# SkyWAAtch

## Cherry Springs Milky Way

David Parmet captured this image of the Milky Way at Cherry Springs State Park in north-central Pennsylvania. David used a Nikon D7000 with a 20mm lens.

The Cherry Springs observing field sits atop a 2,300-foot high mountain. A state forest surrounds it. Nearby communities are in valleys, reducing the sky glow that might detrimentally effect the site. The net result is a superior location for viewing and photographing the stars.

## In This Issue . . .

# Events for August

## Upcoming Lectures

**Lienhard Lecture Hall,**
**Pace University, Pleasantville, NY**

As usual, there will be no WAA lecture for the month August. Our Lecture series will resume on September 11th with Members Presentations Night.

## Starway to Heaven

**Saturday August 8th, Dusk.**
**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 rain/cloud date is August 15th. **Note**: By attending our star parties you are subject to our rules and expectations as described here. Directions.

## Perseid Meteor Shower

**Wednesday August 12th, Dusk.**
**Ward Pound Ridge Reservation,**
**Cross River, NY**

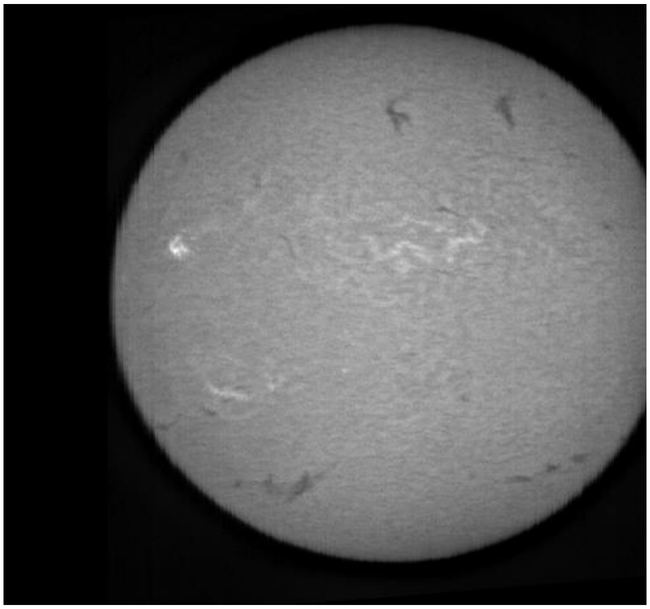
Come view the Perseids with WAA. The Perseid Meteor Shower peaks on Wednesday night, August 12-13th, as the Earth passes through the orbit of Comet 109P/Swift-Tuttle. Perseid meteors are frequent for several days before that date. At the peak 60-100 meteors an hour might be seen. Meteor counts increase after midnight, peaking towards dawn, but this year there might be substantial numbers a bit earlier. **Note**: By attending our events you are subject to our rules and expectations as described here. Directions.

## New Members. . .

Richard Cuiffo - Katonah
Andy Poniros - New Haven
Jack Rudman - Mohegan Lake
Mark Korsten - Hastings on Hudson

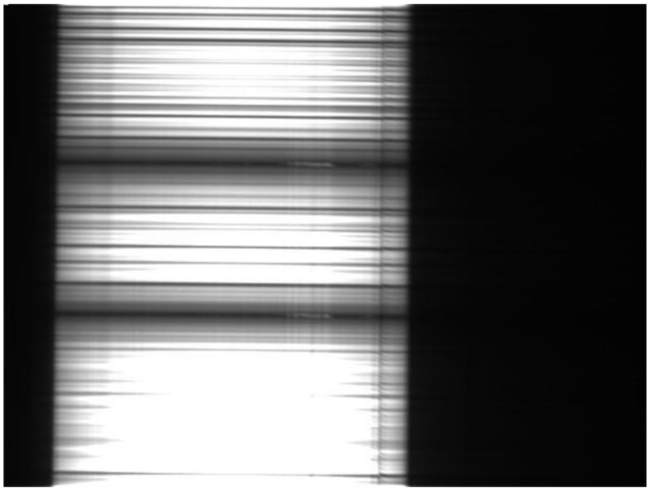
## Renewing Members. . .

John Paladini - Mahopac
Jan Wauters - Larchmont
Deidre Raver - Wappingers Falls
Eric and Katherine Baumgartner - Redding
William Newell - Mt. Vernon
Michael & Angela Virsinger - Seaford
Michael & Ann Cefola - Scarsdale
Roman Tytla - North Salem
Andrea Anthony - Yorktown Heights
Ihor Szkolar - White Plains
Patricia Mahon - Yonkers
Tom & Lisa Cohn - Bedford Corners



### Spectroheliograph Follow-up

Last month's issue highlighted John Paladini's spectroheliograph. Above is another image with this instrument taken in the Hα. Below is a spectrum shot showing a glowing calcium cloud on the Sun in CaK and CaH.



