a veritable sun on Earth, and his growing conflict about it with Manhattan Project director J. Robert Oppenheimer. Teller conceived of this device even before the fission bombs had been made or tested. He saw the potential for greater energy release from fusion and he was concerned in particular that the Soviets would be on our heels with their own atomic weapons, which proved to be the case (mainly as a result of espionage in the US program). After developing (with Stanislaw Ulam) and eventually testing a thermonuclear device, Teller went on to crush Oppenheimer, exposing his early communist associations (they were very limited in their object—it seems he did it primarily to meet women). Oppenheimer's security clearance was pulled, easy to do during the time when the United States was in the throes of the post-nuclear "Red Scare" led by FBI Director J. Edgar Hoover, Senator Joe McCarthy and others.



J. Robert Oppenheimer (L) and Edward Teller (R)

There's no "natural" fission reactor because there isn't a supply of fissile elements in sufficient concentration anywhere on Earth, or elsewhere, we imagine. Fissionable elements are heavier than iron, the most stable nucleus, and so to make them you need a net addition of energy. They can only be made in supernova explosions, so they tend to get scattered right after they are synthesized. Furthermore, if there were such reactors, they would instantly reach criticality and explode. It takes rather clever engineering to modify the neutron flux so that the chain reaction in a nuclear power plant is neither too fast nor too slow. As power sources go, fission reactors were easy to construct, and would have been a perfect solution to human energy needs for millennia were it not for the problem of nuclear waste and the more recent concern about potential diversion of nuclear material for terrorism.

Nuclear fusion is essentially the inverse of fission. The nuclei of two light elements are brought together to make a new, heavier element, releasing energy, some of which can be used to get more nuclei to fuse in a chain reaction. Robert Atkinson and Fritz Houtermans accurately measured the masses of light elements and predicted that enormous amounts of energy could be released if they could be made to fuse, because the mass of the products was less than the mass of the reactants, the difference being energy. Mark Oliphant, in 1933, was able to make tritium (hydrogen-3) and helium-3 by accelerating deuterium (hydrogen-2) at various targets. He detected excess energy production in these reactions, and he was the first to suggest that the stars were powered by fusion. Hans Bethe worked out the exact stellar fusion pathways over the next few years.

The major force involved in either fission or fusion is the strong nuclear force. A uranium nucleus needs an input of about 8 million electron volts (MeV) to overcome the strong force that holds the nucleus together. This is supplied by a neutron; the products are a barium nucleus, a krypton nucleus, two neutrons and 200 MeV of energy in the form of gamma ray photons. Chemical energy produces just one or two eV (not MeV) per reaction, 200 million times less than fusion.

In fusion, the object is to get the nuclei close enough together and moving fast enough for the strong force to take over and bind them into a new nucleus. The positively charged nuclei repel each other at distances greater than the range of the strong force, through the electrostatic force, also known as the Coulomb force. The only way to get them together is to pack a lot of them together very closely and heat the heck out of them, to provide kinetic energy to the atoms. Once the temperature is high enough, the atoms ionize and a plasma is created: electrons and nuclei are dissociated. The loss of the shielding electrons makes it easier for

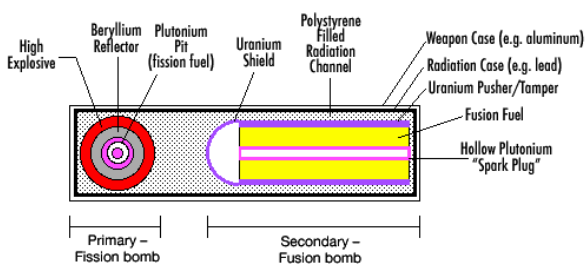
the nuclei to interact with each other, but they still need to be moving fast enough to overcome the Coulomb force. The temperatures needed are in the millions of degrees.

The sun can do this easily. Temperatures in its center, where fusion occurs, are estimated to be 17-20 million degrees Kelvin, and the density is at least 150 gm/cm^{-3}. The main reaction in the sun involves the fusion of 4 protons to form alpha particles (helium-4 nuclei consisting of 2 protons and 2 neutrons). The sun uses about 6.2×10^{11} kg of hydrogen per second, resulting in the release of the equivalent of 9.192×10^{10} megatons of TNT. The reaction, which has several intermediate steps, is:

$$4\ H^1 \rightarrow He^4 + 2\ e^+ \text{ (positrons)} + 2\ \nu \text{ (neutrinos)} + \gamma \text{ ray photon.}$$

The energy output is about 25 MeV per cycle.

