SkyWAAtch

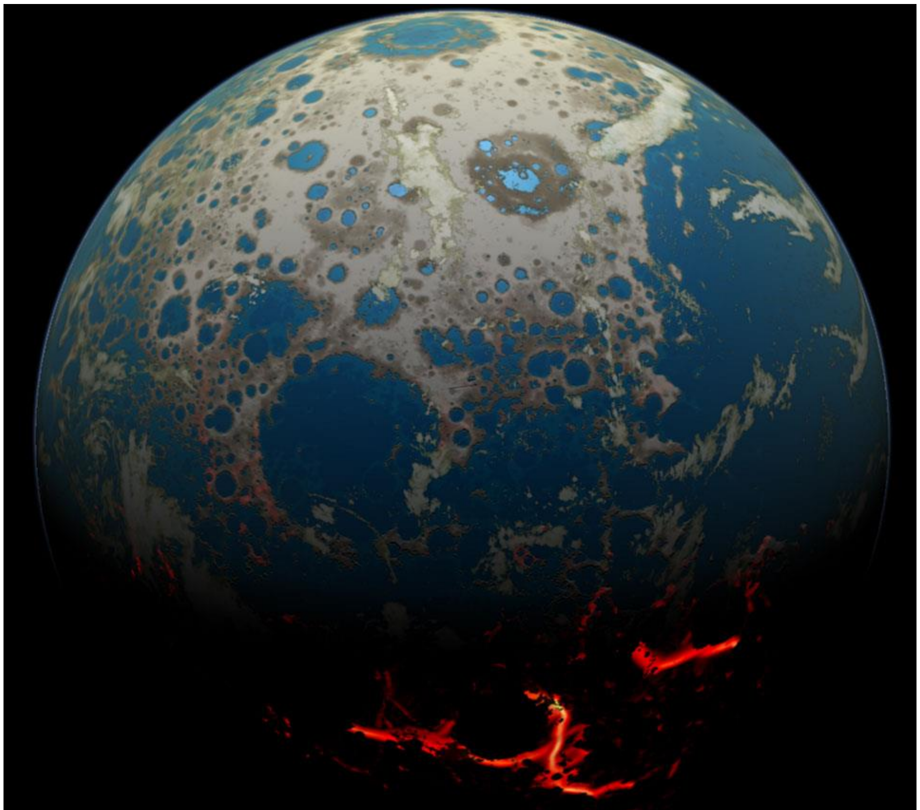


Illustration Credit: Simone Marchi (SwRI), SSERVI, NASA

When the Earth Was Young

Four billion years ago, our Solar System was a dangerous shooting gallery of large and dangerous rocks and ice chunks. Recent examination of lunar and Earth bombardment data indicate that the entire surface of the Earth underwent piecemeal upheavals, creating a battered world with no remaining familiar landmasses. The rain of devastation made it difficult for any life to survive. Oceans thought to have formed during this epoch would boil away after particularly heavy impacts, only to reform again. The above artist's illustration depicts how Earth might have looked during this epoch, with circular impact features dotting the daylight side, and hot lava flows visible in the night.

Credit: APOD

In This Issue . . .

Events for August 2014

WAA Lectures

Lienhard Lecture Hall, Pace University Pleasantville, NY

As usual, there will be no WAA lecture for the month of August. Our Lecture series will resume on September 12th. During the Fall we have tentatively scheduled presentations by Victor Miller on the Galileo Jupiter Probe Mission; Dr. Caleb Scharf on his new book, and Dr. Michael Tuts on gravity.

WAA September Lecture

"Member Presentations Night"
Friday September 12th, 7:30pm
Lienhard Lecture Hall, Pace University Pleasantville, NY

WAA members will showcase their astrophotos, equipment and astronomical insights. Those wishing to present should contact the WAA Speakers Coordinator. Free and open to the public. Directions and Map.

Starway to Heaven

Saturday August 23rd, 8:00 pm.
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 rain/cloud date is August 30th. **Note**: By attending our star parties you are subject to our rules and expectations as described here. Directions.

