SkyWAAtch

Tulip Nebula

Doug Baum took this image of the Tulip Nebula in Cygnus (a 30 minute exposure in H-alpha). He used his Takahashi FSQ 106 refractor and a QSI 532wsg CCD camera. The Tulip is an emission nebula about 6000-8000 light years distant.

In This Issue . . .

Events for November 2013

WAA November Lecture

“Remembering the Space Shuttle”
Friday November 1st, 7:30pm
Lienhard Lecture Hall, Pace University
Pleasantville, NY

Andy Poniros, amateur astronomer, telescope maker, NASA/JPL outreach volunteer, science reporter and radio host for WPKN will discuss his media coverage of Space Shuttle events, with close-up images and videos of launches, landings, "lift and mates," "rollouts" in the Vehicle Assembly Building, visits to Launch Pad 39a, Discovery & Atlantis Days, and personal experiences with astronauts. Free and open to the public. Directions and Map.

Upcoming Lectures

Lienhard Lecture Hall,
Pace University Pleasantville, NY

On December 6th, Mr. Al Witzgall will speak on the history of the telescope. Mr. Witzgall holds a Bachelor’s degree in Earth Sciences from Kean University. He is the past president of the Amateur Astronomers, Inc. of Cranford, NJ. Lectures are free and open to the public.

Starway to Heaven

Saturday November 2nd, Dusk
Meadow Picnic Area,
Ward Pound Ridge Reservation,
Cross River, NY

This is our scheduled Starway to Heaven observing date for November, weather permitting. Free and open to the public. The scheduled rain/cloud date is November 30th. Participants and guests should read and abide by our General Observing Guidelines and Disclaimer. Directions.

WAA APPAREL

Charlie Gibson will be bringing WAA apparel for sale to WAA meetings. Items include:

- **Caps and Tee Shirts, $10**
- **Short Sleeve Polos,**
- **Navy hoodies for $22.**

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

New Members. . .

Edgar S Edelmann - Ossining
Michael Lomsky - Wilton
Cliff Wattley - Ridgefield

Renewing Members. . .

Mark Girvin - Larchmont
Kevin Doherty - White Plains
James Steck - Mahopac
John James - Sunnyside
Kevin Shaw - Yonkers
Olivier Prache - Pleasantville
Josh & Mary Ann Knight - Mohegan Lake
Vince Quartararo - Katonah
Deidre Raver - Wappingers Falls
Pierre-Yves Sonke - Tarrytown
Woody Umanoff - Mount Kisco
Hans Minnich - Bronx NY

Twice the Fun

Courtesy of John Paladini is this image of the double star Albireo in Cygnus taken through a 6 inch RC reflector with a canon rebel camera (1.5 minute exposure). Officially known as Beta Cygni, Albireo is consists of orange giant with a hot blue star thought to be orbiting at a distance of 4500 AU.

Almanac

For November 2013 by Bob Kelly

Nov 3 Nov 10 Nov 17 Nov 25

November will be - literally – a make or break month for Comet ISON. Maybe both. Its 3-mile-wide nucleus will come only 800,000 miles from the surface of the Sun on the 28th, flirting with disaster in the heat of the Sun and being stretched by strong tidal forces. There may be nothing left of the head of the comet by the end of the month. The longer ISON holds together, the better the show is likely to be for early risers Thanksgiving weekend. If ISON falls apart before closest approach, its dust may be spread out so far it will be hard to see. Falling apart after perihelion could spread ISON's dust into lovely fans extending outward into the morning sky. I've found that spectacular events like this hit the news fast, but details that would help enthusiasts like us observe the unfolding events are vague until the next issue of Sky and Telescope. Of course, with comets, almost anything can happen (except all the nutty stuff about colliding with Earth and bringing alien spacecraft). Even checking the sky right after sunset or blocking out the midday sun in a clear sky might be surprisingly fruitful.

In the meantime, look for ISON low in the pre-dawn sky early in the month, passing Spica on the 17th and 18th, and diving down below Mercury and Saturn after the 22nd. So even if ISON stays dim, you'll have a consolation prize for the best morning appearance of 2013 of Mercury and Saturn's return from behind the Sun. Saturn will look three times larger than Mercury in a telescope, making an interesting comparison, especially around the 25th/26th, when they will be side-by-side. The Moon shines above them late in November, parking between Mercury and Saturn on December 1st.

While you're at it, there are three other comets in the morning sky; periodic comet 2P Encke, and newcomers Lovejoy and LINEAR are around 8th magnitude. LINEAR (2012 X1) just jumped from 16th magnitude as it appears to have recently ejected lots of dust and ice. Catch it while it lasts.

Mercury and Venus start the month tied for closest planet to the Earth, but Mercury speeds away and Venus scoots closer, with Mercury three times further away by the end of the month. Mars is creeping closer, flying higher in the morning sky, further away, about the same apparent size as Mercury, but still small in the telescope. Some astrovideographers are starting to tease out large-scale features on Mars, go to Japan's ALPO site for the latest, and greatest, planetary photos from Earth.

November 3rd's solar eclipse starts as a partial eclipse at sunrise here in the eastern United States. You'll only get 41 minutes after sunrise to see the dark form of the Moon make the Sun into a strange sunrise crescent. Remember to set your clock back an hour on Saturday night, as we go back to standard time.

The Moon passes over first magnitude Spica, but it's during the day on Friday the 29th, and the Moon is so thin that it may be hard to find. The Moon makes a wider pass by Venus on the 6th. Venus makes it's furthest excursion out from the Sun in the evening sky at the start of the month, but sets a bit later each night in November, shrinking in phase past half lit, but getting 50 percent larger across as well.

