BPAA Newsletter

Battle Point Astronomical Association, Bainbridge Island, WA

ISSUE 56: MAY – JUNE 2003

MAY - JUNE - JULY CALENDAR

(Unless otherwise noted, all events are at the Edwin Ritchie Observatory, Battle Point Park)

May

May 1: Lecture Series 2003 7 p.m. Paul Middents; Cosmology, Bainbridge High, Rm. 311
New Moon 5:10 a.m.
May 7: BPAA Board Meeting 7 p.m.
May 9: First-quarter Moon 4:54 a.m.
May 10: Astronomy Day (See Calendar Notes, p.2 & President's Message, p.5.)
May 14: Member Meeting 7 p.m.
May 15: Lecture Series 2003 7 p.m. Paul Middents; Cosmology, Bainbridge High, Rm. 311
Full Moon 8:37 p.m.; Total Eclipse of the Moon 8:41 p.m.
May 22: Last-quarter Moon 5:32 p.m.
May 24: Star Party Battle Point Park. Beginner session 7 p.m. Paul Below
May 31: New Moon 9:20 a.m.

June

June 4: BPAA Board Meeting 7 p.m.
June 7: First quarter Moon 1:29 p.m.
June 9: Pluto at opposition (4435 million km from Earth)
June 11: Member Meeting 7 p.m.; Dr. Paul Hodge, University of Washington: "Higher Than Everest"
June 12: Venus, Mercury and the Pleiades close in northeastern predawn sky
June 14: Full Moon 4:17 a.m.
June 19: The waning gibbous Moon passes south of Mars in Aquarius
June 20: Mars and Uranus in conjunction
June 21: Star Party Battle Point Park. Beginner session 8 p.m. Paul Below
Summer Solstice 12:12 p.m.; Last-quarter Moon 7:46 a.m.
June 29: New Moon 11:40 a.m.

July

July 2: BPAA Board Meeting 7 p.m.
July 4: Grand Old Fourth in Winslow
July 6: First quarter Moon 7:33 p.m.
July 9: Member Meeting 7 p.m.
July 13: Full Moon 12:22 p.m.
July 16: First fragment of Comet Shoemaker-Levy 9 hit Jupiter (1994)
July 19: Star Party Battle Point Park. Beginner session 8 p.m. Paul Below
July 20: Apollo 11 landed on the Moon at Tranquility (1969)
July 21: Last-quarter Moon 12:02 a.m.
July 22: Last fragment of Comet Shoemaker-Levy 9 hit Jupiter (1994)
July 24 – 26: Table Mountain Star Party www.tmspa.com
July 29: New Moon 11:54 p.m.
July 31 – August 3: Mt. Bachelor Star Party www.mbsp.org

Calendar Notes:

It's Party Time! Star Party Time, that is. The first notable event in the region is the Table Mountain Star Party, which is being held later than usual this year, on July 24, 25 and 26. These later dates should mean clearer skies than usual. The following weekend, July 31 through August 3, is the Mt. Bachelor Star Party. This Star Party offers the amenities of the Mount Bachelor ski area. To me, personally, that means the availability of flush toilets. Then, on August 28-30 is the Oregon Star Party. OSP is for many the highlight of the Star Party season; it is well organized, offers truly dark skies, and features an always interesting array of speakers. Check out OSP's web site at www.oregonstarparty.org.

There are others; links can be found on BPAA's web site. And don't forget our own Star Parties, which will have a greater promise of clearer skies in the coming months than we've experienced in the past several months. Note that the Star Parties in June and July will begin at 8:00 p.m. rather than at 7:00 p.m.

In June, BPAA is featuring an interesting speaker, Dr. Paul Hodge. Dr. Hodge is a Professor of Astronomy at the University of Washington and Editor-in-Chief of the *Astronomical Journal*. Hodge's research has spanned subjects from interplanetary dust to the extragalactic distance scale and currently includes star-formation and galactic evolution, using the Hubble Space Telescope to investigate nearby galaxies. His lecture will be based on his recent book, *Higher Than Everest*. In the book, he conducts a virtual tour to exotic locations such as Mars' Mt. Olympus (much higher than Everest), the Moon's Alpine Valley, Venus' scorching Mt. Maxwell, the snows of Saturn's rings, and a high icy cliff on the smallest of Uranus' major moons. *Higher than Everest* is based on a popular undergraduate course on the planets that Dr. Hodge has taught for many years.

