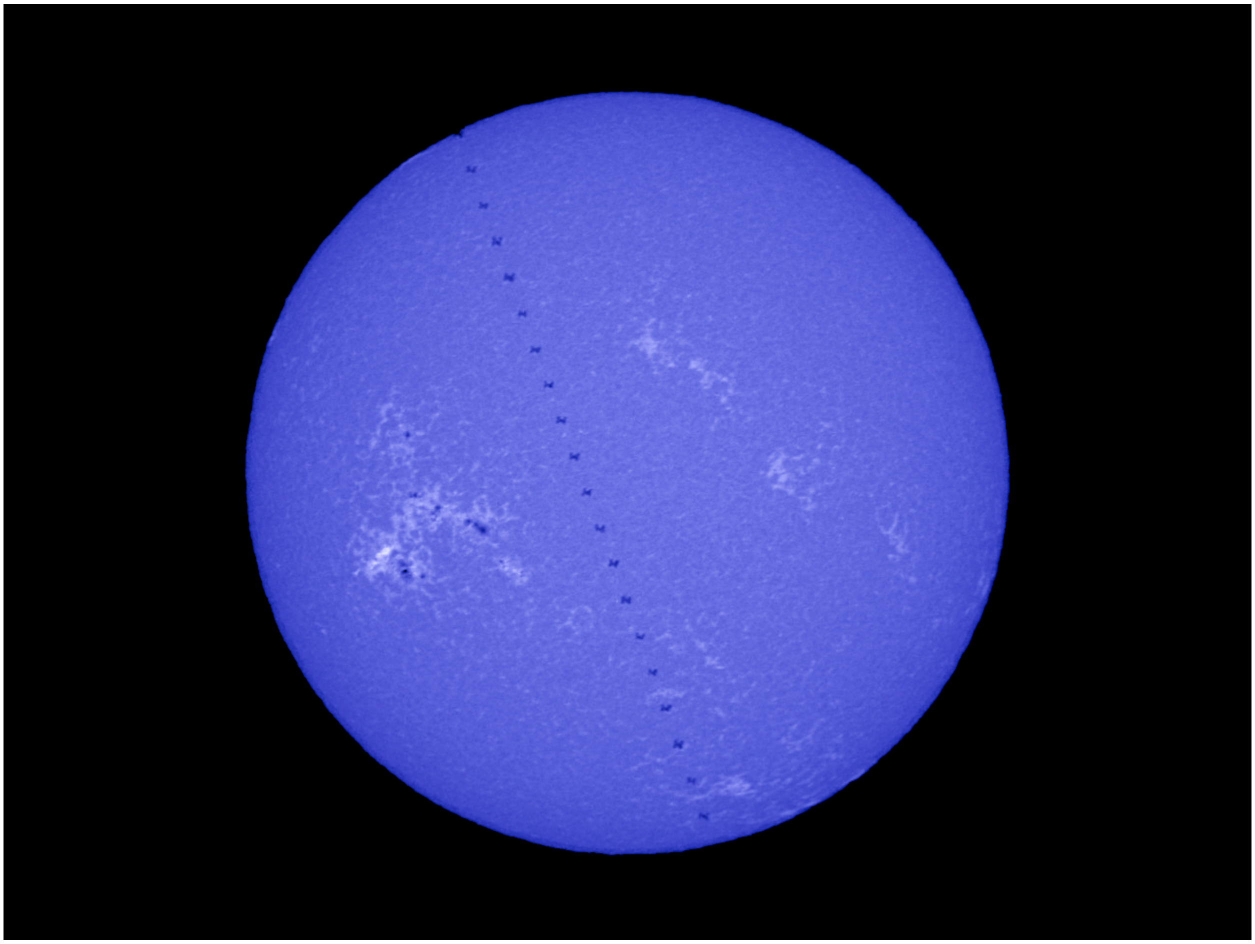
SkyWAAtch



ISS Solar Transit

Charles Higgins took this image of the International Space Station transiting the Sun from a spot outside of Oriskany Falls, NY using Barlow Bob's 70mm CaK scope (20 frames combined). Notes Charles: As predicted, at 11:48:38 am (on January 19th) the ISS passed overhead . . . The detail isn't that great. The sun was only at 26 degrees, the ISS was 500+ miles away, and a front was coming in (lots of wind both on the ground and high in the air). Even so, I was pretty pleased to get anything. The entire transit lasted about 1.5 seconds.