Needless to say, it's hard to get temperatures and pressures this high on Earth. In Teller and Ulam's thermonuclear bomb, they were achieved by making a double-atomic bomb.

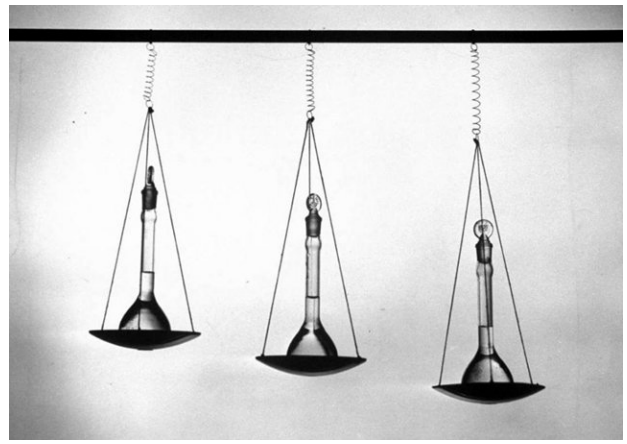


The Teller-Ulam thermonuclear bomb

Basically, a primary fission explosion creates high-intensity radiation which vaporizes material surrounding a cylinder of fusion fuel (a mixture of deuterium and tritium in the original, lithium deuteride in contemporary thermonuclear weapons), compressing it. Then a second atomic explosion inside the cylinder creates outward pressure and heat. The D-T mixture is compressed between the 2 explosions, achieving ignition temperature and pressure (in modern bombs, a pressure of 64 billion atmospheres is reached), initiating fusion. All if this happens in a matter of milliseconds. The first fusion bomb was the Ivy-Mike test on November 1, 1952. It yielded 12 megatons, creating a fireball over 3 miles wide and vaporizing the island of Elugelab. Ivy Mike weighed 62 tons and was the size of a small factory, but a model of a contemporary thermonuclear bomb I saw at the Bradbury Museum at Los Alamos a few years ago was about 4 feet tall and looked like a giant suppository.

Deuterium and tritium are used, rather than regular hydrogen, because they need less energy than single protons to overcome the electrostatic force. Fusion results in about 17.5 MeV for the deuterium and tritium reaction, which is:

$$H^2 + H^3 \rightarrow He^4 + n \text{ (neutron)} + \gamma \text{ ray photon.}$$



Equal volumes of water made from H1, H2 and H3 show the weight differences (Life Magazine, 1950)

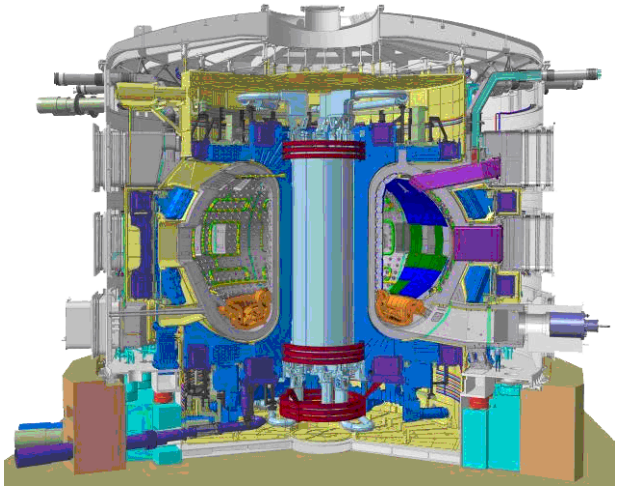
Deuterium is plentiful (one atom out of every 6,420 in water, but think of how much water there is!). It's easy to separate from hydrogen (because the mass differences are large, as compared to the difficult process of separating U^{235} from U^{238}) and it's is stable (in fact, all the deuterium the universe was made in the nucleosynthesis era a few seconds after the Big Bang, so it's all 13.8 billion years old). Tritium is radioactive, with a half life of 12.32 years. It doesn't occur in nature (atoms made during Big Bang nucleosynthesis decayed long ago) but it can be made fairly easily in nuclear reactors.