Check out the Seattle Astronomical Society's web site (www.seattleastro.org) for information on Astronomy Day programs in Seattle. BPAA is hoping to host an expanded Star Party on July 19—our regular Star Party date. Look for more details in the next newsletter.

Finally, a reminder that any member at any time who is planning to observe can invite others to join in by sending an email to bpaa@yahoogroups.com. To join our email group, send an email with your name to bpaa-owner@yahoogroups.com and we can enroll you. If you want to also have web access to the messages and files, you can join the yahoogroups by clicking the register link for new users on http://groups.yahoo.com/, and then you can request to join our group on this page: http://groups.yahoo.com/group/bpaa/. The system will send us a message, and we'll approve your request after we verify your membership. Diane Colvin (dcolvin@bainbridgeisland.net)

NEWS BRIEFS

The Department of Corrections

By Diane Colvin

In the last issue I reported the following information about the American Astronomical Society meeting in January:

"[W]e did learn during the course of the meeting one fundamental thing. Einstein was right. Among the many press releases issued during the meeting, one informed us that astronomers have now concluded that the speed of gravity matches the speed of light. This conclusion was drawn by measuring the amount that light from a distant star was deflected by the gravity of Jupiter as the planet passed in front of the star."

Turns out this may have been misinformation. *Sky and Telescope* (April 2003, p. 28) reports that this experiment didn't actually measure the speed of gravity, but merely measured the speed of light itself. Apparently, a mathematical mistake was made in a key equation.

Darn! I should have caught that. My apologies.

Morgan County Observatory Foundation

An AP article dated January 26, 2003 reports that a group of people in Berkeley Springs, WV have built an observatory with a telescope similar to the BPAA operation. Starting with a 16-inch Zerodur 'scope that had been out of use since 1994, they organized the Morgan County Observatory Foundation. Then they raised about $100,000 to build their observatory and repair the 'scope which celebrated its first public viewing this January.

Like BPAA's 27.5-inch, this 'scope is intended as an educational tool for the neighborhood. The Foundation is aiming to have a paid observatory staff who will both manage its program and teach classes in astronomy.

Wander Space

For an exciting, instructive 12-minute space trip, go to <http://spacewander.com > This is a NASA-based collection of space photos used on a journey stopping first at Mars and going on to glimpses of many galaxies.

The Check is in the Mail

By Diane & Harry Colvin

On April 9 BPAA Treasurer Eric Cederwall sent the Astronomical League a check in the amount of $2005.03 for the ISS-AT project. Thanks to the generosity of BPAA members attending the fund raising event on February 25 and of other individuals interested in the potential of the ISS-AT project, we were able to take full advantage of the matching amount of $1,000 approved by BPAA's Board.

This is the letter that accompanied the check:

April 9, 2003

Joanne Hailey, Treasurer, Astronomical League
1116 42nd Street
Des Moines, Iowa 50311

Ms. Hailey:

On behalf of the Battle Point Astronomical Association, I am pleased to present you with the enclosed check in the amount of $2,005.03 for the benefit of the International Space Station Amateur Telescope. BPAA held a fund-raiser for the ISS-AT project on February 25, 2003. As you know, Richard Berry was the featured speaker at this event. Individuals attending the fund-raiser generously donated $1,005.03 to BPAA for the project; BPAA is providing matching funds in the amount of $1,000.00.

BPAA is especially committed to the ISS-AT because it was first conceived by Mac Gardiner, President Emeritus and one of the founders of BPAA. We are hoping that our efforts will serve as a catalyst to other astronomical societies throughout the country. If each of the League's member societies held a similar fund-raiser, the continued progress of the ISS-AT would be guaranteed.

Sincerely,
Eric Cederwall, Treasurer, BPAA

Our thanks to all those who contributed: Michael Walker, Mauri Pelto, Marjorie Anderson, Diane and Harry Colvin, George McCullough, Allan and Helen Saunders, John Goar, Mac Gardiner, Bill and Anna Edmonds, Eric Cederwall, Jim Vaughn, John Rudolph, Sonny Tremoulet, Malcolm and Vicki Saunders, Miranda Mittleman, Bruce and Patricia Muggli, Barbara Johnson, and Paul Below. Special thanks to Allan and Helen Saunders, Mac Gardiner, and Miranda Mittleman, who together contributed almost half of the total amount raised from individuals.