Check out Barlow Bob's website for information on solar observing.

Events for February 2012

WAA Lectures

"Telescopic Infrared Spectroscopy to Measure Planetary Atmospheres"
Friday February 3rd, 7:30pm
Miller Lecture Hall, Pace University
Pleasantville, NY

Br. Robert Novak will describe the images taken by an infrared spectrometer attached to a telescope along with the methods used to interpret those images. The end result of this imaging is a global map of the distribution of the atmospheric gas across the planet Mars. Br. Robert is a Professor of Physics and Chair of the Physics Department at Iona College; he has been a full time faculty member there since 1980. He holds degrees in Physics from Iona College (B.S., 1972), Stevens Institute of Technology (M.S., 1977), and Columbia University (M.Phil, Ph.D., 1980). Since 1996, he has worked with the Astrobiology Group at NASA's Goddard Space Flight Center in Greenbelt Maryland. The Group studies comets and the atmosphere of Mars using ground based telescopes. Free and open to the public. Directions and Map.

Upcoming Lectures
Miller Lecture Hall, Pace University
Pleasantville, NY

On March 2nd, Br. Novak will present a lecture entitled "The Latest on Water on Mars with a Description of the Launch of Mars Curiosity". Free and open to the public.

Starway to Heaven

Meadow Picnic Area, Ward Pound Ridge Reservation, Cross River

There will be no public *Starway to Heaven* in February. *Starway to Heaven* events will resume in March 2012.

Renewing Members. . .

Roger Woolcott - Brewster
The O'Rourke Family - Mamaroneck
Kevin Shaw - Yonkers
Warren Lindholm - Cortlandt Manor
Doug Baum - Pound Ridge
Dave Parmet - Pound Ridge
Mandira Roy - Hastings-on-Hudson
Harry Butcher - Mahopac
Michael Rinaldi - Scarsdale

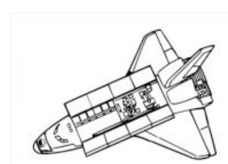
WAA APPAREL

Charlie Gibson will be bringing WAA apparel for sale to the February meeting. Items include:

•**Hoodies, $22** (navy with heather gray trim)
•**Tee Shirts, $10** (navy, royal blue, and white).
•**Long Sleeve Polos, $17** (navy).

Belt of Venus

Larry Faltz captured this image of the 13-day old moon rising over the Bronx and above the "Belt of Venus." The Belt is the reddish band of scattered sunlight that can be seen above the earth's shadow opposite the sun just after dusk or before dawn. (Taken from Fort Tryon Park near the Cloisters, January 7, 2012.)



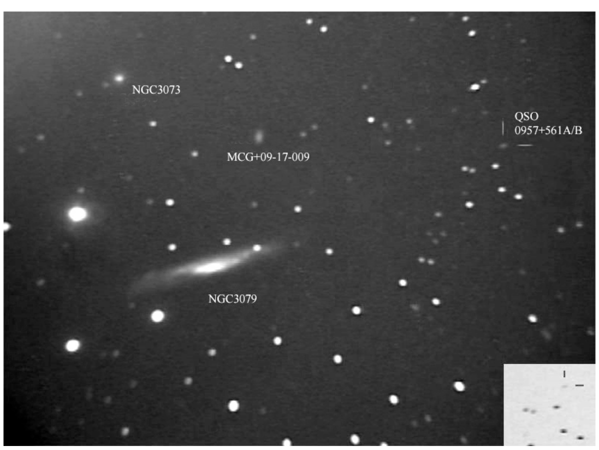
Westchester Amateur Astronomers, Inc., a 501(c)(3) organization, is open to people of all ages with the desire to learn more about astronomy. The Mailing address is: P.O. Box 44, Valhalla, New York 10595. Phone: 1-877-456-5778. Observing at Ward Pound Ridge Reservation, Routes 35 and 121 South, Cross River. Annual membership is $25 per family, and includes discounts on *Sky & Telescope* and *Astronomy* magazine subscriptions. Officers: President: Doug Baum; Senior Vice President: Larry Faltz; Vice President Public Relations: David Parmet; Vice President Educational Programs: Pat Mahon; Treasurer: Rob Baker; Secretary/Vice President Membership: Paul Alimena; Vice President Field Events: Bob Kelly; Newsletter: Tom Boustead.