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

## Almanac
### For August 2015 by Bob Kelly


Oh, August! It's an astronomically neglected month due to heat and extended twilights, busyness and bug-gyness. For many of us, the last two weeks of August are a vacation-time for that special family trip. For travelers, many places, especially our National Parks and Wilderness areas, are reintroducing vacationers to the wonders of a dark sky so often masked in our cit-ies.

Of the brighter planets, Saturn has the evening sky pretty much all to itself. He's starting to fall out of our skies; highest in the southwest at dusk. Being at quadrature, we get to peek around the side of the plan-et. The shadow of the planet is just visible on the rings, maximizing the effect of depth, making Saturn the most 3D object seen from Earth, after our own Moon. You can compare the two as the Moon passes by on the 22$^{nd}$. Don't neglect Saturn on hazy nights – the high-pressure systems that concentrate our pollu-tion into haze are linked with nights when the bub-bling jet stream is far away. Saturn's largest moon, Titan, stands out near the planet, despite the glare from the wide-open rings. Among Saturn's other moons, you may find it easier to find Saturn's fourth-brightest moon, Iapetus, going from magnitude + 10 to +11 this month, as it moves from west of Saturn to passing north of Saturn on the 29$^{th}$. Titan also passes to the north on the 7$^{th}$ and the 23$^{rd}$.

If not for Saturn, the headline this month would be the reliable Perseids meteor shower peaking just after midnight on Thursday the 13$^{th}$. It's a great year for seeing a good number of bright meteors, since the moon waits to rise until almost dawn. Since the mete-ors are radiating from the northern skies, sideways to the Earth's movement, we get to see a good number of Perseids even before midnight. Just after dark, when the radiant is near the horizon, we might see some long-lasting meteors skipping across the top of our atmosphere. If the evening of the 12$^{th}$/13$^{th}$ looks to be cloudy, the Perseids are known for showing up in good numbers up a few days either side of the peak. Don't worry if you don't see 90 meteors in an hour – that's the number noticeable to the human eye at a very dark site, with the radiant overhead and if you could see the whole sky at once.

Venus and Jupiter leave the evening sky. Venus stakes her claim as the morning star by the end of the month. She moves quickly from low in the west right after sunset at the start of the month. Venus is a crescent almost one arc second wide, seen best with optical aid in a bright sky. The closest plant to Earth this month gives the Sun a wide berth, passing 7.8 degrees to the south (below) the Sun on the 15$^{th}$ - 67.9 million miles from the Sun and 27.0 million miles from the Earth. Mercury passes Jupiter on its way out, closest on the 6$^{th}$and 7$^{th}$, very low in the west. Regulus is in the same area, but you'll need binoculars to see it.

Uranus and Neptune are well placed in the middle of the night and pre-dawn hours. Pluto is still hanging out on the 'teaspoon' of Sagittarius, photo-bombed by the Moon on the 25$^{th}$.

August's Full Moon occurs less than 24 hours after perigee, so be aware of higher-than-normal tides for a few days after the 29$^{th}$. Let's hope for no landfalling hurricanes then (or late next month).

The International Space Station over flights start off being visible every 90 minutes or so all night and soon become visible before local midnight until the last week of the month.

Dates to mark on September's calendar--
4$^{th}$/5$^{th}$: Aldebaran is occulted by the Moon
21$^{st}$: Venus at maximum brightness (morning sky)
29$^{th}$: Lunar Eclipse, total between 10:11 and 11:23pm, within an hour of lunar perigee