Let's hope this local fund raising campaign burgeons into a national effort, ultimately leading to the fruition of the ISS-AT project, just in time for those "children now in diapers," who, as recognized in the Astronomical League's ISS-AT proposal to NASA, will constitute the "next generation of scientists, technicians and inventors."

Seeing Solar Flares

BPAA has ordered a Solarmax 40/5 that will arrive shortly at the Observatory. This is a filter that will allow us to look without damage to our eyes at the Sun during the day. With it, not only will we be able to see and study the Sun spots, but also to watch the flares as they erupt from the Sun's surface. Previously these were seen only during a total solar eclipse.

To Make the Money or Not

The "Pied Piper" of popular astronomy, John Dobson, could have made millions from his invention of inexpensive, home-made telescopes. According to the science section of *The Oregonian* (April 2, 2003), Dobson says, "I was the one who's always made fun of naming telescopes after people, and naming these [Dobsonians] after me is silly." Instead, his life-long goal has been to get people out onto the sidewalk, looking at the sky.

Long-period Multimode Pulsating Sub-dwarf B Stars

Stars that shake like St. Nicholas' belly? On a rainy night in July 1999 an undergraduate student at the University of Arizona, Melissa Giovanni, happened on what Elizabeth Green, the Steward Observatory assistant staff astronomer, said was the funniest looking light curve she'd ever seen. And with it was born a new field, asteroseismology, the study of light that pulsates regularly from a single star rather than from two stars revolving around each other. With this, not only has a new class of star been identified, but also a new way for astronomers to study how stars evolve.

Melissa Giovanni is a Kitsap County girl, a 1997 Central Kitsap High School graduate. Now a PhD candidate in UCLA's Earth and Space Sciences Department, she was joined in her research by other undergraduates; their studies have identified 23 such pulsating stars and have attracted astronomers from around the world to continue their work.

These sub-dwarf B stars are very hot, have little atmosphere, and quiver typically in one-hour cycles. They are far along in their evolution and have lost the giant red atmosphere that obscured their surface. Thus their helium-burning cores (rather than hydrogen-burning) are exposed to observers from the Earth. In the same way that geologists study earthquake-generated density waves to learn about the interior structure of the Earth, astronomers hope that these stars' jelly-like modes of 100 to 200 seconds and their hour-long periods will give them new evidence for understanding their interior structures and how they evolve.

BPAA Financial Summary: March 30, 2003

Total Assets and Equity:		$265,696
Income: March	$235	YTD $6,657
Expense: March	$984	YTD $1,652
Net Income: March	($749)	YTD $5,005

Eric Cederwall, BPAA Treasurer

ARTICLES AND REPORTS

President's Message
Paul Below

We recently received a letter from the BI Park District regarding a proposed cell tower in Battle Point Park. I immediately envisioned a hundred foot tall tower with flashing beacon lights and so (as you might imagine) immediately wrote a formal letter back to the Park stating our concerns with lights. I also included information from the US Fish and Wildlife Department on recommendations to limit the impact of towers on birds.

I then attended a Park Board meeting and discovered that my fears were unfounded. The proposal is to add a 10 (ten) foot high mast to the top of the water tower in Battle Point Park. I was assured that there would be no lights placed on the mast. There would also be a small footprint at the bottom of the tower where Cingular would place their equipment. I was also told that there would be no measurable increase in the background emissions, which means no health impact to us or other Park users.

I told the Park Board that, since there were no lights, and since a ten-foot mast would not materially obstruct the view of the sky from the Observatory Dome (except a very small spot low in the North right above the water tower), that BPAA would have no objections to the proposal. I suspect that if we were going to do radio astronomy from the Park that there might be some interference. However, since we have no current or future plans to do radio astronomy, I did not feel justified to raise an objection on that point alone.

The Board still had to finalize the agreement with Cingular. The attraction from the Park's view is that they would receive some regular income.