Jupiter extends its reign into the evening sky, rising about 9:30pm EDT at the first of the month, and as early as 7:30pm by Thanksgiving. There a several times when two of Jupiter's moons cast their shadows on Jupiter, the best time for us is on the 13th just after 10pm EST.

Uranus and Neptune are well up in the evening sky. Cygnus the Swan heads off lower and to the north and west, going opposite the natural migration direction of south. The winter constellations arrive earlier each night, while our next-door neighbor galaxy, M31 in Andromeda, is overhead. M31 is coming closer all the time, but don't expect to be easier to see for a billion years or so.

The ISS is visible in the morning skies from the 8th onward, as bright as magnitude -3. Tiangong has some nice overflights of magnitude +1 during early November. If you like keeping tabs on the U.S. Air Force's X37-B space plane, it appears as bright as magnitude +2 in the morning early in the month and in the evening at and after mid-month. Always check for the latest updates, since the Air Force likes to adjust X37-B's orbit from time to time.

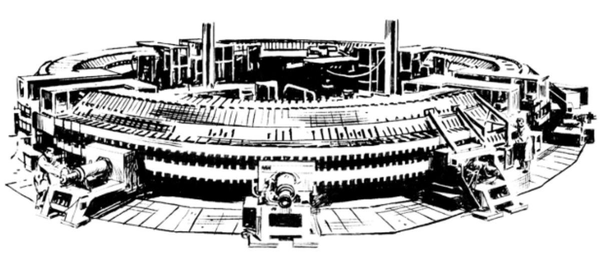
Westchester
Amateur Astronomers

Articles and Photos

We Visit the Relativistic Heavy Ion Collider at Brookhaven
by Larry Faltz

We generally don't think of New York in terms of important astronomical research. There are no large telescopes in the metropolitan area, not even any significant ones from the pre-electric light era. That's unlike Boston, where the Harvard College Observatory (in next-door Cambridge) houses the famous 15-inch Great Refractor (installed in 1847), and Washington, DC, where the US Naval Observatory's 26-inch Clark refractor (1873) is situated in what is now the Vice President's residence on Massachusetts Avenue in the heart of the city. In 1975 I viewed Jupiter through this instrument, which was the telescope that Asaph Hall used in 1877 to identify the two moons of Mars, Phobos and Deimos. Even in the summer murkiness of downtown DC, Jupiter's bands were an impressive sight. The entire wooden floor of the observatory rises and falls to keep the observer at eyepiece height, a rather disconcerting experience at first.

New York's academic contributions are much greater in the area of physics, particularly at the Columbia University Physics Department, where such notables as Isidore Rabi, Harold Urey, Enrico Fermi, John Dunning, T.D. Lee and more recently Brian Greene have had academic homes. During World War Two, Dunning and Fermi built a cyclotron in the basement of Pupin Hall on Broadway and 120th Street, and later a larger cyclotron was built at Nevis Laboratories, the Columbia Physics Department's research and experimental design facility housed on an estate in Irvington, right on Broadway (Route 9). Many current Columbia and NYU faculty and graduate students participate in international collaborations, including the successful search for the Higgs boson with the Large Hadron Collider at CERN.



The Brookhaven Cosmotron, operated from 1953 to 1968. It was 75 feet in diameter. (Brookhaven)

Columbia physicists were some of the original researchers at the Brookhaven National Laboratory, which opened in eastern Long Island in 1947. In particular, Lee and CN Yang used data from the Cosmotron, one of the early Brookhaven accelerators, to discover parity violation in the weak interaction, for which they received the 1957 Nobel Prize in physics.

Brookhaven has since gone on to house ever-larger accelerators, making many important discoveries in particle physics. This area of science critically informs our understanding of the universe, in particular its content and behavior in the first instants after the Big Bang. The largest and most important research instrument at Brookhaven is the Relativistic Heavy Ion Collider (RHIC), a device designed to create a quark-gluon plasma (QGP) in order to test the theory of quantum chromodynamics, which merges three of the four fundamental forces (electromagnetism, the weak force and the strong force). RHIC recreates the environment that the universe found itself in right after the end of inflation, approximately 10^{-32} seconds after the Big Bang, when matter was created. This era lasted until 10^{-6} seconds, when the temperature fell enough for hadrons (protons and neutrons) to form. We can't observe this period with our telescopes, so we have to create it in the laboratory. Like telescopes, particle accelerators are a form of time machine.

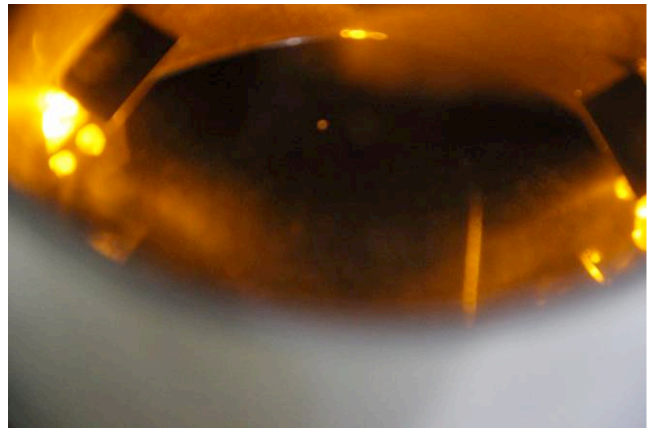
Brookhaven is open to the public for tours of the RHIC on several Sundays in the summer, and Elyse and I went on August 4th, the last open house this year. The lab is located just north of exit 68 on the Long Island Expressway, a little over an hour from southern Westchester. The enormous power demands of the device, particularly the requirement to cool a large amount of helium to 4° K, make summer operations risky due to the possibility of brown-outs on hot days or complete power system failures from lightning storms. So in July and August the machine is shut down for maintenance and the Brookhaven staff, including engineers, equipment operators, scientists and graduate students, become docents for the day.