Articles and Photos

A Remnant of the Early Universe
by Larry Faltz

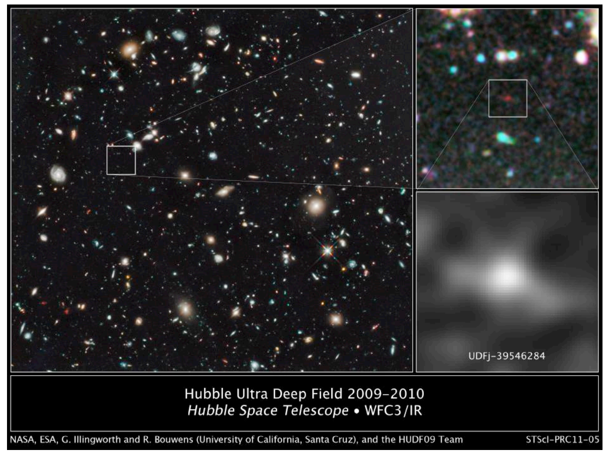
One of the most charming aspects of our Ward Pound observing nights is the reaction of "newbies" to the view of a distant galaxy. Often, when told that the light from that object started its earthward journey millions of years ago, their reaction is an outburst of excitement and amazement. It's the time, not the distance, that most enthuses them. Telescopes are time machines.

It's hard to see the early universe. Most visual "faint fuzzy" galaxies we see in our telescopes at Ward Pound are less than 100 million light years away. The most distant object we've seen is the Twin Quasar in Ursa Major, QSO 0957+561A/B. Taking up a challenge from John Paladini, on a particularly clear night at the May 2010 *Starway to Heaven* we used my Celestron CPC800 with a Mallincam Color Hyper Plus video camera to see this 16.7 magnitude gravitationally split (from an intervening even fainter galaxy) active galactic nucleus, although we were unable to fully resolve its two components at the focal length we were using. At a distance of 7.8 billion light years (red shift 1.4), the object is not all that far away when we consider the *really* early universe.



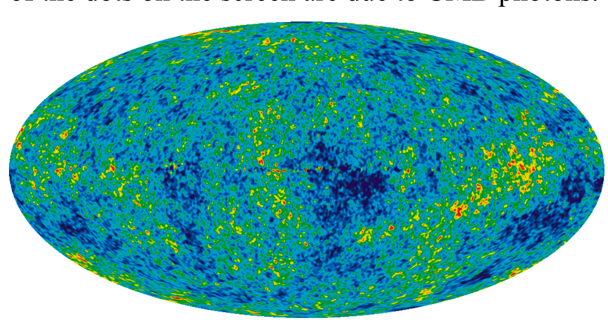
Our Mallincam screen shot of QSO 0957+561A/B, May 15, 2010

As we go further back in time and distance, we see older objects with larger red shifts. The youngest galaxy detected to date, in the Hubble Ultra Deep field, is estimated to be 13.2 billion light years away, its light starting out just 500 million years after the Big Bang, which occurred 13.7 billion years ago. It has a red shift of about 10. Galaxies from that era appear to be small, hydrogen-rich, and have intense star formation rates.



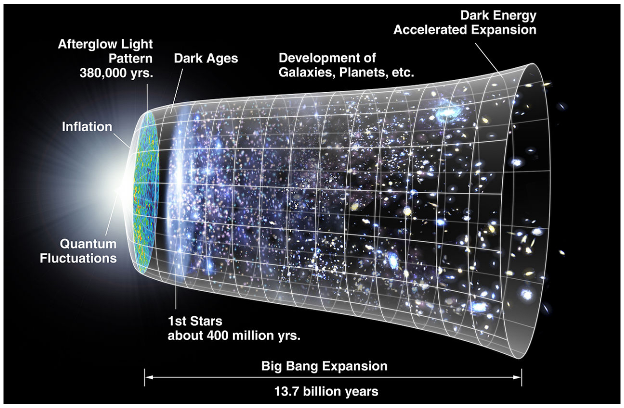
The most distant galaxy seen by Hubble (so far)