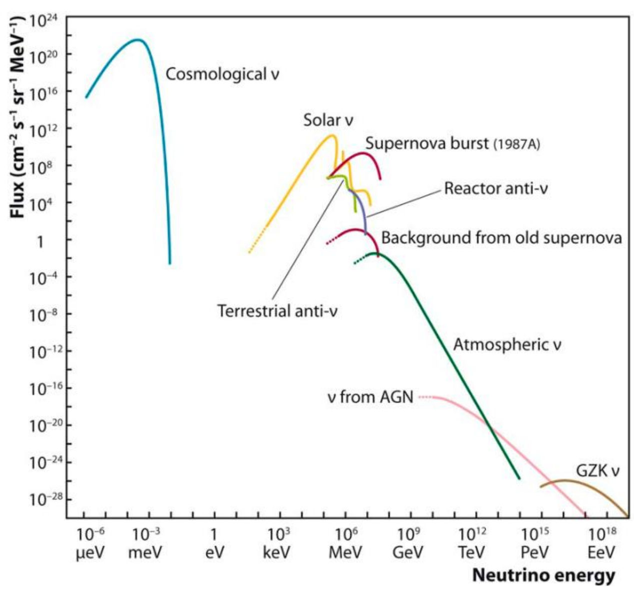
Westchester
Amateur Astronomers

# Neutrinos from the Big Bang

Larry Faltz

As you read this article, at least 65 billion solar neutrinos are passing through every square centimeter of the sun-facing surface of your body each second. In addition to neutrinos emitted by the sun, there are vast numbers emitted from nuclear reactors, supernova bursts, cosmic ray interactions with the atmosphere, terrestrial radioactivity and even active galactic nuclei. They travel through space and through matter paying almost no attention to what's around them. Interactions are extremely rare: a light-year's thickness of lead is unlikely to stop the average neutrino.

But it turns out that many of the neutrinos in the universe were formed during the Big Bang and have been coursing through space ever since. These neutrinos were once very energetic. When they were formed they accounted for a substantial proportion of the energy content of the universe, but because of the expansion of the cosmos they've been cooled to very low energies, making them impossible to detect even though there are perhaps 330 million of them in every cubic meter of space. A bold new detector is being designed to find them.




A plot of neutrino energy vs. flux

Neutrinos are electrically neutral particles that arise from beta-decay, the process in which a neutron in an atomic nucleus is transformed into a proton and an electron with the release of energy. Neutrons were first postulated in 1920 by Sir Ernest Rutherford, who had established the nuclear model of the atom in 1911. Because beta decay was characterized by the emission of an electron and a gain of one in the atom's atomic number (meaning an additional positive charge resided in the nucleus), Rutherford proposed that electrically neutral particles made up of a positive proton and negative electron resided in the nucleus. In beta decay, the electron would be released and the proton would remain. He didn't call these particles neutrons, however. He thought of them as simply a bound state of the two charged particles. We now know that this is too simple: the neutron is really composed of a trio of quarks and one of them changes "flavor" in the beta process, but that's a whole other story. Discrete neutrons were found by Chadwick in 1932.

Enough was known before Chadwick's discovery to question the energy budget of beta decay. Certain properties of the system must be conserved: energy, momentum and angular momentum among them (the Standard Model of particle physics requires several additionally conserved quantities). In 1930 Wolfgang Pauli proposed that a light, probably massless, electrically neutral particle, which he called a neutron (later changed to neutrino at the suggestion of Enrico Fermi to distinguish it from Chadwick's particle) is also a product of the reaction, with characteristics that provide the necessary conservations.

$$n^0 \rightarrow p^+ + e^- + \bar{\nu}_e$$

The specific neutrino in this reaction is actually an electron anti-neutrino. Don't panic! I won't challenge you in this brief article with complex but fascinating details about neutrino physics that demonstrate, among other things, that there are three types ("flavors") of neutrinos as well as their antiparticles.

Neutrinos arising from beta decay are "relativistic," in that they travel at or near the speed of light. It was thought for a long time that they were massless, as suggested by theory, and therefore traveled exactly at the speed of light. The velocity of neutrinos created in nuclear reactors are, within experimental error, indistinguishable from $c$ (we recall the claim in 2011, later refuted, that super-luminal neutrinos [velocity > $c$] were detected). However, there is substantial evidence now that neutrinos of each flavor have a tiny amount of rest mass, estimated from terrestrial experiments to be something on the order of 0.04 to 2.0 electron volts (eV). For comparison, the rest mass of an electron is 0.51 million eV and the mass of a proton is 938.3 million eV. Neutrinos are nearly, but not actually, massless. Having mass allows the neutrinos to "oscillate" among the three flavors. This solves the "solar neutrino problem", where the number of solar electron anti-neutrinos actually detected on Earth is only a third of what is expected on (solid) theoretical grounds. Neutrino detectors only measure electron anti-neutrinos and not the other flavors. If they change in flight, we won't see them.

Detecting neutrinos is difficult. They only feel the weak force and gravity. The "interaction cross section" with matter is extremely low, which is why they can pass unimpeded through your body, the earth, the sun and the mythical light-year of lead. But every once and a while the neutrino's energy is just right and it's proximate enough to the right kind of particle that it can be absorbed by a process called "beta capture", where a proton absorbs an electron anti-neutrino to create a neutron and a positron (positive electron).