We were part of a crowd of at least 600 visitors who came throughout the day. After a lecture in the spacious visitor's center on the technology and science of RHIC, buses took us to the two current experiments, PHENIX and STAR, and then to the beam tunnel itself to see the actual beam rings and their superconducting magnets. The buses come and go continuously, so we could spend as much time as we wanted in each location.

RHIC circulates two beams of heavy nuclei (completely stripped of their electrons) in opposite directions at a velocity of 99.995% of the speed of light, using liquid helium-cooled superconducting niobium-titanium magnets surrounding two high-vacuum beam tubes, one for each direction. At six points in the 2.4-mile circumference, slightly hexagonal ring, the beams can be made to cross so that the nuclei can smash head-on into each other. At these locations, complex detectors, feeding banks of computers, track and measure the products of the collisions. Current experiments use completely ionized gold nuclei (Au^{+79}), although copper and uranium nuclei have been accelerated as well. RHIC is the only collider that can smash spin-correlated protons to investigate certain aspects of proton behavior.

The nuclei are prepared in external generators, partially accelerated and ionized in storage rings, and then injected in pulses into the RHIC for final ionization and acceleration to 0.99995*c*. They circulate in packets, making almost 80,000 revolutions per second. The speeding nuclei, flattened because of the Lorentz contraction of special relativity, smash into each other like two pancakes with energies of up to 200 GeV per collision (the equivalent of two mosquitoes colliding, which doesn't sound like much except that it takes place within a diameter of a few Angstroms). The collision creates a temperature of 4 trillion degrees Kelvin, 250,000 times hotter than the center of the sun. At this temperature the force that bind quarks into protons and neutrons can no longer hold, and free quarks are liberated, surrounded by gluons, the particles of the strong nuclear force. This quark-gluon plasma is sometimes called "quark soup."

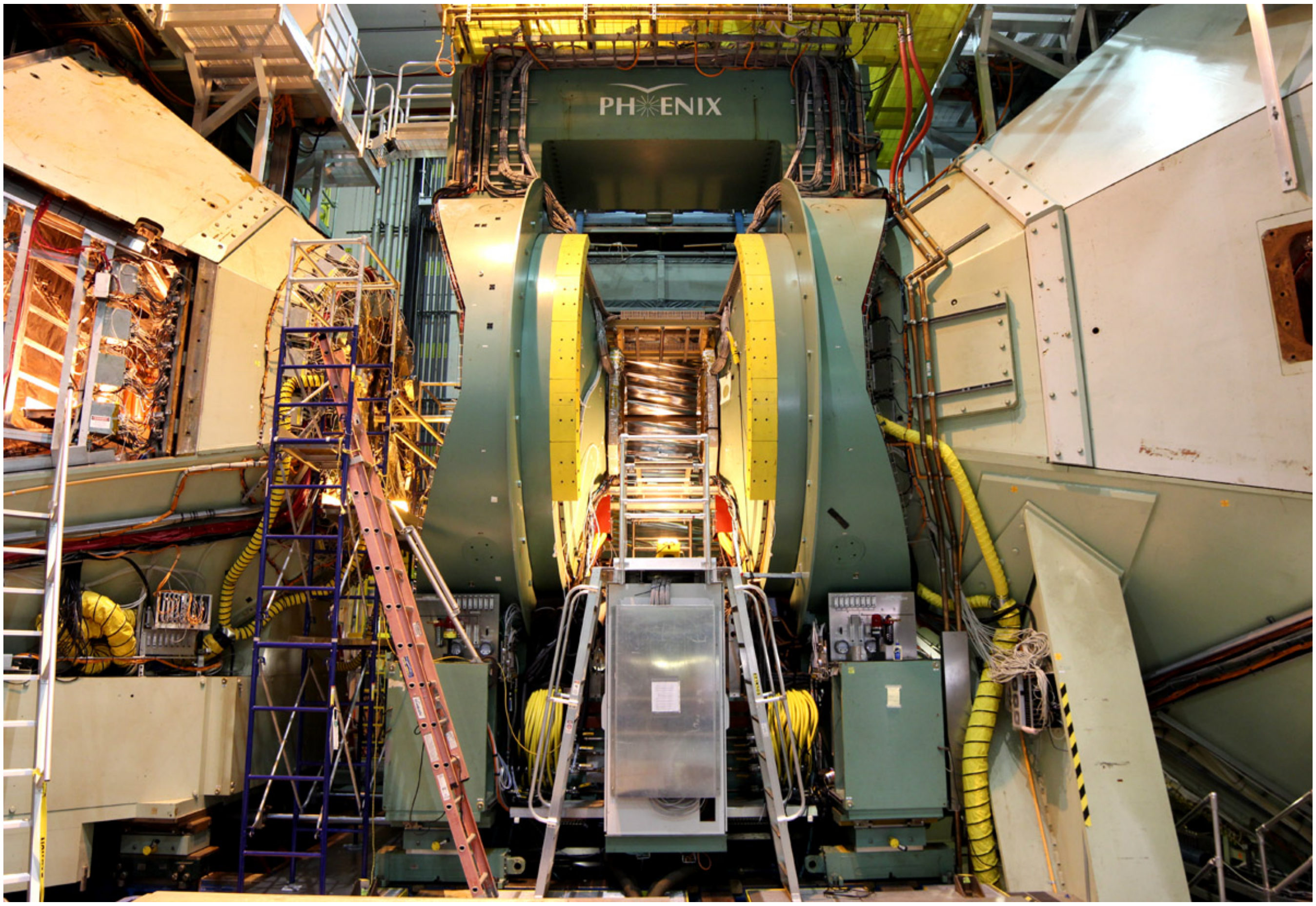
We stopped first at PHENIX, the *Pioneering High-Energy Nuclear Interacting Experiment*. The experiment is a collaboration of 565 scientists and technologists from 69 institutions in 13 countries. From the outside, it doesn't look like much, just some industrial warehouse-style buildings set against the earthen berm that contains the accelerator rings. Inside the entrance, there were displays of various detector parts and other high tech equipment as well as posters describing the construction and operation of the devices.