The only "object" we can see from an earlier epoch is the cosmic microwave background (CMB), the image of the universe 377,000 years after the Big Bang. This is the so-called "surface of last scattering", when the universe became transparent to photons. It's the image of the slight temperature differences that arose from quantum fluctuations in the newborn universe. The red shift of the CMB is 1,089. Although we can't see it as an image in our telescopes, there is a way to see some of its photons. Disconnect the antenna from an old *analog* TV and tune to any channel. You'll see lots of static, electrons shot from the set's cathode ray tube when the receiver encounters a photon in the right frequency range. About 1-2% of the dots on the screen are due to CMB photons.



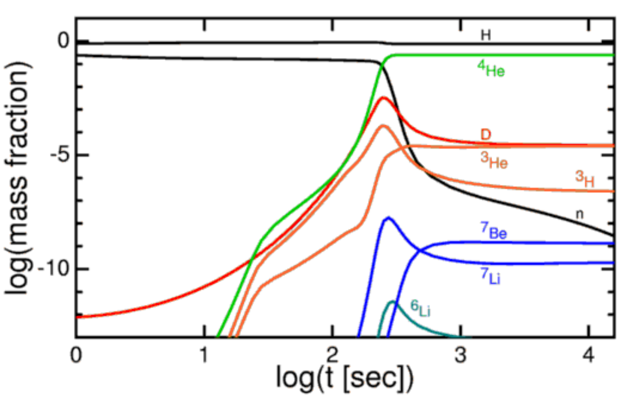
The Cosmic Microwave Background (7-year Wilkinson Microwave Anisotropy Probe (WMAP) data)

The one-microsecond-old universe consisted of electrons and quarks. The quarks condensed into equal numbers of protons and neutrons in thermal equilibrium. Neutrons are slightly (0.1%) heavier than protons, so as the universe cooled the equilibrium shifted in favor of protons. When the temperature was lower than the mass difference (10^9 ºK), 3 minutes after the Big Bang, the ratio was frozen at 7:1.



The evolution of the universe (NASA/WMAP)

Over the next seventeen minutes, the neutrons fused with protons into nuclei, but continued expansion and cooling (to $4*10^8$ ºK) eventually stopped the process. The chemical composition of the universe was about 75% hydrogen, 25% helium-4, and trace amounts of deuterium, helium-3, tritium, lithium, and beryllium. These abundances are by weight, which means the actual number of hydrogen nuclei to helium nuclei is 12:1, not 3:1 (since each helium nucleus is 4 times heavier than a hydrogen nucleus). We know that nuclei formed at this time, because if they hadn't, all the free neutrons would have decayed (by beta decay, with a $t_{½}$ of 617 seconds) into protons, and the universe would have consisted of 100% hydrogen. Cosmic abundances of the elements and subsequent evolution of the universe would be different.



Cosmic abundances in the early universe (from Wagoner/UCLA)

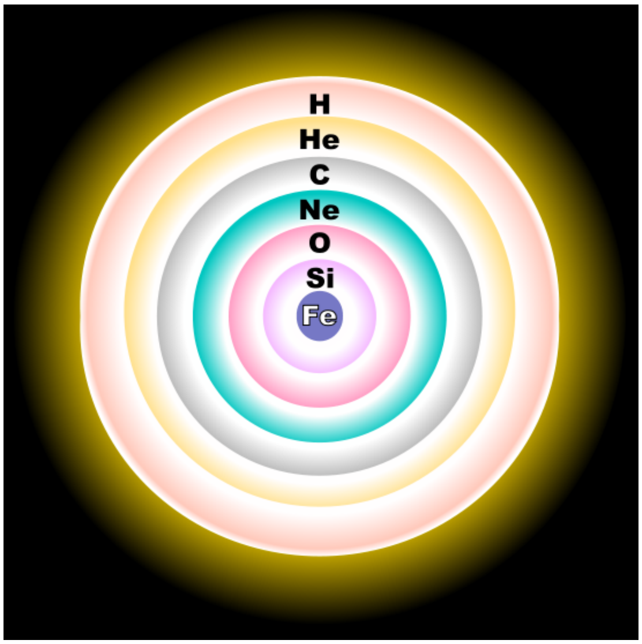
The concept of Big Bang nucleosynthesis was originally proposed in a famous paper by Ralph Alpher, Hans Bethe and George Gamow published in 1948 (Bethe's name was puckishly included by Gamow so that in Greek the initials, the author's names would read "α, β, γ") and amplified by Wagoner in 1973. A fairly straightforward review of the steps, with more detail than my brief description, can be found on a page at UCLA's web site.