It was only 6 years from the Trinity A-bomb test to the first electricity-generating nuclear fission power plant, in 1951 in Idaho, and the first plant connected to an electricity grid, in 1954 in Obninsk, USSR, but even then there was hope that the cleaner fusion process would be harnessed for power generation. It would be cheaper too, since its fuel source was essentially inexhaustible. A design for a fusion power plant was patented in 1946. Yet almost three-quarters of a century later we still have not achieved sustained, controlled fusion.

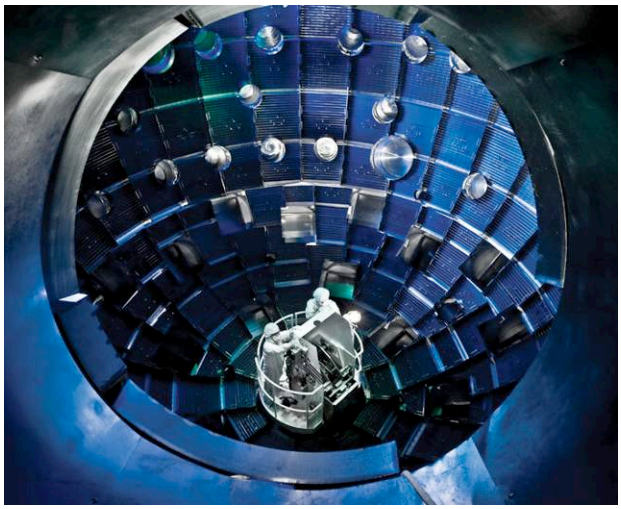
The history of fusion power, or lack of it, is detailed in Charles Seife's excellent 2008 book, *Sun in a Bottle*, which I picked up while wandering in a used book store on Fillmore Street on a trip to San Francisco in

April. Seife, a former reporter for the magazine *Science*, explains the history of fusion from the scientific, military and industrial perspectives. He describes the two major technologies that are hoped to compress fusion fuel to ignition conditions: magnetic confinement and laser confinement. Both have so far failed because of the inherent properties of heated, compressed hydrogen plasma. The interacting magnetic and thermal currents in a macroscopic amount of plasma make it unstable and impossible to control. Think of the roiling surface of the sun and you'll have some idea of what would be going on inside a fusion reactor. Another problem is that the large flux of neutrons produced in the D-T reaction would damage the materials that the reactor was made from.

Seife provides details of the development and construction of magnetic and laser fusion experiments, each of which was heralded with claims of unlimited power just around the corner, and none of which have succeeding in producing more power than it takes to ignite the tiny amounts of fuel that can be confined. An international collaboration, the International Thermonuclear Experimental Reactor (ITER), is building a magnetic confinement reactor using the "tokamak" design (a word derived from Russian for "toroidal chamber with axial magnetic field"). It is under construction in France. It expects to achieve temperatures of 150 million degrees Kelvin, 10 times that of the solar core. At these temperatures the D-T reaction is maximally efficient. ITER, still only a research facility, is hoped to achieve "first plasma" in 2020.



Drawing of the ITER magnetic confinement container



Target area of the NIF

The National Ignition Facility at Livermore Laboratories in California is the largest laser confinement fusion reactor. If you want to see some of it in action, see the new movie *Star Trek: Into Darkness*. Some of the scenes were shot there. It's an immense and complicated device. The NIF focuses extremely short-duration laser pulses (ranging between 100 trillionths and 25 billionths of a second) from 192 lasers, whose beams are amplified to 20,000 joules of energy, on a BB-pellet sized ampoule of D-T fuel. The density of neutrons during the tens of picoseconds the NIF target undergoes ignition is expected to be 10^{33} per cubic centimeter. Like ITER, NIF is a research facility, not a power plant.