Bubble-chamber streak made by a muon. You are looking down into a side-lit vessel filled with cooled alcohol. (LF)

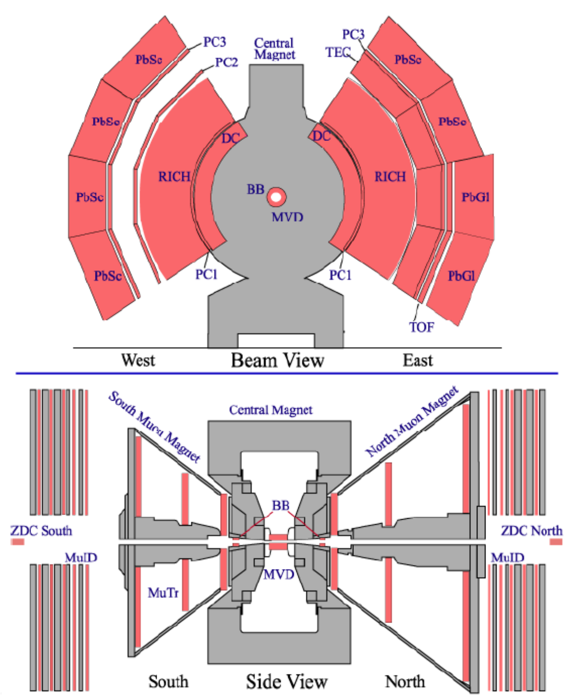
One of the docents was operating an alcohol bubble chamber in which we could occasionally see streaks made by muons generated in cosmic-ray collisions in the upper atmosphere. The streaks appear all at once every 5 or 10 seconds and dissipate in a second or two. My photo suffers from blurring due to the long hand-held exposure, but the muon track is easily visible right of center.

A Brookhaven graduate student explaining some of the detector technology. (LF)



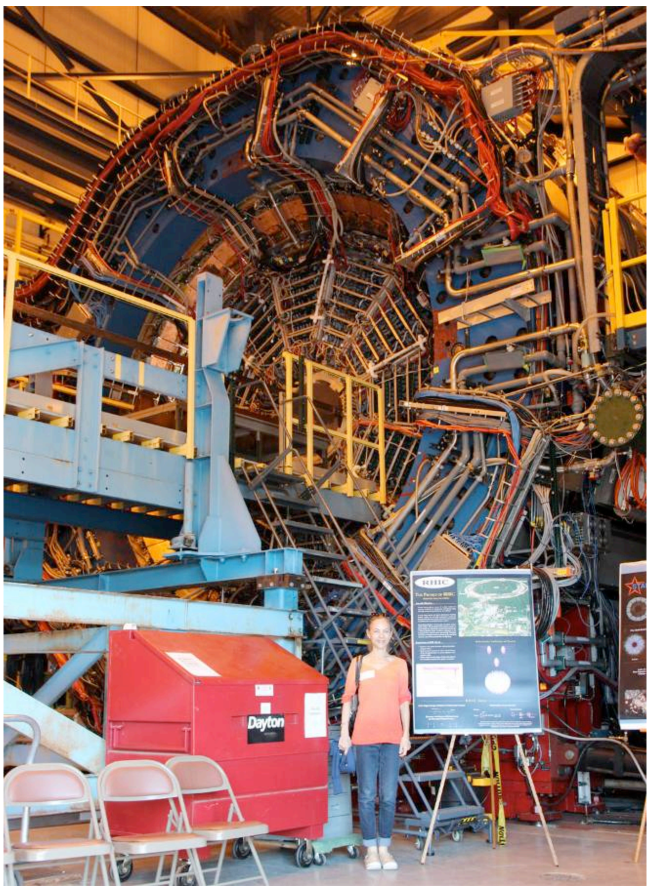
PHENIX. A front detector has been removed to reveal the location where the nuclei collide. The beams enter from either side and meet in the center. (LF)

Past the displays, we went up a few steps to the enormous PHENIX detector itself. We were permitted to get within 20 feet of the massive device. The detector weighs 4,000 tons. Its colossal iron magnets bend the paths of charged particles emitted from the collisions that take place in its heart, several million each second. The positions and momentum of muons, electrons and protons, as well as the energy of co-emitted photons and other neutral particles, are sensed by more than a dozen specialized detectors surrounding the collision point. The front detector housing had been pulled away to reveal the collision zone. Enormous numbers of wires and electrical devices surround and penetrate the mechanism. On the walls, both in the detector area and elsewhere in the building, are dozens of circuit breaker boxes, switches and vents. The enthusiastic and knowledgeable staff answered many questions and provided all sorts of fascinating information about the design and operation of the device.