The universe consisted of a plasma of ionized nuclei and electrons in a state of thermal equilibrium. When the temperature dropped to 3,000 ºK, the nuclei and electrons combined to form neutral atoms, allowing photons to travel freely (they're scattered by charged ions), producing the CMB and the surface of last scattering. Over the next 500 million years, hydrogen and helium condensed into the earliest stars. These stars have "low metallicity", a metal in astronomy being anything heavier than helium, since they are made from the primal atomic soup of the universe. These so-called Population III stars were large and massive, and as a result had short life spans, most terminating in a special type of cataclysm known as a "pair-instability supernova". In these large stars, energetic gamma rays produced during hydrogen fusion produce electron-positron pairs when they interact with other hydrogen atoms. These recombine and reradiate the gamma rays, but as a result of the interaction the distance traveled by the gamma rays is reduced. The core temperature rises faster and the gamma rays, in spite of their energy, can no longer support the stellar periphery against the gravitational pull of the core. Rapid collapse occurs.

X-ray image of a suspected pair-instability supernova (Chandra)

Stars ending their lives by this method weigh between 130 and 250 solar masses (stars over 250 solar masses don't explode; they just collapse into black holes). We can only deduce the properties of Population III stars; none have been unequivocally found to date. They are presumed to have formed at red shifts of 10-20, and the earliest galaxies were made up of these objects.

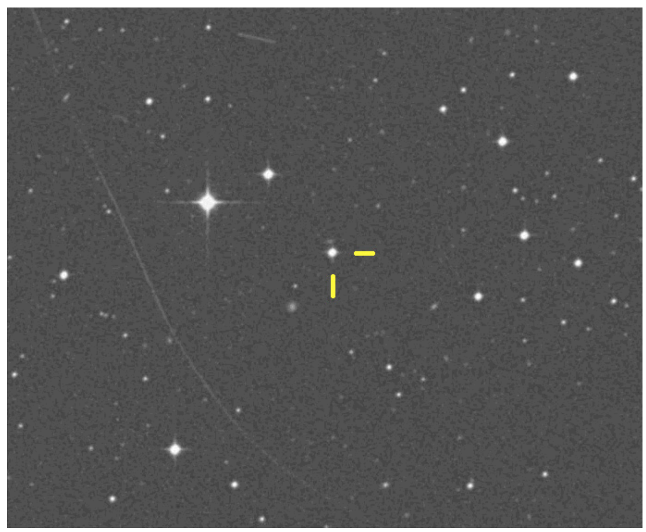
Elements heavier than helium are made in stars. Lighter "metals", from carbon through iron, are made by stellar nucleosynthesis during the star's lifetime. Elements beyond iron in the periodic table and other light isotopes are fusion products from the vast power of supernova explosions at the star's demise.



Chemical composition of the layers of a mature star just prior to core collapse

It would be expected that the aging universe would become enriched in metals. Stellar winds distribute the chemical species and stars forming in subsequent eras ought to have higher metallicity. Indeed, that seems to be the case. Population II stars, the next oldest generation, are still relatively metal-poor, but higher in metal content than the primordial universe. They tend to be found in the outer bulges and haloes of galaxies and they are the major component in globular clusters, which also surround galaxies. Population I stars, of which the sun is a typical example, are found in the arms and cores of galaxies. They are formed in the presence of higher metal concentrations later in the history of the universe, when at least the first two stellar cycles have already been completed. The metallicity of the sun is 1.8%. When stars form in the presence of metals, they have more intense solar winds and the balance between gravitational attraction and solar wind radiation is achieved at a lower mass and size.