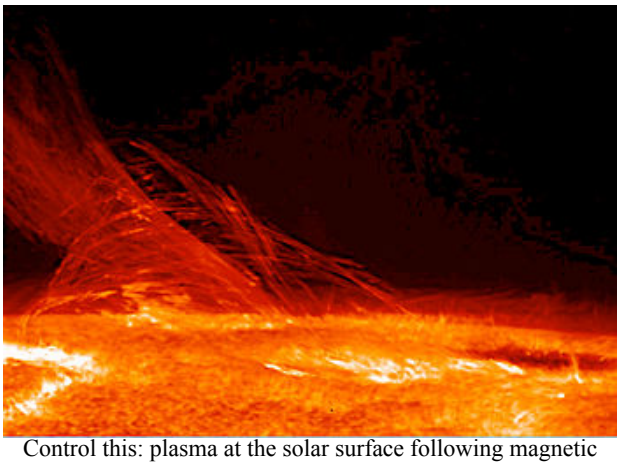
Seife provides great detail about the "cold fusion" debacle. In 1989, two well-known electrochemists, Stanley Pons and Martin Fleischmann, announced they had produced excess energy at room temperature in heavy water (D_2O) using a palladium catalyst. Scaled up, this would have been the greatest technological breakthrough in human history. Ultimately it was debunked and its originators humiliated and scientifically exiled. Another false lead was "bubble fusion", announced in 2002 by Rusi Taleyarkhan and collaborators from Purdue University. This technique claimed to compress fusable fuel inside rapidly collapsing liquid bubbles by a process known as "acoustic cavitation." This too went nowhere, and allegations of academic fraud resulted in Taleyarkhan being stripped of his professorship.

Seife is a wonderful writer. His prose is concise and the exposition of the science and technology is clear. He was on the scene for the bubble fusion debacle and

even had access to the principals prior to public release of information. He tells a detailed and ultimately frustrating story about fusion. He concludes that fusion power, in spite of the hope and promises of the last 70 years, is not likely to be achieved for decades, if ever.

We have to marvel at stars. They produce their power seemingly without effort. Balancing the gravity from the mass of their hydrogen fuel with the energy it produces from fusion, they emit enormous amounts of power for millions or even billions of years. The sun, only half way through its life, uses 4.26 million metric tons of hydrogen fuel every second. It's been doing it for 5 billion years and will do it for another 5 billion. Most stars are less luminous than the sun (perhaps 85% are class K or M) and have an even longer life; their lower luminosity means they consume less fuel per second.

So far, we've only been able to harness the power of fusion through inefficient chemical or physical means. Photosynthesis converts solar radiation into chemical energy, which is transformed via the food chain into muscle power. Then man discovered fire, combusting the chemical products of photosynthesis: wood, then coal, then oil and natural gas. We can transform solar energy directly into electricity by building solar panels, through the photovoltaic effect, or through wind power (since wind is ultimately a product of the sun-influenced atmosphere). If we could channel fusion directly, we'd eliminate pollution and have a truly unlimited source of power, which will have an untold beneficial impact on humanity (unless we do something really stupid…I'm thinking of the Krell in *Forbidden Planet*). At least fusion reactors should be safe: the worst thing likely to happen is that the reaction fizzes out and the power goes to zero. There's no "China Syndrome" scenario, no fusion "dirty bombs" and no radioactive waste, although we do have to worry about those pesky neutrons. Let's hope.



Control this: plasma at the solar surface following magnetic force lines (Hinode Solar Optical Telescope)

Part of the crowd at the WAA Picnic

(Larry Faltz).

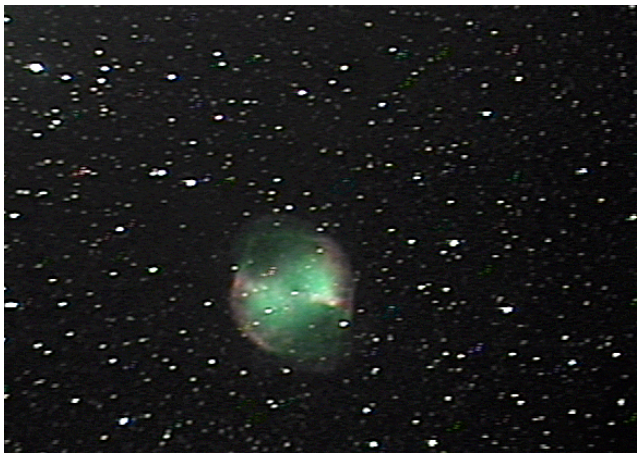
Starway to Heaven Star Party, July 6th

Larry Faltz

Our regular July star party took place on a hot and humid evening, but the forecast for possible thunderstorms followed by high clouds was blissfully wrong and the clear, if not optimally transparent, sky made the sticky weather tolerable. Many of the attendees found their optics fogging up as soon as they were removed from air-conditioned cars, but either tincture of time or the application of a little hot air (from dew heater strips or the 12-volt mini-hair dryer I'm never without) cleared things up. The temperature was in the very high 80's at dusk and never dropped much below the high 70's by the time we left after midnight, and the humidity was…well, we were *schvitzing* most of the evening.