Design of the PHENIX detectors (Brookhaven)

The STAR detector (*Solenoidal Tracker at RHIC*) is the other currently operating experiment at RHIC, housed in another complex of warehouse-like buildings. There are 609 collaborators on the STAR instrument, from 55 institutions in 12 countries. Unlike PHENIX, which is fixed in place and accessed by removing the surrounding detectors, the entire STAR device rolls on a track into and out of the particle beam. When we saw it, it was in the anteroom undergoing maintenance and display. STAR weighs 1200 tons, but there must be additional weight in the enormous number of wires running from it to control areas. The central part of STAR is called the Time Projection Chamber, a Star Trek-like name if ever there was one (I thought of "The Guardian of Forever" from the *City on the Edge of Forever* episode.) This area is surrounded by detectors that record the collision products.

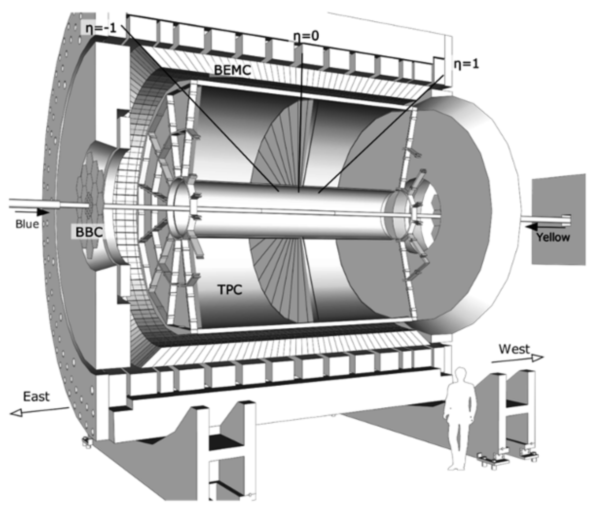


Elyse in front of one side of the Time Projection Chamber at STAR. (LF)

Both PHENIX and STAR have the same goal, but use different detector technologies and look for different collision products. This is similar to the LHC at CERN, where the two detectors, ATLAS and CMS, are tuned to different decay products and energies. Quantum chromodynamics, the theory of the strong nuclear force, predicts a variety of quark-gluon decay routes, for which specific detectors are sensitive. The goal is for both PHENIX and STAR to end up finding the same thing in different ways, which increases confidence in the results. This is what ATLAS and CMS did at CERN, when they both detected the Higgs boson by measuring different decay products.

One beam portal at STAR. The device is rolled back into position and the Time Projection Chamber mates with this housing. There's one on the other side. (LF)

When the experiments are running, RHIC is operating 24 hours a day for weeks at a time. The particle beam decays slightly, so the results are generally more abundant early in the experimental run.



STAR cutaway diagram (Brookhaven)

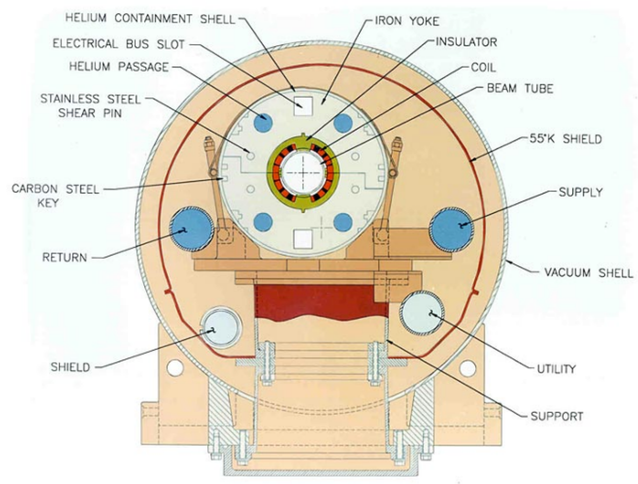
After an hour at STAR, we took the bus over to the RHIC headquarters, where there is access to the tunnel. The route is down stairs and around some corners, the path designed to prevent escape of the intense *bremsstrahlung* gamma radiation that is emitted by nuclei following the curved path through the ring. No human can be in the tunnel when it is operating. An emergency cord runs along the inside of the entire 2.4 mile tunnel, so that anyone caught inside can stop the machine before being fatally irradiated.

Part of the bank of computers at STAR. (LF)

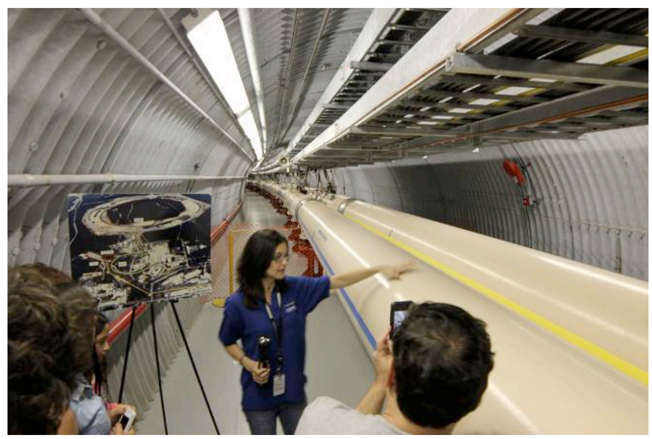
Before we went down to the tunnel, we saw part of the helium cooling plant. The RHIC has a helium supply of 40,000 gallons, which is processed through a 7-stage system designed for maximal thermodynamic efficiency. The compressors need 15 megawatts of power to operate.