In other news, we received new glossy brochures from *Sky & Telescope* plus an even larger number from *Astronomy Magazine*. These provide great information for beginners and are in the Observatory, available for anyone to take away. Thanks to both of those companies for their support of amateur astronomy clubs.
We always encourage everyone to attend all or part of the Table Mountain Star Party, July 24-26, 2003, http://www.tmspa.com/. This year they will not be mailing registration forms. Their web site says the online registration forms will be available on May 23. So, remember to register online. Exciting news: Al Nagler will be one of the speakers at the Party this year so all you optics buffs will not want to miss that.

Finally, we have begun planning an annual Observatory Open House, tentatively scheduled for a warm Saturday. I have asked John Rudolph to arrange for clear skies on July 19, 2003 for this purpose. Please tell us if you would be happy to help with the event, or even better, offer to coordinate it for us! Contact any Board Member (our contact information is always on the last page of the *BPAA Newsletter*).

Astrobiology: Red Snow
By Bill O'Neill

A recent issue of *Science* (April 11, 234-237) reports a conference in Houston about the latest evidence from Mars-orbiting spacecraft on the history of water on the red planet. As we noted last summer (*BPAA Newsletter* July, 2002), instruments on Mars Odyssey detected water near the surface in both hemispheres. The latest measurements appear to confirm that a lot of ice is buried beneath a few centimeters of dry soil from the Martian poles down to about 60 degrees latitude. In the high southern hemisphere, ice is now reported to constitute 40-73% of the soil (by volume) averaged over hundreds of kilometers. (Terrestrial permafrost contains up to 30% ice.)

The data from Odyssey's Gamma Ray Spectrometer suite coincide nicely with photos taken by the Mars Global Surveyor, presented at the Houston "Microsymposium." Pole-ward of about 60 degrees (the terrestrial latitude of Greenland's southern tip), wherever the Mars Orbiter Camera scanned, the surface looks "as if meters of heavy snow lie upon the land. But when viewed at highest resolution, this smooth mantling… [shows] a pattern of closely spaced, meter-scale knobs that give a stippled or 'basketball' look to the surface." The texturing of this high latitude mantling could result from partial loss of the shallowest ice. Permafrost on earth can get similarly lumpy with warming. In the mid-latitudes between 30 and 60 degrees there appear to be scraps of this thin mantling scattered across the Mars-scape.

In the latest photo analysis, Brown University researchers find a progressive disruption as they approach the equator. "In places, the mantling (appears) partially stripped way, revealing multiple layers that total a few to ten meters in thickness. This dissected mantling is most abundant at about 40 degrees latitude."

The photographic evidence is supported by topographic data from Global Surveyor's Laser Altimeter, which "shows high-latitude terrain, smooth at a scale of tens to hundreds of meters, extending to 60 degrees, where it roughens…. topography and imagery both give the impression of a thin layer or layers (Cont. on p. 5)

of dirty ice that were once continuous above 30 degrees, but now look different because warming has driven out the ice up to a latitude of 60 degrees."

Inspection of 13,000 images from the Mars Orbiter Camera provides many examples of "viscous flow features," resembling the effects of rock-laden glacier flows on Earth. The evidence of viscous flows is greatest at 40 degrees, where the "dissected mantling" is most abundant. "Furthermore, the mysterious gullies – where liquid water seems to have flowed down steep slopes in the recent past – follow the same latitudinal distribution…they even tend to cluster in the same three or four places as the viscous flow features do." Lots of controversy remains about icy Mars, but the picture seems to be getting clearer.

THE MUG, THE MOON FACES AND THE GOATS – By John H. Rudolph

While attending the Utah Rock Art Research Association Symposium in Moab, UT three years ago, I bought a handsome mug with a well-known petroglyph printed on one side of the mug. The legend read, "Nine Mile Canyon, Eastern Utah." Nine Mile Canyon is actually almost 60 miles long, running from near Wellington in a northeast direction to the Green River. In early times the canyon must have been heavily populated as there is a river the full length with verdant benches and steep cliffs providing good defensive positions. The cliffs are richly embellished with petroglyphs, one of which was copied on my mug.

Fig. 1 *"Hunting Scene" at Nine Mile Canyon, Utah*

As you can see from Fig 1, this panel consists of lines of "goats," noses to tails with several figures with bows and arrows and some enigmatic figures imbedded in the lines of "goats." This panel has been interpreted as "a hunting scene," but why spend so much time and effort describing what was an ordinary activity in the lives of the native people? The more I drank tea from my mug and took time to examine the figures, the more I wondered if this scene had some deeper meaning.