The event was well-attended with a diverse line-up of scopes and interesting people. Elyse Faltz, red LED-illuminated pen in hand, again made rounds just as it got dark to take a census of the participants and their equipment. A latecomer or two might not have made the list, for which we apologize. Tim Holden, who recently joined WAA and was a newcomer to the star party, brought his fine Explore Scientific 4" refractor. Eva and Erik Andersen brought their Televue Petzval NP101 wide-field refractor on its computerized "push-to" altazimuth mount. Long-time club members in attendance were Frank Jones and Dave Butler, each with a Meade LX-90 Schmidt-Cassegrain, Doug Towers with a Meade 90 mm refractor and Harry Butcher with his Celestron Nexstar 5 SCT. Gary Miller again set up his impressive 12½" Obsession Dobsonian truss tube reflector on a tracking platform, and one of the highlights of the evening was a view of the wispy tendrils of the Veil Nebula through this superb instrument. Everett Dickson brought an Orion Starblast 4.5" reflector on a small equatorial mount. A newcomer all the way from St. Albans, Queens, was Gercinda Jones, who brought an 8" Celestron Schmidt-Cassegrain on a Celestron Advanced VX equatorial mount. She was somewhat unfamiliar with the scope, which she had gotten a couple of years ago but hadn't really assembled or used. These go-to equatorial mounts can be rather complicated at first for the non-gearhead. Several of us, particularly Dave Butler, helped her with the basics of mount assembly, balancing and initialization. Gercinda was wonderfully enthusiastic and I hope she makes the rather epic drive from southwestern Queens to join us at future events.

Newcomer Tim Dugan brought binoculars, which, when properly mounted to avoid arm fatigue, always provide nice vistas of the star fields of the summer Milky Way. Finally, the Mallincam video astronomy contingent of Al Ferrari (Meade LX-200 at f/5 set up on a wedge, Mallincam Xtreme) and me (Celestron CPC800 at f/3.8 set up alt-azimuth, Mallincam Color Hyper Plus) traded configuration tips throughout the evening. Elyse was rather tired at the June party walking around the telescope all night to look at my scope-mounted monitor as we slewed to different objects, so this time I set up wireless video transmission to a second monitor, and she got to sit for some of the observing.



M27 (Dumbell Nebula) in Vulpecula, stack of 4 28-sec Mallincam images, IDAS P2 filter, 8" Celestron SCT at f/3.8, 7/6/13. (LF)

A few people observed Venus low in the west just after sunset, but like at the June star party Saturn was a prime object for the early part of the night. Locutis, my 8" SCT, was in good shape throughout the evening. I was able to get my alignment spot-on after acquiring Saturn and several stars (Vega, then Arcturus, then Dubhe) and making appropriate corrections, and subsequent go-to's were extremely accurate. I use a Bahtinov mask to focus, and I recommend this aide to everyone who does any kind of imaging.

The Mallincam always shows M51 and M27 as particularly spectacular objects, and I kept returning to them as new folks came over to see what all the wires and batteries were about. With accurate alignment on a go-to scope, you can jump all over the sky in a matter of seconds, and that means you can show the best stuff to anyone who wanders by.

As soon as it got dark, I went for Comet C/2011 L4 (Panstarrs), slowly fading as it flies away from Earth. Now an 11th magnitude object in Draco 2.4 astronomical units from Earth, it appeared on my monitor as a fat star with a faint, tiny but broad tail. As the evening progressed, I looked at objects large and small. The blue center and red edges of the Ring Nebula (M57) were quite bright with just 7 seconds exposure, the Dumbbell (M27) was impressively big and green. I showed several people the Owl (M97) as a comparison planetary nebula to M57 and M27. I observed a bevy of globular clusters one after another: M13 (Hercules), of course, but also M92 (Hercules), M19 (Ophiuchus) and M4 (Scorpius) and M80 (Scorpius), the last three rather low in the south but still quite striking. I found some faint (mag 9.9-10.3) galaxies in Draco, NGC 6503, 5866 and 5907, and the small mag 11.9 galaxy NGC 6181 in Hercules. The galaxy cluster Hickson 68, consisting of a gaggle of small mag 11-13 galaxies in Canes Venatici looked like a sprinkle of tiny fuzzballs on my monitor. The brightest member of this group, NGC 5350, is 110 million light-years distant.