Part of the helium cooling plant. (LF)

There are two tubes, one marked in blue and the other in yellow, in which the accelerated particles circulate in opposite directions. The tube segments are about 30 feet long. There are 1,740 of them. Dipoles magnets circulate and accelerate the nuclei, while quadrupole magnets concentrate and focus the packets. Each tube holds the evacuated beam channel, wiring, conduits for the liquid helium coolant (which circulates at 4 atmospheres) and of course the superconducting magnets, which operate at 3.5 Tesla (standard MRI machines, which also use superconducting magnets, generally operate at 1.5 T, but there's only one magnet per MRI rather than 1,740).



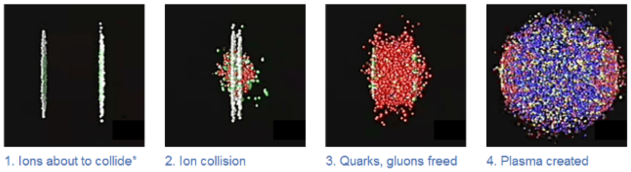
Cross section of one of the tubes, which houses a dipole magnet surrounding the beam tube. (Brookhaven)



Inside the RHIC ring (LF)

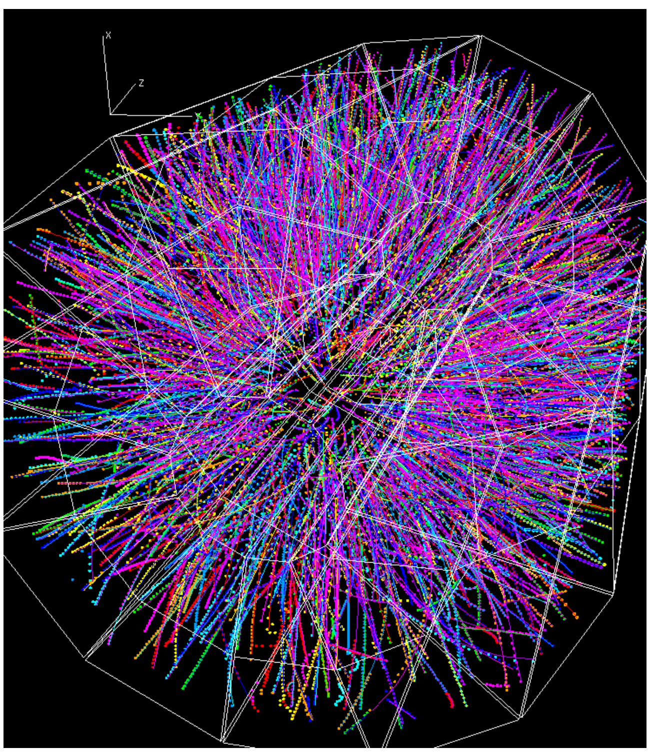
There is a spectacular amount of information available on the Brookhaven web site, as well as on sites for PHENIX and STAR. In fact, it looked to me that the complete design and operating manuals for the two instruments are accessible on line! While some of it is password protected, there are all sorts of operating instructions, design and testing reports, images and of course lots of science.

The evidence is solid that RHIC has achieved the quark-gluon plasma. Although expected to behave like a gas, the QGP instead behaves like a "perfect liquid" flowing without resistance and having no viscosity during the few moments of its existence. This finding apparently can be used to shed light on quark behavior as well as on the internal structure of the nuclei just prior to the collision.



Heavy ion collision at RHIC (Brookhaven)

Another finding is that tiny "bubbles" within the QGP appear to show hints of symmetry violations, with positively and negatively charged quarks not behaving in a mirrored fashion in the presence of the magnetic field. This is a completely unexpected result. The excess of matter over antimatter is thought to arise from symmetry violations in the weak nuclear force, but perhaps the strong force also played a role in the early universe. The STAR detector also found evidence for the production of antimatter helium nuclei, containing strange quarks rather than the usual up or down quarks. Eighteen anti-He^4 nuclei were found among a billion collisions produced and analyzed in 2010.



Products of a collision event at STAR. Analyzing the data requires vast computer and human resources (Brookhaven)

As a national laboratory, Brookhaven's costs are part of the Federal budget, which means they are under Congressional control, subject to political forces and competing with the entire range of Federal budget expenditures. The RHIC is the only operating atom-smasher in the US (the Tevatron at Fermilab outside of Chicago closed last year in spite of being very productive and getting a possible glimpse of the Higgs boson, ahead of LHC), but there is strong pressure to close the project, in order to save taxpayers $170 million a year at a cost of 750 Long Island jobs. $170 million sounds like a lot of money, but the simple fact is that Medicare spends this amount of money in *less than three hours*. (It's true. Trust me, I'm a doctor.) There are a number of new, worthy projects competing for increasingly limited government support in both physics and astronomy. The National Science Foundation and the Department of Energy, prime supporters of physics and astronomy research, are both targets of government cost-cutters, and some segments on the political spectrum want to do away with the DOE altogether. Enthusiasm for spending on basic physics and astronomy research, both for their own sakes and for the possibility that they can stimulate advances in technology that can have a salutary effect on standards of living (think of what the Apollo mission ultimately did for microelectronics, computers and communications) is a hard sell to a public increasingly distanced from a meaningful understanding of science. Failing educational systems, the lure of gibberish on the Internet, and the immediate gratification mind-set in our contemporary society don't mesh well with relatively abstract intellectual pleasures provided by an interest in pure science or high art. Congress has less than 20% of the Federal budget to play with to address its goal of reducing deficits (Medicare, Medicaid and Social Security entitlements, government and military pensions, debt interest and minimum credible needs of the national defense program consume more than 80% of Federal expenditures). Most folks can't imagine what might be lost when large science projects get cancelled. The payoffs are simply not concrete enough. The Enlightenment ideal of Progress, which holds that advances in science and technology coupled with social organization can lead to general improvement in the human condition, seems sadly to be a waning factor in civic discourse.