Fig. 2 *Moon Faces on the Agate Pass Petroglyph, Bainbridge*

You may recall that I published my interpretation of the "Agate Pass Petroglyph Stone," (see Fig. 2) situated here on the northeast corner of Bainbridge Island. Because this stone serves as a station point where an observer can watch the equinox sunrises directly out of the Skykomish Canyon across Puget Sound, I believe that the faces pecked into the Nine Mile Canyon stone represent full Moons that occur each lunar month as the year progresses. In Fig. 2,if one calls the farthest right hand face the Moon occurring near the Summer Solstice "our June" and the next ones to the left, "July" and "August," one arrives at the sunburst that represents the Autumnal Equinox of our "September." Moving farther to the left are " October," "November," and finally at the far left end, "December," with the story of the Raven rescuing the Sun, the Moon and the stars from the Magician's lodge. Just as the Sun moves northwards from the winter solstice position, we can call the moonface with the crown "January," the next one "February" followed by the sunburst indicating the Vernal Equinox. Moving to the right we can call these Moon faces our "April" and "May" and finally back to our "June" and the Summer Solstice full Moon.

In the "Hunting Scene" shown in Fig. 1, there is a count similar to the Moon faces in Fig. 2. In the top line of animals, beginning at the left end, we have three, all connected. If we make the assumption that each animal stands for a lunar month, we can start with our "June," "July" and "August." The next figure is an armless horned entity of some importance representing the Autumnal Equinox, "September." A serpentine line of six lobes connects to the next animal, "October," followed by "November" and "December." Then, as happens in some years, there is an extra Moon.

The Winter Solstice is a dangerous time because if the Sun kept going farther and farther the world might became totally dark. The large hour-glass figure armed with a bow and arrow, leaning in a threatening posture toward the line of animals, can be what we call "Orion," complete with a prominent phallus instead of the classic sword. It guards against the danger of the Sun not turning back from the Winter Solstice, and thus keeps the cycle of the year. "Orion" does appear in the winter sky at a time appropriate to guard against (Cont. on p. 6)

the Sun's escape. Ignoring the extra Moon, the "blue" Moon, we can begin to count the remaining months from "December." Proceeding to the left we have "January," "February," and back to "March," the horned figure marking the Vernal Equinox. Then moving again to the left, we have "April," "May" and back to "June" again, completing the yearly round.

The lower lines of animal figures are not as clear as the upper line, but seem to represent the entire year of lunar appearances. Beginning at the left again, we have a diminutive "goat" that could represent, in each case, a small new crescent Moon. Each large "goat" has a small companion, and again, the figures are connected. In this array, the count begins at the left with new crescent and full Moon, "June," "July," and "August" leading to a round figure with a square head for the Autumnal Equinox of "September." This entity has a "goat" attached that may indicate the Moon of "September." The round figure with the belly band merely indicates the equinox. Moving to the next lower line we can find "October," "November," "December," "January," and "February." Then the bottom line has “March," "April," “May," and "June" with a rectangular figure with a half circle on each side marking the end of the year. Below is a single "goat" that may be the "sometime" extra "blue" Moon. To the right there seem to be several armed bowmen and a round figure (possibly with a round shield) preventing the groups of "animals," representing Moons in this interpretation, from getting out of order.

One glyph that I have no explanation for is the lower half of a human figure just to the left of "Orion." I can only hope that this article will stimulate the reader to look deeply into the petroglyph panels found throughout the world. It is evident that they are metaphorical and may well have layers of meaning.

MIDDENTS' LECTURES

By Cathy Koehler

Paul Middents' classes on archeoastronomy have covered the use of astronomy/astrology in ancient cultures. First was the Hebrew Lunar (or Lunisolar) calendar which has a 19-year cycle keeping the months tied to the moon and, over the years, their important celebrations in the correct season. The modern (western) calendar, the Gregorian, arose out of the Christian Church's desire to keep important events (notably Easter) within their seasons while reducing reliance on proclamations by the Jewish astronomers. To this day, the Churches are still striving to come to an agreement on a uniform dating of Easter. In contrast, the Muslim calendar is strictly a lunar one; thus their year is somewhat shorter than a solar year, and their dates drift through the seasons from year to year.