New Members. . .

Roman Tytla - North Salem
Geoard & Susan Lewis - Mamaroneck

Renewing Members. . .

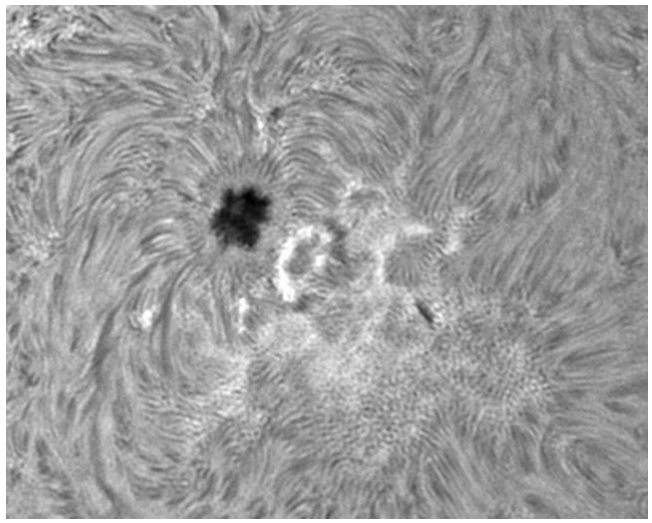
Arthur Linker - Scarsdale
Tom & Lisa Cohn - Bedford Corners
Enzo Marino - Harrison

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

Kopernik AstroFest 2014

This event will be held at the Kopernik Observatory & Science Education Center – Vestal, NY on October 24th and 25th, 2014. Presented by the The Kopernik Astronomical Society, the Astrofest will feature astronomy workshops, solar viewing, observatory tours and speakers from the amateur and professional communities as well as observing at night. To register and for more information go to the Astrofest website.

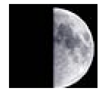
(Note this event is not affiliated with the WAA).



John Paladini took this image of a sunspot with his home-made 90 mm H-alpha scope.

The Rockland Astronomy Club Summer Star Party offered several nights of good to excellent viewing as well as considerable rainfall (5+ inches over two days). After the rain stopped, I took this image of a rainbow-like cloud (a sundog?) with my IPhone. A double rainbow occupied the other side of the sky. (Tom Boustead).

Almanac
For August 2014 by Bob Kelly


Aug 3


Aug 10


Aug 17


Aug 25

Sesame Street had an entertaining and educational segment called ‘Near and Far’ with a Muppet running away from and toward our television screen, getting progressively more out of breath with each trip.

On the 18^{th}, low in the eastern morning sky, the two brightest planets in our skies align. Jupiter makes a close pass by Venus on its way to morning sky domination. Venus is “near” us at 150,600,000 miles away while Jupiter is “far” at 576,300,000 miles. Find a good vantage point open to the eastern sky. Venus and Jupiter will be within a degree or two of each other from the 16^{th} through the 19^{th}. The next chance to see them this close together is next June.

On the 31^{st}, shortly after 1pm EDT, our Moon jumps in front of Saturn, from our point of view. At close to a billion miles beyond the Moon, Saturn looks tiny next to the Moon. The midday Sun and the low elevation of the Moon and the low surface brightness of Saturn will make either of the pair hard to see. Try shading your telescope from the Sun and use coordinates to point in the right spot. A filter to increase contrast in a hazy sky may help.

Mars and Saturn will waltz closer to each other this month. After Mars, Saturn and the first magnitude star Spica do a line dance across the southwestern sky after sunset, each about a fist-width apart in the sky for the first week of the month, with Mars 10.6 light minutes away, Saturn 1.3 light hours away and Spica 250 light years away.

Venus has been hanging out in the morning sky since January, and Mars is going to have a long goodbye as well, staying low in the southwestern evening sky well into 2015. In contrast, Saturn will be lapped by the Sun in a few months. Mars was fuzzy like dark pink cotton candy at our July Starway to Heaven. Venus is a tiny gibbous disk, at its dimmest for the next few months but still magnitude minus 3.9. Not much to see on either.