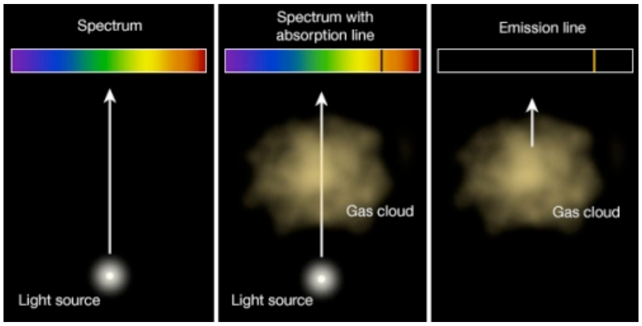
It's not just star-forming regions of galaxies that should be metal-enriched. Over the course of the lifetime of the universe, the composition of intergalactic gas ought to be influenced by the chemical products of stars coming from supernova explosions, gravitational mixing and galaxy interactions. Simulations of supernova behavior of primordial Population III stars suggest that the intergalactic medium should have had reasonable metallicity as soon as 1 billion years after the Big Bang (a red shift of about 5). The distribution of galaxies in clumps and walls would limit some of that mixing, as interstellar gas would be absent from the voids, but over large distances we should be looking through relatively metal-enriched gas. Indeed, metals have been detected in all astrophysical environments. Up to now.



Snedin's Star, BPS CS22892-0052, a Population II star in the Milky Way galactic halo (Sloane DSS/Aladin)

In a paper published in early December (Fumagalli, M, O'Meara, JM, Prochaska, JX, Detection of pristine gas two billion years after the Big Bang, *Science* 2011; 334:1245-1249), astronomers using the 10-meter Keck Telescope on Mauna Kea observed two regions of intergalactic gas at red shifts ~3.0 that appeared to have a composition similar to the early universe. These gaseous environments may be the source of material for metal-poor Population II halo stars (perhaps with near-Population III metallicity), and the very existence of these regions implies that transport of heavier atoms from galaxies to their surroundings is inhomogeneous. Galaxies forming later may have been seeded from similar pockets of primal gas, accounting for their haloes of metal-poor stars.

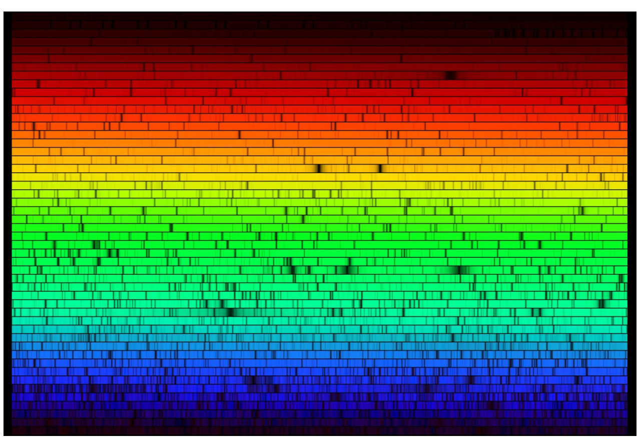
The group observed the spectra of two quasars (active galactic nuclei) with red shifts of 3.522 and 3.297 respectively. They studied the absorption lines in the spectra, which reflected the composition of the intervening gas.



The detection technique depends on Kirchoff's Laws of spectroscopy, formulated in the 1860's. The three laws are:

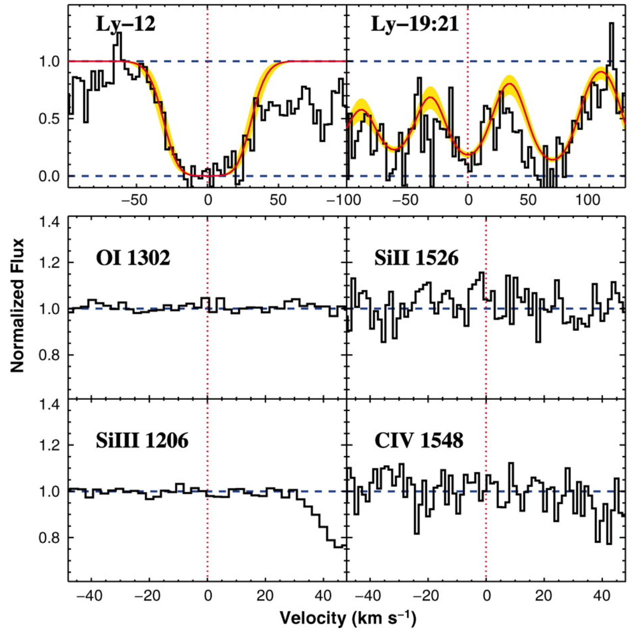
- A luminous solid, liquid or dense gas emits light of all wavelengths.
- A low density, cool gas in front of a hotter source of a continuous spectrum creates a dark line or absorption line spectrum.
- A low density, hot gas seen against a cooler background emits a bright line or emission line spectrum.