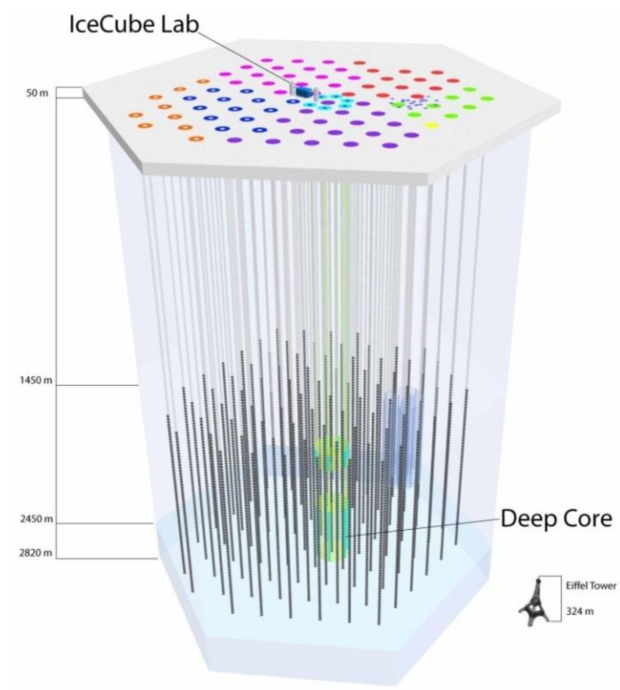
$$\bar{\nu}_e + p^+ \rightarrow n^0 + e^+$$

Neutrinos were first detected by Clyde L. Cowan and Frederick Reines in 1956. The source of neutrinos was the nuclear reactor in Hanford, Washington, and the detector was a tank of water ($H_20$ is obviously a good source of protons—every cubic centimeter of water has over $10^{26}$ protons) surrounding by scintillation detectors. In beta capture, the emitted positron almost immediately encounters an electron. Matter (electron) annihilates antimatter (positron), emitting a pair of photons in opposite directions with a very specific energy (511 keV). When correlated scintillations are seen in the detectors, a beta capture event is recorded, indicating a neutrino hit. Cowan and Reines were able to detect 3 neutrinos per hour from a theoretically predicted flux of $5\times10^{13}$ neutrinos per second per square centimeter, testimony to the neutrino's shy nature. Reines was awarded the Nobel Prize in 1995 for this work; Cowan passed away in 1974 and Nobels aren't given posthumously, but the history of science acknowledges his contribution.

The neutrinos Cowan and Reines detected had substantial energy, something on the order of 3.5 to 4 million eV, with a maximum energy of about 10 MeV. About 4.5% of the energy from nuclear reactors is lost by the emission of neutrinos, since they zip out of the reactor at near-light speed without interacting with anything.

**Neutrino Astronomy**

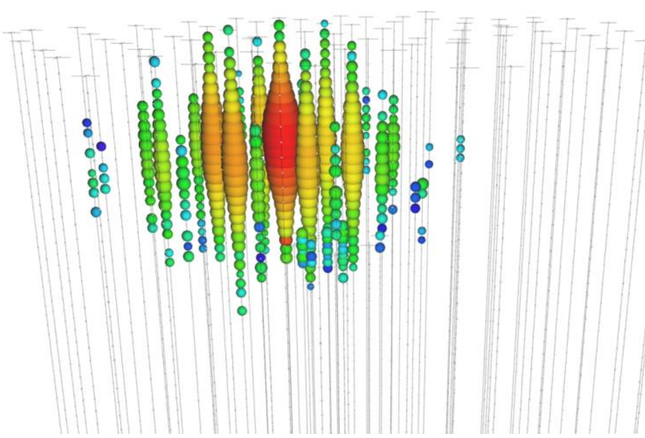
Neutrino astronomy seeks to detect neutrinos from astrophysical processes. Detection is still a very rare event, and solar and terrestrial neutrino detections have to be filtered from the data. Detectors have to be shielded from muons arising from cosmic ray showers, and so they are generally buried deep in the Earth, under water or sunk in the Antarctic ice. To date, only Supernova 1987A has been identified as a distinct source of astronomical neutrinos. This result was essentially obtained by accident. When Supernova 1987A exploded, a total of 11 anti-neutrinos were detected in underground facilities at Kamiokande II (Japan), 8 at IMB (near Cleveland) and 5 at Baksan (Caucasus mountains), in a period of less than 13 seconds. These 24 neutrinos were a huge deal in the neutrino detection world and contributed vastly to our understanding of supernova dynamics. It is estimated that a supernova puts out $10^{58}$ neutrinos. The neutrinos from SN1987A arrived 2 hours before the light pulse, because they escape the center of the exploding star without any hindrance from matter, while photons experience electromagnetic interactions until they are free of the high matter density in the stellar core (photons created from fusion in the core of our sun take 100,000 years to reach the surface, while the neutrinos come out instantly). Were it not for the optical detection of SN1987A, the source object probably would not have been verified. As more neutrino detectors come on line, it might be possible for them to correlate the direction of sources without optical aid. Detectors operating today on Earth would have captured at least ten thousand neutrinos from SN1987A.