Mayan Temple at Chichen Itza (a possible Observatory?)

Moving to North America, we spent quite a bit of time with the Mayans who had one of the most sophisticated mathematical systems in the world. They were one of the few cultures to have a place-based number system (like the one we use today, the Arabic system; and in contrast to a non-place-based system, like the Roman). They had a zero; surprisingly, the West didn't understand zero until after the Dark Ages. I don't know about you, but this astonishes me, in light of the fact that Newton and Leibniz developed calculus in the 1600s. The Mayans were equally sophisticated in their astronomical observations and records; they were particularly interested in the cycle of Venus over the years, and they could predict eclipses well in advance.

We talked about the Chaco culture, commonly referred to as "Anasazi," a people who lived in the southwestern part of what is now the United States (the Four Corners area). They built surprisingly sophisticated cities (or centers of worship/ritual), and their cities and sacred sites were connected by mysteriously wide roads that were often lined up more or less on the cardinal directions, indicating an observation and understanding of what's happening in the sky.

The Polynesian Navigators also made sophisticated use of astronomy (as well as a wide variety of other factors). Their navigational know-how had been lost in many areas of the Pacific, but was kept alive in the Solomon/Marquesas Islands. Their ability to get around their watery environment using traditional methods rivals anything we can do with our "science." And, a reminder, these, like the peoples of the Americas, were a stone-age culture before European contact.

Because of much (inaccurate) speculation on understanding the Celts/stone circles of Great Britain, we also discussed them and their uses.

The lectures are always well-informed and feature up-to-date research, with lots of recommendations for further reading and web sites. Middents (Cont. on p. 7)

is a gripping lecturer. Cone and enjoy these last two, May 1 and May 15 at Bainbridge High, Room 311.

The Search for the Edge of the Universe

by Lyon McCandless

What person has not been impressed with the night sky and its many distant points of light, constantly wheeling overhead, but never changing? The fleeting meteor or comet visitors are a hint that there is probably more happening out there than we can see, or even imagine. What is at the edge of our universe? What would we see if we could somehow be at that limit?

After thousands of years, at last astronomers have discovered that the universe outside our solar system is far from being unchanging. It is full of billions of majestic galaxies moving, colliding, radiating energy at incredible intensities. In some places new stars and planets are being created, and in others stars are disappearing forever into black holes. And we have discovered that our heritage is quite literally in the stars, because our bodies contain iron and other heavy elements that did not exist in the early universe. Billions of years ago many giant stars fused light elements into heavier elements and exploded, seeding the universe with the elements essential for our life.

About 100 years ago we found that the Sun was only a medium-sized star nowhere near the center of an inconceivably huge spiral galaxy. In 1996 the Hubble Space Telescope was pointed at a very small, apparently blank area in between the stars in an attempt to explore totally unknown regions of the cosmos. An exposure of sixteen hours astounded even veteran astronomers. There were hundreds of very distant galaxies in the tiny area! Our own Milky Way galaxy alone contains more than one hundred billion stars, and we can see billions of galaxies, almost an unbelievable number. On a very large scale, the universe is homogenous and isotropic, that is, the same in all directions. The average density of matter in the universe is fairly constant. What we can see, even with the most powerful telescopes, is probably only a small part of the whole universe.

Edwin Hubble was the first to observe that distant galaxies were receding from ours, and that the rate of recession appears to increase linearly with distance. Later astronomers refined the accuracy of the 'Hubble constant' relating recessional velocity to distance, and showed that that relationship holds true for much greater distances.

The fact that almost all galaxies are receding from each other immediately suggests that the universe is expanding. This idea required a minor modification to one formula of Einstein's General Relativity theory. Projecting the expansion backward to find the common starting time is a difficult process, with some degree of uncertainty. The event was soon labeled the Big Bang. The current estimate is that the Big Bang started approximately 15 billion years ago. Note that there is *no starting place, no central point.* Moments after the start of the Big Bang the whole universe was contained in one infinitesimal ball of intense energy which then expanded in four dimensions just as a balloon expands in three.