When we look at the sun through a spectroscope, we see both a continuous spectrum and absorption lines from atoms in the sun's surface and gaseous envelope, through which the solar photons must pass on their way to us. Except for lines from hydrogen and helium, all the other lines are from metals.



The solar spectrum (McMath-Pierce Solar Observatory, Kitt Peak/ NOAO). Absorption lines are superimposed on a continuous background emission spectrum.

Fumagalli *et. al.* found strong absorption lines from the Lyman-alpha transition of hydrogen while there was little variation from baseline for the heavier atoms. Since the gas had a red shift of about 3.0, it is "recent" in cosmological terms, and the absence of metals is surprising. The content of the gas comes from the sum of the absorption intensities; its distance comes from the lines' red shifts.



Part of Fig. 3 of Fumagalli *et. al.*, showing Lyman alpha transitions from hydrogen in intergalactic gas (upper panel) but minimal activity from heavier atomic species (red line = best fit model).

A conclusion from the data is that it would be possible for brand-new Population III stars to form in these gaseous regions, some 2 billion years later than we would have expected them to do so. Some metal poor stars in the periphery of galaxies could be much younger than we might think if they arose in one of these pockets.

The technical details in paper are necessarily intricate, reflecting sophisticated exploitation of the scientific details of spectroscopy and complex extrapolations and corrections based on earlier studies (common to all valid research). This isn't Galileo's or Herschel's astronomy anymore. Research teams today don't just point their telescopes, pop in an eyepiece, have a look and get to say, as Galileo might have, "Mamma mia! Look at that!" A study like this also shows the fantastic power of spectroscopy, which has really been the major tool of astronomical discovery for a hundred years or more.

Opportunity Rover Spots Greeley Haven

As winter approached in the southern hemisphere of Mars last November, the Opportunity rover had a problem -- it needed a place to go. The reduced amount of sunlight impacting Opportunity's solar panels combined with the extra power needed to keep equipment warm could drain Opportunity's batteries. Therefore Opportunity climbed onto the 15 degree incline of Greeley's Haven, shown as the rocky slope ahead. The incline increased power input as Opportunity's solar panels now have greater exposure to sunlight, while also giving the rolling robot some interesting landscape to explore. Visible in the distance, beyond Greeley Haven, lies expansive Endeavour Crater, the ancient impact basin that Opportunity will continue exploring as the Martian winter concludes in a few months, if it survives.

Image Credit: Mars Exploration Rover Mission, Cornell, JPL, NASA

Almanac

For February 2012 by Bob Kelly

Feb 7 Feb 14 Feb 21 Feb 29

Welcome to February! The length-challenged month gets a one-day enhancement in 2012. 2012 was going to be even longer than 366 days, but the leap second planned for the end of June has postponed pending further review. Why might we need a leap second? Because each day is slightly longer than the 86400 seconds we've assigned to each 24 hours, when defined by wavelengths of cesium atoms. By this standard, each day the Earth takes too long to rotate by .002 seconds, which adds up to a second every year or so. Since the Earth's rotation varies (plus or minus by tiny, tiny amounts), the leap second does not occur every year.

Moving from the sublime to the ridiculous: Remember the (often parodied) scenes in romantic movies where a couple runs across a field toward each other in slow motion? Jupiter and Venus play the romantic leads gliding toward each other in our evening skies. Will they meet? Find out in March - or you can read ahead in an annual almanac or by using a planetarium program. This upcoming close encounter will be noticeable to everyone and we may get some calls about purported UFO sightings from people not used to seeing these two brightest planets in the night sky, with great opportunities to let everyone know that they, too can see our planetary neighbors.