IceCube, a neutrino detector at the South Pole

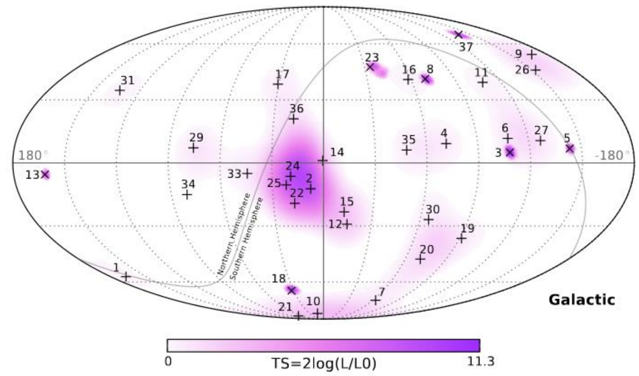
All current neutrino detectors, such as the remarkable IceCube experiment, detect high energy neutrinos. IceCube consists of "strings" of spherical optical sensors, 5,160 in total, buried in the ice at the South Pole, some 1,450 to 2,450 meters under the surface, covering an area of over a cubic mile.

The detector takes advantage of neutrino interactions with the vast amount of (frozen) $H_20$ surrounding the instrument. A similar strategy is used by new large undersea neutrino telescopes off the coasts of France and Greece, surrounded by much more pleasant Mediterranean liquid water (not to mention nicer places for the staff to go for a break). When a high-energy neutrino interacts with a proton, a lepton (electron, muon or even tau lepton) is created, which then gives off visible Cherenkov radiation that can be detected and localized by the sensors. IceCube is particularly sensitive to muons. For every muon liberated by an astronomical neutrino, $10^6$ atmospheric muons are detected, but because of its discrete sensor array, IceCube can reconstruct the muon's trajectory and determine whether its parent neutrino came from the atmosphere above or through the Earth below. IceCube recently detected the most energetic neutrino ever, a $2\times10^{15}$ eV strike nicknamed "Big Bird" after the Sesame Street character (two previous high energy record-holders were named "Bert" and "Ernie").



The Big Bird event in IceCube

IceCube is also trying to localize the source of extra-terrestrial (non-solar) neutrinos and has made an early all-sky map of sources. In addition, it can address more subtle problems of neutrino physics, such as neutrino oscillations and whether a class of neutrinos that interact only with gravity, known as sterile neutrinos, actually exist. IceCube can also probe cosmic ray physics and has even provided some early data regarding dark matter.