Currently there is no agreement on how or why the Big Bang started. But there is good evidence that moments after the start of the Big Bang the universe was still extremely small, was completely filled with raw energy, and was expanding very rapidly. The energy was so intense that no matter could exist. As space expanded, the energy density dropped, and elementary particles became possible. At this stage space was *entirely filled* with quark soup and energy. Solid! You might say wall-to-wall matter, except that there were no walls due to the curvature of the space-time continuum. In several minutes the volume of the expanding universe became much larger and the energy density dropped enough to allow densely packed, fully ionized nuclei of hydrogen, helium, deuterium and lithium to form. After 300,000 years of expansion, the energy density was low enough to allow electrons to recombine with the nuclei, thus forming ordinary matter. During the *recombination* process each atom radiated a quantum of light at wavelengths specific to that element.

The light of the *recombination* was the first radiation free to propagate through the universe. Initially in the high ultraviolet end of the spectrum, it has spread through the universe for 15 billion years. As the universe continues to expand, the wavelength of the *first light* stretches and its intensity diminishes, but it still carries the spectral fingerprints of the first elements. This living signature of the Big Bang is still detectable as faint microwave background very evenly distributed in all quarters of the sky. Recently sensitive satellite instruments have detected very slight variations in the radiation. These patterns are perhaps analogous to sound waves in the densely packed primordial universe. Those 'sound' waves eventually resulted in the clumps of matter which were destined to become giant stars and galaxies.

The *first light* comes to us from all directions almost uniformly in the form of microwaves. It is the oldest possible signal that we will ever receive, since electromagnetic radiation at any wavelength was not possible in free space before then. In order to get a visual image we must wait a few hundred million years more after first light for galaxies and quasars to form. Let us look into that. The light elements newly created by the Big Bang were free to drift after *first light*. Slight variations in the original tightly packed mass caused them to clump together; with their very weak gravity, the clumps drew in other particles. Then somewhere between 500 million and a billion years later, stars, supernovas, black holes and galaxies were formed. (Cont. p. 8)

We know these events took place because astronomers can see these events happening. The speed of light, 186,272 miles per second, may seem very fast, but on an inter-galactic scale it is slow. But the low speed of light means that looking through a telescope at distant objects is like looking back in time. We can't see our own past because it is too close. When we look at the Moon we see the Moon as it was one second ago; the Sun six minutes ago; Jupiter an hour ago. We see the star Alpha Centauri as it was four years ago. Pity the paleontologists who have to study dead fossils! Astronomers can look back in time and see real stars, galaxies and clusters of galaxies full of energy, moving, exploding and interacting millions or even billions years ago.

Einstein showed that the universe is a multidimensional continuum with no boundary, just a curvature in the space-time continuum that bends three dimensional space back on itself. We don't have to understand the mathematics if we can accept certain of its implications. One is that if you could travel long enough in any direction you would end up where you started. This is analogous to a person traveling on a globe. He thinks it is flat and unending because he cannot see the Earth as a sphere. But if he goes far enough he will be back to his starting point.

Many of Einstein's predictions have been validated by experiment, and most astronomers accept his concept of a curved space-time continuum. The exact shape is the subject of much debate, and depends on how much matter is really present, which is another open question. What does this mean regarding the ultimate "Edge"? It means that space never reaches an edge or a boundary. Now thanks to Edwin Hubble, we know that *there is an absolute maximum distance that we will ever be able to see with any possible type of instrument*. It's an interesting edge, one that is easier to understand: the edge of the *observable* universe. If we had a perfect telescope, how far would we be able to see, and what is happening at this limit, the edge of the *observable* universe?

Many clues to the past of the cosmos lie in the distant, dim regions that are a challenge to the ingenuity of our astronomers. The best instruments are still not enough. But several natural phenomena have added significantly to our ability to detect and analyze distant objects. The first is the discovery of a class of very active galaxies called Quasars, these 'quasi-stellar objects.' At first, quasars were interesting only because they didn't fall into categories established for other galaxies. But when their extreme distances were determined, it was calculated that each quasar had a brightness exceeding one trillion times that of our Sun. Thus, quasars turned out to be near the limit of lookback time.