However, Saturn will be great fun to watch in a telescope! This month, the planet’s shadow will cover the greatest extent, a tiny notch of black on the part of the rings near the planet. Even in unremarkable seeing, Titan, Saturn’s largest moon, is visible.

Our Moon is closest to Earth the same day it is full, making our largest full moon of the year. This has little astronomical effect, but produces large effects on tides and blog columnists as well as providing an opportunity for great photos with foreground scenes at moonset and moonrise on the 10^{th}.

The Moon passes some lovely planets this month: Jupiter and Venus on the 23^{rd}; Mars, Saturn and Spica for few nights around the beginning and end of the month. Uranus is visible near the Moon on the morning of the 18^{th}. In July, the nearby Moon made Uranus easy to find. Even with a little twilight, the planet’s tiny disc was apparent in moderate power in my 8-inch telescope.

The Perseid meteor shower peaks on the night of the $12^{th}/13^{th}$. This is a reliable shower, but the nearly full Moon will wash out the fainter meteors. Block out the Moon and look for some bright meteors in the darkest part of the sky. It’s worth looking even a few days before and after the 13^{th}.

This is a great month for the Milky Way overhead. If you have an electronic camera with manual exposure settings, see how long an exposure you can take before the stars start to make trails and see how many stars you catch.

You’ll need clear skies and an open southern horizon to see the star clouds rising like ‘steam’ out of the ‘spout’ of the teapot at Sagittarius. Find a friend with south-facing beachfront property! Years ago, I had a great time at my wife’s uncle’s house near Horseneck Beach in Massachusetts looking out over the water at the clusters in Sagittarius and Scorpius with my 60mm refractor. Binoculars can help find where to aim the telescope. It’s also better without the Moon, the first few days of the month and the last half of the month.

The Earth comes to opposition with Neptune this month, easiest to see in the middle of the night. Later this year, Uranus and Neptune will be available higher in the sky during evening primetime.

If you are packing the car for an August vacation at oh-so-early-in-the-morning, look east to see our friend Orion lying on the horizon. He’s probably resting before beginning the long ascent high into our winter skies.

Into the Belly of the Beast: The ATLAS Detector
By Larry Faltz

Elyse and I arrived in Geneva, Switzerland on June 22nd to start a two-week vacation built around a visit to the ATLAS detector at the Large Hadron Collider at CERN, the European Organization for Nuclear Research. After a couple of days exploring Geneva, the historic lake-side center of watchmaking and international diplomacy, and a sunny boat ride on Lac Léman to the charming medieval French town of Yvoire, we took the tram from central Geneva to CERN, at the end of the #18 line, a 20-minute trip from city to suburbs. The tram station deposits you outside a fairly non-descript complex of buildings on one side of the street, but on the other side is a large wooden sphere, the "Globe of Science and Innovation," which marks the location as something out of the ordinary. In the Reception Center we met up with our guide, electrical engineer Dr. Thomas Hofmann, an expert in laser photometry currently working on a project to enhance the flux of protons in the collider, and a group of about 10 other visitors.

Our visit was arranged by Columbia University physics professor Dr. Michael Tuts, the US Operations Manager for the ATLAS experiment. Dr. Tuts spoke to WAA about the discovery of the Higgs boson last January and he noted that since the LHC was off-line this year for upgrades to its magnets in order to boost the power to its maximum design limit, one could actually visit the underground detectors. When the LHC is operating, the amount of gamma ray synchrotron radiation generated by the protons traveling along their radial course would be rapidly fatal to anyone in the device, and so it's not possible to give tours or even perform maintenance.

The LHC is a machine of discovery, very likely the largest and most complex machine ever built by the human race. It has a circumference of 26.659 kilometers (16.8 miles). At six points along its not-quite circular track there are detectors ("experiments") of varying designs, the largest of which is ATLAS, 150 feet in length, 83 feet high and weighing as much as the Eiffel Tower, over 7,000 tons. It has 100 million electronic channels and over 3,000 kilometers of cabling. It is served by a large staff of engineers and technicians and over 3,000 physicists process the enormous stream of data that the experiment produces.