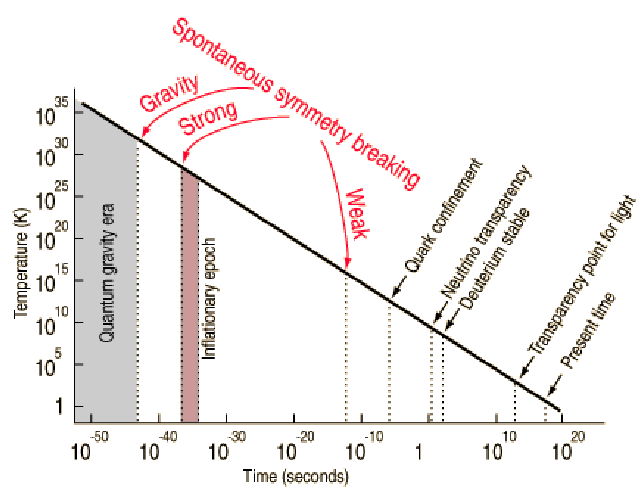




IceCube's galactic source map

**Relic Neutrinos**

Neutrinos were created copiously during the Big Bang once the weak force separated from the strong force via "spontaneous symmetry breaking." The universe consisted of a soup of elementary particles in thermal equilibrium. Neutrinos were absorbed and emitted from protons and neutrons freely, changing one into another at equal rates. At about t=1 second, expansion and cooling of the universe (although it was still $10^{10}$ degrees K) lowered neutrino energies enough to prevent them from interacting with other particles and they started moving through the universe unimpeded. This is equivalent to the decoupling of photons from matter 380,000 years after the Big Bang, releasing the Cosmic Microwave Background (CMB). The "primordial" or "relic" neutrinos experienced the same cooling and red-shifting that photons did as the universe expanded. They exist today as a sea of very low-energy particles, forming the Cosmic Neutrino Background (CvB). They have a temperature of 1.9° K, lower than the CMB because they started much earlier.





Time vs. temperature in the universe

There is some evidence for the existence of relic neutrinos in data from Planck. Because neutrinos feel the gravitational force, they have an impact on the primordial density of matter in the early universe and thus on the radiation map of the CMB. Sophisticated modeling of Planck data confirms, indirectly, the presence of relic neutrinos and strongly argues against the possibility that there are more than 3 neutrino flavors. An additional flavor would challenge the Standard Model of particle physics. Planck also set an upper limit of the sum of the neutrino masses of 0.23 eV.

The neutrino data from Planck is indirect. It would be a Nobel-worthy task to directly detect relic neutrinos. This challenge has been taken on by the PTOLEMY experiment. PTOLEMY stands for "Princeton Tritium Observatory for Light, Early Universe Massive Neutrino Yield." It's a combined project of the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) and Princeton University. The principal investigator is Princeton physicist Charles Tully, who presented a talk on the project at the Hayden Planetarium in early June.

Tritium, a hydrogen nucleus with one proton and two neutrons, is unstable, with a half-life of 12.3 years. It undergoes beta decay when one of its neutrons becomes a proton, emitting an electron and an electron anti-neutrino.

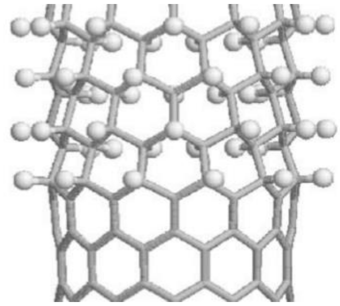
$$^{3}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + e^{-} + \bar{\nu}_e$$

The Standard Model of particle physics allows tritium to undergo a process known as neutrino capture:

$$^{3}\mathrm{H} + \nu_e \rightarrow {}^{3}\mathrm{He} + e^{-}$$

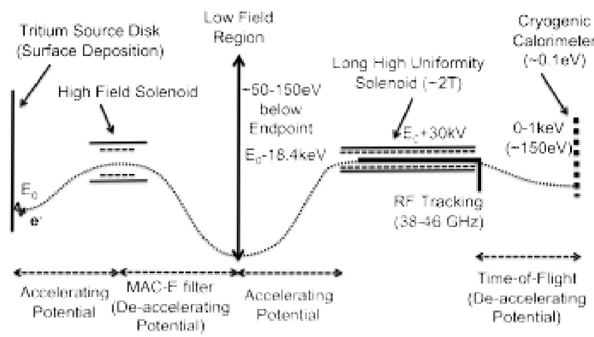
The idea of detecting relic neutrinos by this method was first suggested by Steven Weinberg in 1962. The physics suggests that electrons emitted in the capture process are ever so slightly more energetic than the electrons from tritium's natural beta decay, and the difference, perhaps just 0.05 eV, might be detectable with advanced super high-resolution technology.

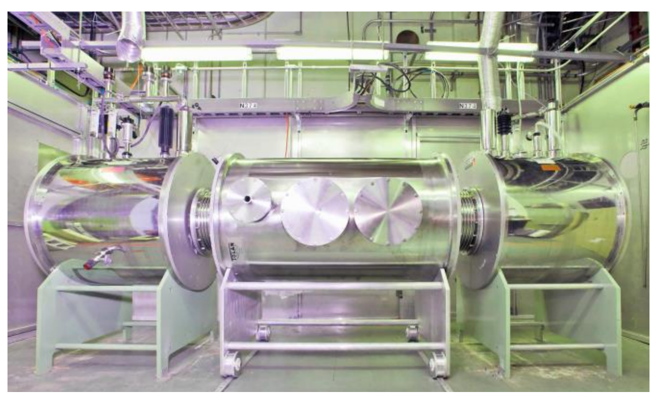
The electron source for the full PTOLEMY device will be 100 grams of tritium covalently bound to carbon atoms on a 12 cm diameter disc of a single layer of graphene, one tritium atom bound to each carbon atom. The device needs to be evacuated to below $10^{-6}$ torr and cooled to milli-Kelvin temperatures. If an electron is emitted, will it travel through the device guided by powerful magnets and its energy will be measured by a cryogenic calorimeter.