If it's still open next summer, and we hope it will be going for years to come, check out RHIC at one of Brookhaven's Summer Sundays Look at their informative the web site in the spring for dates, times and directions, and lots of information on science at Brookhaven.

Which Almanacs for 2014?
by Bob Kelly

Astronomical Calendar by Guy Ottewell – the 11x15inch large format has great graphics for when you want to find what you're looking for in the sky and how it all relates. Also great for showing your friends the mechanics of the heavens. Often sold at our club meetings. $30.

Sky and Telescope's Annual SkyWatch magazine - monthly star charts and a summary of the bright planets for each month. Has articles with tips to keep new astronomers of any age busy for a year or more. Buy two and give one or two away during the year. $9.

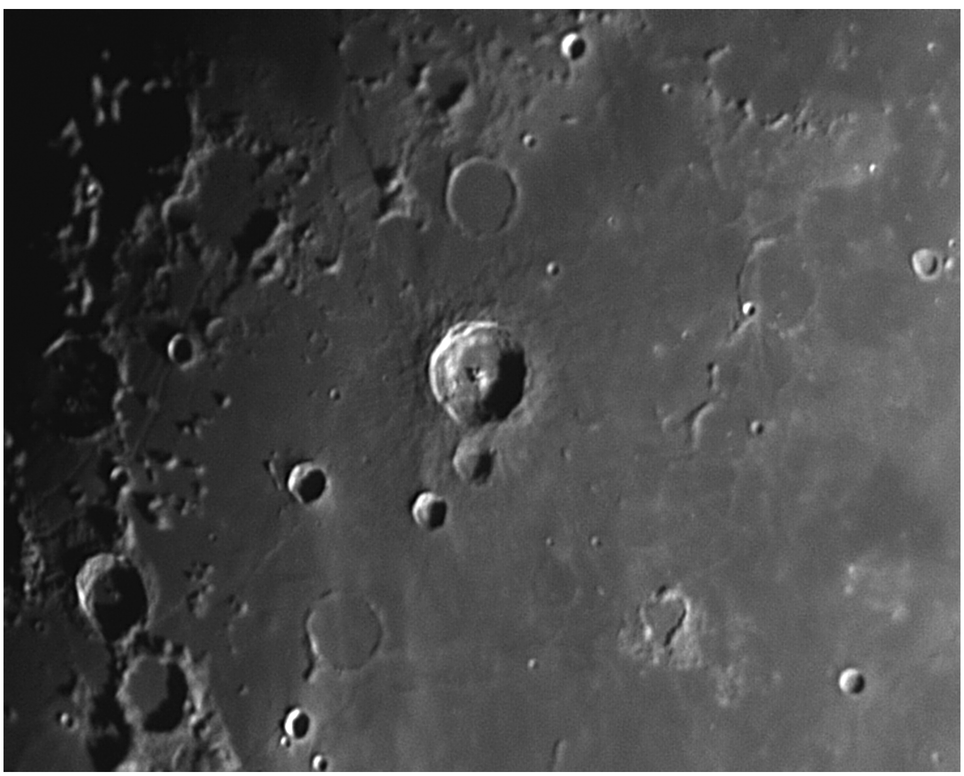
US Naval Observatory Astronomical Almanac – the $40 version has enough data on the positions of solar system objects, planets and their satellites to cure any case of sleeplessness.

Astronomical Phenomena is a condensed version of the US Navy Astronomical Almanac, with descriptions of planetary configurations, sun and moon rise and set data and eclipses. The 2015 edition is available for those who like to plan ahead! $10.

Observer's Handbook by the Royal Astronomical Society of Canada has month-by-month summaries and tons of useful data for the observer of any level. Don't worry, it's good for USA latitudes. The articles make it a 330+ page textbook I go back to again and again. $39.