The LHC is located just west of Geneva and Lac Léman. The headquarters are in Switzerland but most of the tunnel is in France (CERN)

The engineering marvels that are the LHC and its experiments embody all sorts of phenomenal details that went into their design and construction. For example, the tidal effect of the moon on the Earth's crust needs to be taken into account. The crust rises 25 centimeters in the Geneva area at full and new moons. This "ground tide" increases the circumference of the LHC by 1 millimeter, but this is significant enough to require an adjustment in the beam energy at those times!

The starting material for the accelerator is a small bottle of hydrogen gas. The gas is ionized and the protons' energy is boosted by circulating them through several smaller accelerators. When the protons enter the LHC, they are already traveling at 99.9998% of the speed of light. The LHC boosts that speed to 99.9999991%, which kicks each proton's kinetic energy up from 450 GeV to 7 TeV. Now, 7 TeV is actually not a whole lot of energy: 1 TeV is about the kinetic energy of a flying mosquito. But the energy is concentrated in an area the size of a proton, which is only 0.87 x 10^{-15} meters in diameter. That energy density is high enough to coax an occasional Higgs boson into existence from such a small space. The beam itself consists of bunches of about 10^{11} protons, with 2,808 bunches circulating at any one time. The protons make 11,254 circuits per second. I was once told that the beam energy is high enough to cook a pizza in 10^{-15} seconds. Where the beams cross in ATLAS, there are about 1 billion collisions per second, of which just a few are head-on enough to result in energy above the minimum needed to create the Higgs.

Without getting into too much detail about the science, the Standard Model of particle physics predicts that an energetic enough collision between two protons will produce a Higgs boson, which will decay into either a pair of gamma ray photons or a pair of Z bosons. The latter will then decay into electron-positron pairs or pairs of muons. The detectors look for those products. It's estimated that only 1 out of 10^{13} interactions will be energetic enough to produce a Higgs boson, perhaps one every 3 hours. As is well known, the Higgs was detected at a mass of about 125 GeV and a Nobel Prize was awarded in 2013 to Peter Higgs and Francois Englert, who predicted the existence of the particle in 1964.

The Globe of Science and Innovation was built as a temporary structure but now serves as an exhibit hall.

An excellent resource for details about the LHC, its experiments and its scientific goals is contained in a brochure, CERN FAQ: The Guide, available on line. It was written in 2008, before the system went operational, so it doesn't have any information on scientific results. There's a huge amount of information on the CERN website (with links to the web sites of the specific experiments), including the latest results and the story of the discovery of the Higgs boson. The ATLAS fact sheet is also very informative.

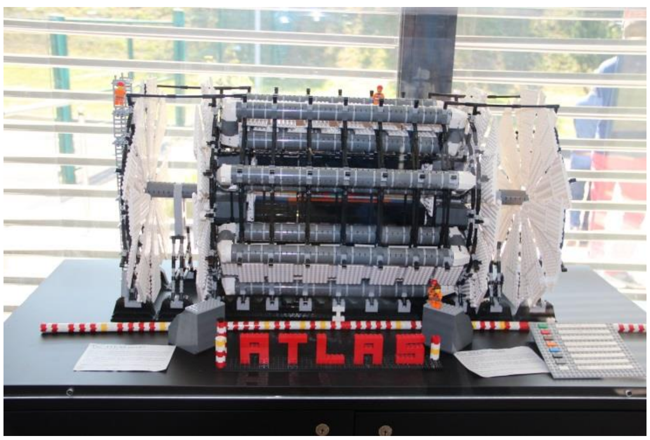
Our guide, Dr. Thomas Hofmann, explaining how the superconducting magnets work.