Tritium atoms bound to graphene

A PTOLEMY prototype has been created to test the overall design. It will not be able to detect relic neutrinos: the actual experimental device will have to be much larger, buried deep underground like other neutrino detectors and operated for a long time to accumulate events. The estimation is that about 10 relic neutrinos per year will be detected. Most of the electrons that impact the detector will have arisen from ordinary beta decay of the tritium. Measuring the energy difference between the two types of electrons would be positively heroic science and engineering.



The overall schematic design for PTOLEMY is shown in the top frame, and the prototype at Princeton is shown below.

Direct detection of relic neutrinos provides another test of standard cosmology. The Big Bang *must* produce them. Their detection may also help answer a critical unresolved problem in the Standard Model of particle physics: whether neutrinos are actually their own antiparticles (known as Majorana particles). ■

## Star Party July 11th (Photos by Larry Faltz)


The 20” Obsession and Doug Baum’s 12.5” Obsession. Left to right: Bill Newell, Mike Cefola, Paul Alimena, Mike Virsinger and Francis O’Reilly.

The weather gods smiled for a change: skies were crystal clear and the temperature near perfect for our monthly star party, which drew at least 18 telescopes and a quite a few visitors. And for the first time in at least 3 years, the club’s 20-inch Obsession was taken out for a drive.

It’s a multi-person effort to transport and set up this f/5 behemoth, but at our Board meeting in March, enthusiasm was expressed for making a more organized effort to observe with it. The Board is also considering adding encoders and digital setting circles to allow a wider range of objects to be acquired and viewed through this rather extraordinary instrument. A “Big Dob” committee, chaired by Paul Alimena and including among others Mike Virsinger, Bill Newell, Mike Cefola and Darryl Ciucci, are putting together the upgrade and transportation plans. If you’re interested in being a part of this project and perhaps helping out once a year, let us know.

Here are some pre-darkness photos:

Bill Newell and Paul Alimena unloading the mirror box.

Bill Newell and Gary Miller adjusting the shroud

Mounting the secondary on the truss rods. A multi-person job.

Doug Baum collimating the 20".

Bill Newell, Mike Cefola and new member Rich Ciuffo with Rich's brand new Celestron 150 mm SCT on an AVX mount.

Elyse Faltz and Angela Virsinger

Mike Lomsky showing the innards of his new Orion SkyQuest XX14G go-to Dobsonian to a young guest

Guest Lars Schneidenbach with WAA members Woody Umanoff and Dave Butler

WAA Senior Vice President Charlie Gibson with Steve and Sharon Gould and the Goulds' 90 mm Orion. I supposed we should have photographed this scope next to the 20"!

Gary Miller with 12.5" Obsession truss-tube Dob.