Mercury and Mars join the evening show later in the month. Mercury peeks over the twilight horizon in the last two weeks of February into early March. On the other side of the sky, Mars rises earlier each night as we approach opposition in March. Mars brightens up from magnitude minus 0.6 to minus 1.2, but only gets to 13.8 arc second in size. Compare that to Jupiter's blazing minus 2.2 magnitude and 36 arc seconds size and Venus cracking the minus 4 magnitude mark and swelling to 17 arc seconds. Mars is at its aphelion in February, so our opposition in March will be one of the more distant of our close passes by Mars. So we'll have to strain to make out details on Mars this month, but the North Polar Cap was still bright in January. When I lock in on the white polar cap, my eyes have an easier time focusing on the tiny gray shadings. The gray markings show up when the summer Martian winds move the reddish dust off the darker volcanic rock. If you see this, you can rediscover why some observers thought that the wave of darkening looked like seasonal plant growth watered by the shrinking polar cap.

This month, Venus is following 42 degrees behind the Sun, and at two-thirds lit it's a good target for careful daytime observers as the Sun will precede Venus in the sky and make it less likely to make a surprise blinding appearance in the unwary observer's telescope. Mercury, gets out to 17 degrees behind the Sun, but at only magnitude minus one and 6.3 arc seconds wide, will be harder to find and harder than Mars to see details on, since its polar ice is carefully disguised under dust and rock. Mercury maxes out at 11 arc seconds, but then it is a thin crescent too close to the sun to observe. Sky and Telescope's annual SkyWatch 2012 has a great photo-diagram showing how Jupiter, Venus and Mercury would look at 50x, giving a better view of what these planets look like in a telescope.

Many almanacs, including this column, will tell you when the Moon is in the neighborhood of planets. Many will make special mention of when the Moon passes the Pleiades. Most of the time, you can use the Moon to point out bright planets, but most of the time the Moon overwhelms the fifth-magnitude-ish Seven Sisters. But when the Moon is in its crescent phases, the Pleiades and its neighbor the Hyades open cluster are easier to see. Combine these open clusters with the earthshine on the Moon – we have a great photo opportunity. Try it out over the next few months. In February, the gibbous Moon will pass these clusters on the 1st and an almost first quarter Moon passes by on the 28th and 29th. Compare these scenes when the crescent Moon and these clusters partner up in late March.

But let's see what the Moon can point out this February…. Mars and the Moon come up over the horizon together on the evening of the 9th. On the morning of the 13th, the Moon goes by Saturn, but gives it a wide berth, coming no closer than half a fist-width. Just after sunset on the 22nd, way low in the western sky, you can see if minus magnitude 1 Mercury is easier to see than the skinny Moon in the bright twilight. On the 25th, the Moon does its monthly photo-op with Venus. Venus gets the chance to outshine a fainter neighbor when Uranus is 0.3 degrees away at magnitude 5.9 on the 9th.

Early morning astronomy was good in January, with Mars brightening and Saturn's rings widening. One morning at the bus stop we saw three satellites pass over us. I later found they were the Air Force's X-37B, the International Space Station and a leftover rocket booster. So, it's always good to check the satellite sighting web sites to see what's up!

In February, the ISS is visible in the morning sky through the 5th, then in the evening sky from 10th through the end of the month. The Chinese space station, Tiangong, is often as bright as a first magnitude star, and is visible in the morning sky through the 13th and in the evening sky from the 21st into March. While the International and Chinese space stations are not in similar orbits, they might both be visible at the same time when their orbital tracks overlap one of these mornings.

I don't like getting up early. But when I get up early, I like to getting out to see the morning planets, finally getting to see the division in Saturn's rings (now magnitude 0.5, 18 arc seconds). But since I don't get up really early, I've missed Comet Garradd--the sky was too bright for faint wispy objects but still ok for bright planets. In February, Garradd will pass through the Draco gap of fainter stars between Ursa Major and Minor. Sweeping through the area with binoculars may capture this fuzzy visitor from the distant outskirts of our solar system.

Bob Kelly at http://bkellysky.wordpress.com