Our trip into ATLAS started by our group walking across the street to the Globe, next to which was a dipole superconducting magnet. These 35-ton, 15-meter long, 8.33 Tesla magnets, of which there are 1,232 among the 6,700 discrete magnets of 50 types in the LHC, operate at a temperature of 1.9°K (-271.3°C). There are also quadrupole, sextupole, octupole and even decapole magnets to control and finely focus the beam, and the various experiments have other magnets for detection purposes. After explaining how the magnets work and why cooling with liquid helium is required, Dr. Hofmann took us through an ID pass-controlled gate to the ATLAS control center building. A painting of the detector at ½ scale adorns its side. One hundred meters below ground, the actual detector sits in a huge cavern.

The building above ATLAS.

The ATLAS control room, just inside the entrance, was visible through a glass partition. Only a couple of engineers were inside and most of its monitors were switched off, as the accelerator is not scheduled to go back into operation until January 2015. There were some explanatory exhibits in the hallway outside the control room, including something that really intrigued Elyse, a model of ATLAS made from Legos.

ATLAS control room

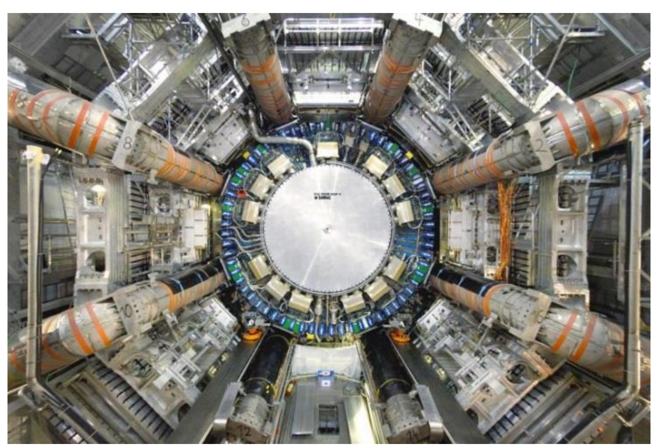


Lego ATLAS. You can buy a 500-piece ATLAS jigsaw puzzle at CERN (not on line, however).

Once in the ATLAS building, we noted large numbers of pipes, conduits, wires and equipment, the density of which was amplified when we went down the elevator 100 meters to the level of the instrument. We passed several banks of the many servers that are part of the system that handles the vast amount of data generated by the experiment (the data from one billion collisions per second would generate 100,000 CDs each second but a real-time filtering process results in final storage of a manageable 200 terabytes of analyzable physics data per year). At cavern level we were all given hard hats, mainly to protect us from banging our heads on low-hanging equipment, since it's relatively unlikely that pieces are falling off the ATLAS, at least we (and CERN) hope not. Then we walked down a long tunnel and through a metal security door which again required Dr. Hofmann's ID badge.

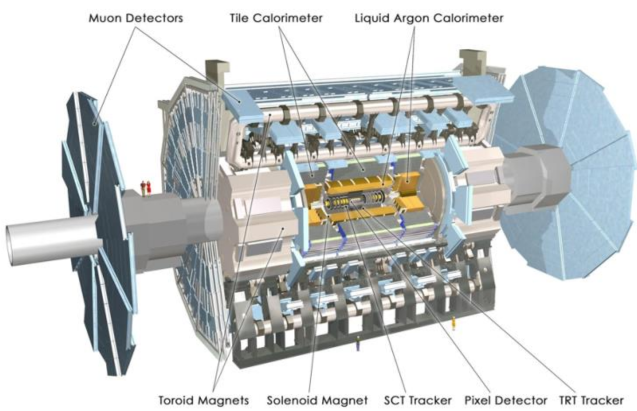
One bank (of many) of computers serving ATLAS

Our view of the ATLAS detector was from a walkway at about the level of the beam, at a location between the muon detector end-plate of the main part of the detector and the outside muon detector panel, the two detectors being about 20 feet apart. The floor-to-ceiling height was 83 feet, more than 5 stories. At first it was hard to figure out where we were and what was going on, until Dr. Hofmann oriented us. The actual collision site in the heart of ATLAS was about 60 feet to our left, hidden behind the mass of the muon detectors. I was disappointed not to have the famous end-on view that was widely circulated when the LHC was built (and prominently shown in the movie *Particle Fever*), but that perspective is no longer available to anyone since the muon detectors at either end of the main magnets were installed and the cavern filled in with equipment. ATLAS is built so that the particles coming from any collision in any direction will be detected and measured. That way, the physics of the particular collision can be reconstructed. So we didn't get to see the large tubes containing the toroidal magnets that surround the collision zone.