Doug Towers and his old reliable 90mm Meade refractor

Sharon Gould and WAA Vice President for Programs Pat Mahon

Jordan Webber with 8” Orion Newtonian

Paul Alimena, Elyse Faltz and Chris DiMenna with 6” Meade refractor

*Locutis*, Larry Faltz’ 8” SCT set up for Mallincam video

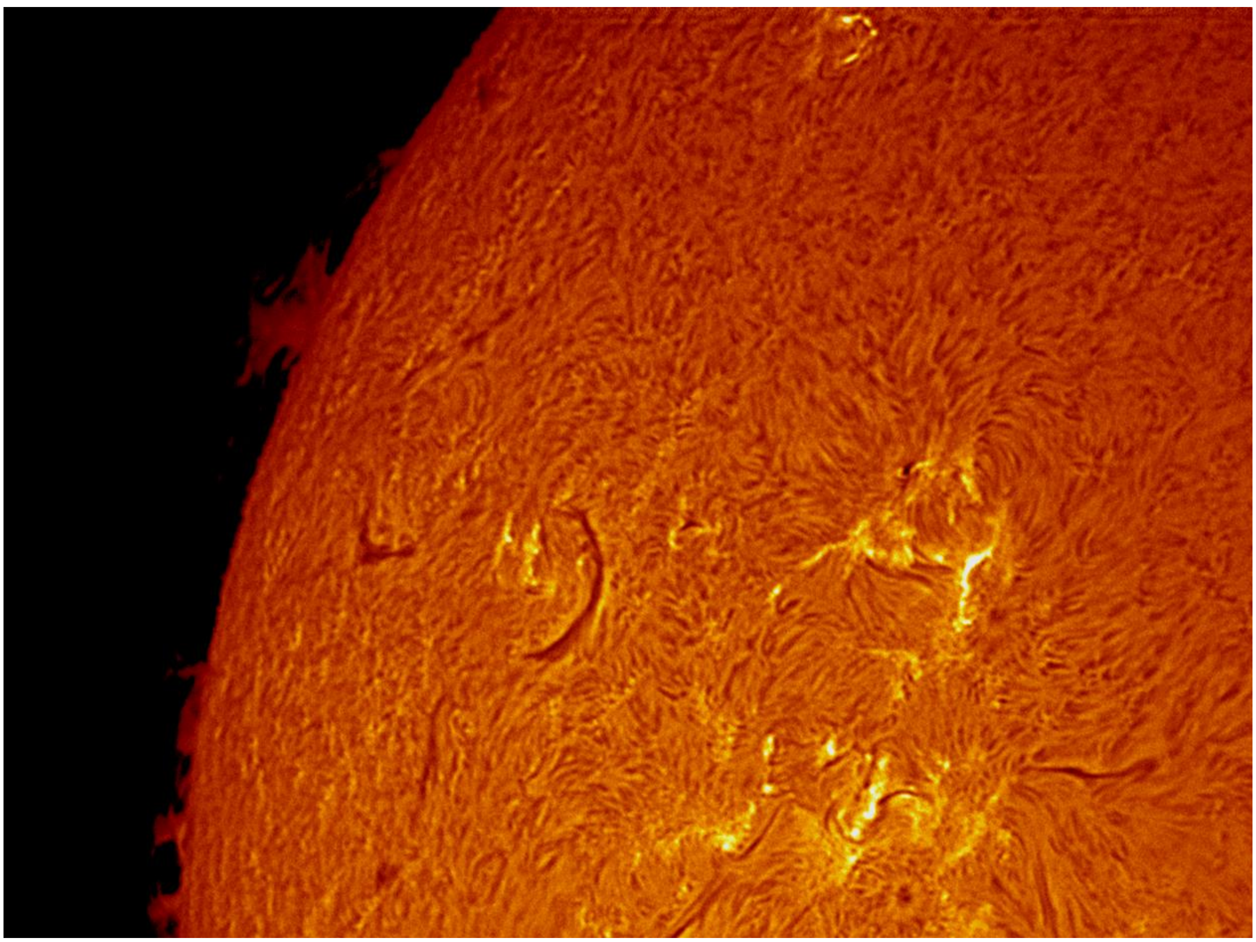
## July 23rd Outreach at Camp Ramah

Bob Davidson using the club's 20 inch obsession introduced me to Camp Ramah years ago. The Obsession created huge lines wherever it went. This year, the huge lines were back when Mike Lomsky brought out his 14 inch go-to. For Dede Raver it was her third time at the Camp. For Jordan Webber this was his first outreach event. The kids flowed in and out; the groups starting a 9 PM EDST (8 PM camp time). Very quickly we were all busy. At the height there were 150 kids on the field singing and enjoying the views. We keep yelling out our targets so different scopes did different objects. The Moon was 1/2 light and Dede's stabilizing binoculars had kids repeat viewing saying that they had forgot to press the button.

The camp has about 1000 kids. I viewed the Moon, Alberio, M11, M13, Swan Nebula and Dumbbell Nebula once, M39 twice and Saturn three times with different groups. The Ring Nebula was seen in different scopes and other objects were also shown. We pointed out the Milky Way and constellations. We were viewing until almost 11 PM camp time. The total number of kids shown the night sky is hard to estimate but it was very successful. Mitchel Mernick (Camp Ramah) and Larry Faltz and our club members Dede, Mike and Jordan made this event Succeed.

--Dave Butler

## Photos



The sun in hydrogen alpha light (656.28 nm) on June 7, 2015. Transparency 8/10, seeing 7/10. Lunt 60 mm double-stacked Hα telescope on iOptron Minitower mount, band pass 0.5Å, Celestron Skyris 445 monochrome camera (1280x960 pixels), best 300 of 3000 frames stacked and wavelet processed in Registax 6.0, final adjustments including color overlay in Photoshop Elements 2.0. Larry Faltz