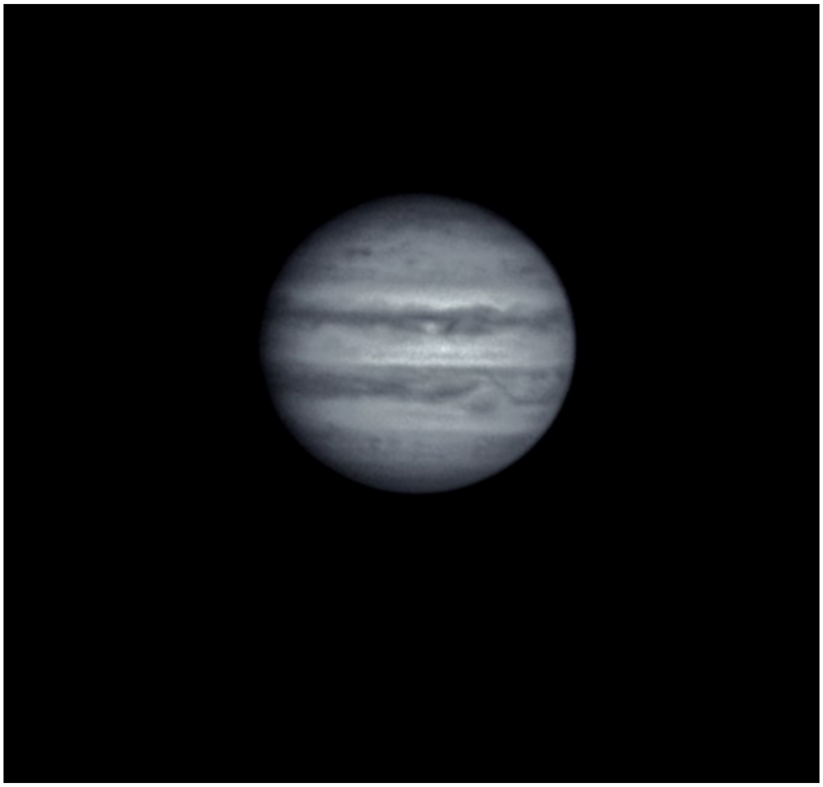
Abrams Planetarium Sky Calendar is one page per month with a calendar of great events for bright objects on one side and a map of bright stars on the other. Start your 12-month subscription anytime. $11 for a year. Sample for November at http://www.pa.msu.edu/abrams/SkyCalendar/Index.html.

If I could only take one piece of astronomical paper with me - it's Sky and Telescope's Skygazer's Almanac - with its graph of times of rise and set of the planets plus transits of major stars, and sun and moon data. It's worth buying several for home, office and your best friends. $5, 15 for the wall chart version.



Crater Bullialdus

Larry Faltz provided this image of 37-mile diameter crater Bullialdus. The crater is located on the western edge of the Mare Nubium. Its walls are 10,000 feet high. (5" Orion Maksutov, Celestron Neximage 5).



◀ Jupiter

John Paladini used a Chameleon Point Grey camera and an a Celestron 9.25 SCT to capture this image of Jupiter

◀ Andromeda Galaxy

Also from John Paladini is this image of M31, the great galaxy in Andromeda. The largest member of our local group of galaxies, M31 is about 2.5 million light years distant. John used an 80mm f/6 apo refractor (a single 7 minute exposure through a canon rebel).

For another impressive take on M31, check out Olivier Prache's composite image at:

http://www.cloudsbegone.com//NewFiles/M31_LRGB_Final.jpg

September Starway to Heaven

by Larry Faltz

A stretch of very clear early fall weather made for a fine observing night at Ward Pound on Saturday, September 29th. My wife Elyse took the census around 8 pm, when it got dark enough for effective viewing. We may have missed a couple of late-comers and we definitely dropped one last name, for which we apologize.

At sundown, Venus decided to park herself behind two trees at the western edge of the Meadow Parking Lot, so WAA Vice President for Field Events Bob Kelly lugged his 8" Orion Dobsonian over to sight the bright (mag -4.2) gibbous-phase planet between them. Bob spent a good deal of the evening pointing out the constellations for the many visitors who came by.

The skies were clear except for a few stray clouds that came by late and then disappeared. It was reasonably dark, with an SQM reading of 20.19 at about 10 pm, pretty good for WPR. Dew was definitely an issue but most folks had planned ahead with dew shields or heaters. The most popular objects during the evening were globular clusters (M13 and M2, later M3), the Andromeda galaxy (M31), the Double Cluster in Perseus and the perennially popular Ring Nebula. Early in the evening a few scopes tried for the Lagoon and Trifid nebulas in Sagittarius. Many folks sighted the tiny discs of Uranus and Neptune. The Pleiades became visible over the low trees about 9:15 pm.

Among the regulars were Doug Towers (90mm Meade refractor), David Butler (Meade LX-90), Harry Butcher (Celestron Nexstar 5), and Karen Seiter (Meade LX-90). Eva Anderson came by with daughter Liv and some friends, including her Televue NP101 refractor. Sharon and Steve Gould brought a Celestron Nexstar 6. Tim Holden came by with an Explore Scientific 102mm apochromatic refractor. WAA Webmaster Dave Parmet used the club's Meade 8" SCT on a Celestron NGT mount. There's a story to this set-up. The scope's original fork mount had expired long ago but the optical tube was perfect. A couple of years ago the club received a donation of two old but unused Celestron NGT mounts. The declination motor failed on one and the RA motor failed on the other. A few twists of the screwdriver and Dave produced a perfectly functional mount go-to equatorial mount (and we have a few spare parts left over).

Newcomers were Harry & Camille with a Celestron Omni XLT-102, Michael Lomsky with an Orion Astroview 120 mm refractor, Kevin Mathieson and his sons with binoculars and Yutaka Sugawara also with an Orion Astroview 120.

Elyse and I arrived early to set up Locutis, my Celestron CPC800, Mallincam Color Hyper Plus video camera and on-scope LCD video screen. While I was at it I set up a netbook for camera control and a wifi-linked laptop to display a star map that tracked the telescope. After the usual hour of set-up and some additional finagling to get the camera working and the scope accurately aligned, we were able to view and show to visitors many deep sky objects, including some 10th magnitude galaxies in Draco and Pegasus. The two Pinwheel galaxies, M101 in Ursa Major and M33 in Triangulum, difficult visual objects because of their low surface brightness, showed distinct spiral arms and many knots of stars filling the video screen. Dust lanes near the core of M31 were easily seen, but the full galaxy is too huge for the modest field of view of the Mallincam set-up.

Here are a couple of Mallincam screen captures.