End-on view before the muon detectors were installed, looking along the beam axis (CERN photo).

In the cartoon below, our location was between the two muon detectors. The figures give an idea of the device's size.



Cutaway drawing of ATLAS (CERN)

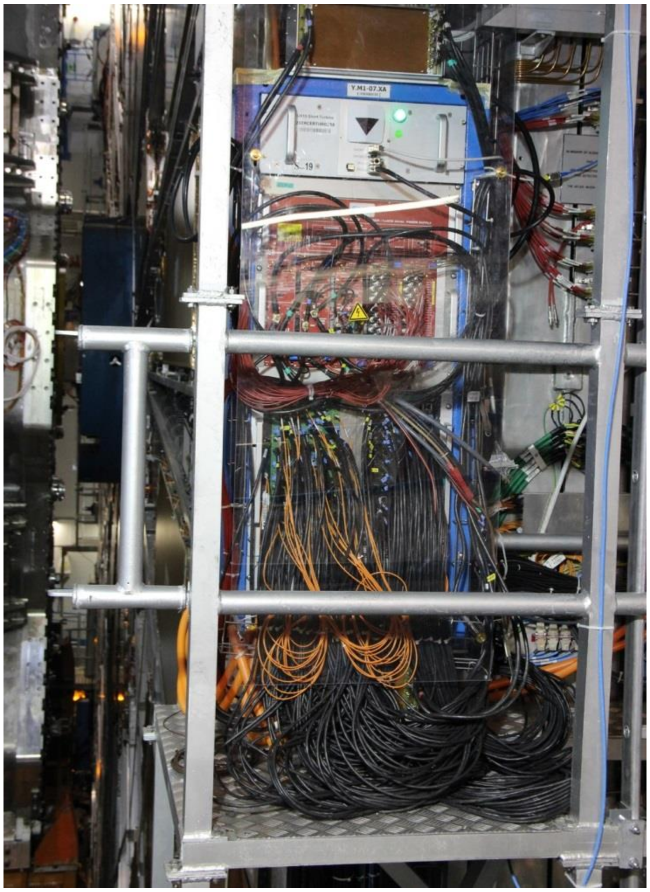
The first word that came into my head upon seeing ATLAS was "audacity." Who would have even thought to design and construct something of such overwhelming size and complexity? An image popped into my mind: the scene in *Forbidden Planet* where Dr. Morbius (Walter Pidgeon) leads Cmdr. Adams (Leslie Nielsen) and Lt. Farman (Jack Kelly) into the heart of the Krell power source, pointing out its dimensions. "Prepare your minds for a new scale of physical scientific values, gentlemen… [He points.] Twenty miles… Twenty miles." The ATLAS detector, one of the major experiments at the Large Hadron Collider at CERN, is utterly gigantic. Unlike the Krell machine, which was constructed out of their desire for mastery over nature (to their race's utter destruction, *hubris* not being reserved for human beings), ATLAS and the LHC are built only for obtaining knowledge of nature.

ATLAS is large, complicated, precise, orderly, meticulous, perhaps quintessentially Swiss. The number of wires, components and pieces of hardware was astounding, but everything had its place. The vast height and depth of the two muon detectors naturally provoked superlatives and outbursts of awe among the visitors. There were some passageways into the heart of the monster for engineers to do maintenance, but we were kept on the observing catwalk lest we do something stupid to the equipment or the vast network of wires or get stuck in a crawl space. "Curious amateur astronomer trips over wire, destroys world's largest particle detector" wouldn't be very desirable publicity for WAA or me personally. My photographs, any photographs in fact, are not capable of giving a true impression of the size and detail of the machine. You had to be there.