The southern Milky Way is a prime target for summer evenings, and the glorious line of emission nebulae stretching from Serpens to Sagittarius with their dust lanes and star-forming regions should never be missed on a clear summer night. The Mallincam shows off M16, the Eagle Nebula with its famous "Pillars of Creation", the red hydrogen gas outlining its dusty star nurseries. Al Ferrari's longer-duration capture was wonderfully detailed, with rich color and pinpoint stars made possible by the tracking accuracy of his equatorial mounting and the longer-exposure capability of the Mallincam Xtreme. M17 (Omega or Swan Nebula), M8 (Lagoon Nebula) and M20 (Trifid Nebula) were also glorious, richly colored targets. I hooked up my netbook to capture M16 (and earlier M27), but by the time I was finished with the southern objects, it was almost 12:15 am and high clouds finally started moving in, so we packed up, not a slow process when you're using 4 power supplies and a gaggle of electronic devices.

M16 (Eagle Nebula) in Serpens. The "Pillars of Creation" are prominent in the center of the nebula. 8" Celestron SCT operating at f/3.8. Stack of 6 28 second Mallincam frames, IDAS P2 filter, 7/6/13 (LF)

Inventing Astrophotography: Capturing Light Over Time

By Dr. Ethan Siegel

We know that it's a vast Universe out there, with our Milky Way representing just one drop in a cosmic ocean filled with hundreds of billions of galaxies. Yet if you've ever looked through a telescope with your own eyes, unless that telescope was many feet in diameter, you've probably never seen a galaxy's spiral structure for yourself. In fact, the very closest large galaxy to us—Andromeda, M31—wasn't discovered to be a spiral until 1888, despite being clearly visible to the naked eye! This crucial discovery wasn't made at one of the world's great observatories, with a world-class telescope, or even by a professional astronomer; it was made by a humble amateur to whom we all owe a great scientific debt.

Beginning in 1845, with the unveiling of Lord Rosse's 6-foot (1.8 m) aperture telescope, several of the nebulae catalogued by Messier, Herschel and others were discovered to contain an internal spiral structure. The extreme light-gathering power afforded by this new telescope allowed us, for the first time, to see these hitherto undiscovered cosmic constructions. But there was another possible path to such a discovery: rather than collecting vast amounts of light through a giant aperture, you could collect it *over time*, through the newly developed technology of photography. During the latter half of the 19th Century, the application of photography to astronomy allowed us to better understand the Sun's corona, the spectra of stars, and to discover stellar and nebulous features too faint to be seen with the human eye.

Working initially with a 7-inch refractor that was later upgraded to a 20-inch reflector, amateur astronomer Isaac Roberts pioneered a number of astrophotography techniques in the early 1880s, including "piggybacking," where his camera/lens system was attached to a larger, equatorially-mounted guide scope, allowing for longer exposure times than ever before. By mounting photographic plates directly at the reflector's prime focus, he was able to completely avoid the light-loss inherent with secondary mirrors. His first photographs were displayed in 1886, showing vast extensions to the known reaches of nebulosity in the Pleiades star cluster and the Orion Nebula.

But his greatest achievement was this 1888 photograph of the Great Nebula in Andromeda, which we now know to be the first-ever photograph of another galaxy, and the first spiral ever discovered that was oriented closer to edge-on (as opposed to face-on) with respect to us. Over a century later, Andromeda looks practically identical, a testament to the tremendous scales involved when considering galaxies. If you can photograph it, you'll see for yourself!

Astrophotography has come a long way, as apparent in the Space Place collection of NASA stars and galaxies posters at http://spaceplace.nasa.gov/posters.

Great Nebula in Andromeda, the first-ever photograph of another galaxy. Image credit: Isaac Roberts, taken December 29, 1888, published in *A Selection of Photographs of Stars, Star-clusters and Nebulae*, Volume II, The Universal Press, London, 1899.