Looking towards the heart of ATLAS

Ultra-wide-angle photo (14 mm lens) of our view into ATLAS, with muon detectors on either side. The main body of ATLAS containing the colorimeters and solenoid magnets is some 20 meters to the left.

Dr. Hofmann explaining details



One of many wired components of the muon detector.

We spent about 25 minutes inside of ATLAS, while Dr. Hofmann discussed its operation and answered questions. Then it was time to leave, drop off our hard hats and ascend to the surface.

We went over to the Globe of Science and Innovation, which features a rather neat, quasi-psychedelic light show about particle physics, and then another hour or so in the Reception Center, where a fine museum has information about CERN, more details on particle physics, a lot of material on the data processing aspects of the project and some equipment from previous CERN experiments.

Elyse gets a charge in the museum

In the Globe of Science and Innovation

Then it was a short tram trip back to Geneva, a lakeside lunch and a visit to the Patek Phillipe Museum, where thousands of elegant timepieces, some dating back to the 16th century, were on display. It was an appropriate follow-up to ATLAS, which was described by one of the experimental physicists in *Particle Fever* as "a 5-story Swiss watch." Although a few early electronic table clocks from the 1960's were shown, the museum celebrates traditional mechanical, spring-driven analog timepieces with a particular emphasis on sophisticated, elaborately decorated pocket and wrist watches, and small table clocks.

On display was the Calibre 89, the most complex pocket watch ever created. Four were made to commemorate the company's 150th anniversary in 1989. The watch is able to display nearly every conceivable time-related function, including moon phases, sidereal time and even the moving date of Easter. All of this is done with 1,728 hand-made parts in a case that's 9 cm in diameter, 4 cm thick, weighing over 1.1 kilograms. You'll need a big pocket. And a big pocket-book. If you want one, expect to pay one of the 4 current owners $10 million, perhaps more.

One of many display cases in the Patek Phillipe Museum (Patek Phillipe)

The Calibre 89, the most complex watch ever made (Patek Phillipe).

But the Calibre 89, indeed to my way of thinking all of the vast number of mechanical watches on display at the museum and in almost every store window in Switzerland, is just an elegant obsolescence. It was built to show off a technology that, in the digital age, is almost functionally irrelevant. All of the Calibre 89's functions, and more, are available on a relatively inexpensive smart phone, in a format that's more accurate and easier to read. Of course, it's a piece of jewelry, perhaps even art, and it makes a definite statement, but it's a decadent kind of progress for sure. Mechanical watches at this point are only valuable if you are traveling a long time away from civilization and would not be able to find a replacement battery for your watch, or maybe in the case of a Carrington Event, which results from solar emissions strong enough to destroy the power grid as well as portable electronic devices. But then, would you want to keep track of time in the ensuing global chaos?

Although most of the technology for the LHC and its detectors is thoroughly modern, there's still a bit of traditional technology around, not the least of which is the tunneling required to bury the accelerator. The Swiss are inveterate tunnelers, a regular race of gophers. Their magnificent rail system depends on over 1,000 kilometers of tunnels, facilitating transportation between cities and to mountain towns (or tops) that cannot be reached by car. Some of these tunnels are graded and curved inside the mountains. We took the electric cogwheel train from Kleine Scheidegg to the Jungfraujoch, a 9.3 km distance 80% of which is *inside* the Eiger and Monch mountains. The route, starting at 6,762 and ending at 11,332 feet, was opened in 1912. At the current time, the Swiss are building a railway tunnel under the Gotthard pass, scheduled to open in 2016. It will be 35.4 miles long.

The tunnel for the LHC was originally excavated for its precursor collider, the Large Electron-Positron Collider (LEP) which operated from 1989 to 2000 and eventually reached particle energies of 209 GeV (as compared to the LHC's 7 TeV [7000 GeV]). The W and Z bosons were discovered at the LEP.

For all of the technological wonder encountered on our trip (which also included a visit to the Bern apartment Albert Einstein lived in during the *annus mirabilis* of 1905, among many other sights and experiences), the most unexpected highlight turned out to be a natural phenomenon, the Alpenglow. We spent 3 days in the small mountain ski town of Wengen, beneath the Eiger, Monch and Jungfrau mountains. One evening before a very late near-solstice sunset, we sat on a bench above the town, overlooking the Lauterbrunnen valley and its waterfalls. In front of us, the massive Jungfrau was bathed in fading sunlight. As the Sun set, the color of the snow slowly began to change, becoming a subtle, almost fluorescent pink that intensified as the light faded. Exposed rock high up on the mountain took on a rich brownish color. The hues morphed ever so slowly and dramatically. Elyse and I watched quietly as the colors grew more intense and electric until the sun was far enough below the horizon that its red wavelengths no longer refracted onto the mountain, and the effect suddenly disappeared. Although Alpenglow isn't specific to Switzerland, it was in these very mountains, the Bernese Alps, that it was experienced, named and popularized by Grand Tour travelers in the late 18^{th} and early 19^{th} century, inspiring poets, artists and composers (for a musical representation, try Richard Strauss' *Alpine Symphony*). I didn't try to photograph it. It's an experience, not an image. So was ATLAS.

The Invisible Shield of our Sun
By Dr. Ethan Siegel

Whether you look at the planets within our solar system, the stars within our galaxy or the galaxies spread throughout the universe, it's striking how empty outer space truly is. Even though the largest concentrations of mass are separated by huge distances, interstellar space isn't empty: it's filled with dilute amounts of gas, dust, radiation and ionized plasma. Although we've long been able to detect these components remotely, it's only since 2012 that a manmade spacecraft -- Voyager 1 -- successfully entered and gave our first direct measurements of the interstellar medium (ISM).

What we found was an amazing confirmation of the idea that our Sun creates a humongous "shield" around our solar system, the heliosphere, where the outward flux of the solar wind crashes against the ISM. Over 100 AU in radius, the heliosphere prevents the ionized plasma from the ISM from nearing the planets, asteroids and Kuiper belt objects contained within it. How? In addition to various wavelengths of light, the Sun is also a tremendous source of fast-moving, charged particles (mostly protons) that move between 300 and 800 km/s, or nearly 0.3% the speed of light. To achieve these speeds, these particles originate from the Sun's superheated corona, with temperatures in excess of 1,000,000 Kelvin!

When Voyager 1 finally left the heliosphere, it found a 40-fold increase in the density of ionized plasma particles. In addition, traveling beyond the heliopause showed a tremendous rise in the flux of intermediate-to-high energy cosmic ray protons, proving that our Sun shields our solar system quite effectively. Finally, it showed that the outer edges of the heliosheath consist of two zones, where the solar wind slows and then stagnates, and disappears altogether when you pass beyond the heliopause.

Unprotected passage through interstellar space would be life-threatening, as young stars, nebulae, and other intense energy sources pass perilously close to our solar system on ten-to-hundred-million-year timescales. Yet those objects pose no major danger to terrestrial life, as our Sun's invisible shield protects us from all but the rarer, highest energy cosmic particles. Even if we pass through a region like the Orion Nebula, our heliosphere keeps the vast majority of those dangerous ionized particles from impacting us, shielding even the solar system's outer worlds quite effectively. NASA spacecraft like the Voyagers, IBEX and SOHO continue to teach us more about our great cosmic shield and the ISM's irregularities. We're not helpless as we hurtle through it; the heliosphere gives us all the protection we need!

Want to learn more about Voyager 1's trip into interstellar space? Check this out: http://www.jpl.nasa.gov/news/news.php?release=2013-278.

Kids can test their knowledge about the Sun at NASA's Space place: http://spaceplace.nasa.gov/solar-tricktionary/.

Image credit: Hubble Heritage Team (AURA / STScI), C. R. O'Dell (Vanderbilt), and NASA, of the star LL Orionis and its heliosphere interacting with interstellar gas and plasma near the edge of the Orion Nebula (M42). Unlike our star, LL Orionis displays a bow shock, something our Sun will regain when the ISM next collides with us at a sufficiently large relative velocity