The second phenomenon that helped extend our view into the farthest reaches is based on a principle predicted by Einstein. Einstein suggested that the gravity of a large mass in space could bend light from a distant galaxy and magnify it much the way a lens magnifies light. This truly amazing process increases the intensity of light received by the Hubble Space Telescope by a factor of approximately 30. The distance and characteristics of the remote galaxy may then be determined by spectral analysis of the received light. The most distant galaxy observed to date using this technique is receding at 95% of the speed of light, and is at a distance of eighty billion trillion miles. It takes light 13.5 billion years (13.5 bly) to travel this distance. The universe was approximately one billion years old when light left that galaxy.

How far would we be able to see with a perfect telescope? By "perfect telescope" we mean a device that derives astronomical information from received electromagnetic waves of any wavelength. We will assume that the instrument is large enough and sensitive enough to collect the needed electromagnetic radiation if it exists (visible, X-ray, gamma ray, infra-red, radio, microwave). Assuming the perfect telescope, there are three other factors that determine the absolute limit to observations made from the Earth: the speed of electromagnetic radiation in space, the rate of expansion of the universe, and the age of the universe. Fortunately, many experiments have verified Einstein's premise that electromagnetic radiation propagates in vacuum at a speed that is constant (186,272 miles per second, or 3 x 10^{10} meters per second) for any inertial reference system, for any direction, and for all wavelengths.

What happens when an object under observation is receding at a high velocity? The velocity of the object has no effect on the speed of the light received by the observer. However, the frequency of the received light is shifted towards the red end of the spectrum due to the expansion of the universe. The most distant galaxy observed to date has a red shift factor of approximately five. This means that the wavelength of received light is five times as long as it would be for a stationary source. What would happen if the velocity of a receding object approached the speed of light? As the speed of the object approaches light speed the wavelength of the light received on Earth would approach infinity, and the received energy, which is inversely proportional to the wavelength, would approach zero. In other words, the object would be undetectable. Using the Hubble formula, we can calculate that an object at a distance of approximately 14.5 billion light years (bly) would be receding at the velocity of light. Any object more distant than 14.5 bly is receding from earth too rapidly, and is not viewable from earth by any means.

In summary, we can say that even a perfect telescope would be unable to observe objects beyond approximately 14 billion light years distance due to (Cont. on p. 9)

the redshift cutoff. This is very close to the time when stars and quasars were first formed after the Big Bang. Going back farther we would be in the dark period with no stars, only atoms of hydrogen, deuterium and lithium.

The question, “What could we see if we were near the edge of our observable universe?” leads to an area of inquiry that is generally skipped over lightly by most cosmologists. Suppose you were an observer in a galaxy 10 billion light years distant from Earth. The accepted model says that the universe is homogenous and isotropic on a large scale. This means that there are no special locations such as a center or a corner. The universe would appear much the same to an observer at *any location in the entire space-time continuum.* The lumpiness of black holes and clusters of galaxies averages out on a large scale. At a distance of ten billion light years from Earth you would see the same sort of universe that we see here, and you would also be limited to an observable distance of approximately 14 billion light years. You would see different constellations, but in general your night sky is much like ours. This is a somewhat dull answer to the question, “What could we see if we could be near that limit?”, but let us look into the implications.

Observations of distant objects from Earth are impossible when the velocity of recession approaches the speed of light. Yet if you were at the edge you would see galaxies more distant than the edge. We would like to say that the distant galaxies are receding at speeds faster than light, but the very term “faster than light” gets us into the Relativity trap because Relativity has grabbed the “light” yardstick as its prime directive. The mathematics of Relativity does not deal with speeds greater than the speed of light because Special Relativity is based on observation. “Observation” implies measurable relative parameters. We lack the mathematical tools to describe in detail what goes on in the region outside our observable universe because we have had no need for such mathematics. We must clear this semantics hurdle before much progress can be made. The idea that light is an absolute limit is so firmly entrenched that it inhibits scientific thought and funding for anything that would violate this principle.

SEEING STARS **Astronomy 0.001**

By Anna Edmonds

The planets we can see with our naked eyes in May and June are Jupiter and Saturn in the evening, Mars shortly after midnight, and Venus for about an hour just before sunrise. Mercury, which has put in a brief appearance, will be lost in the Sun’s glare before this *Newsletter* is published.

Uranus, Neptune, and Pluto all rise after midnight, but without a telescope we won’t be able to see them.

Besides looking for the steady lights in the night sky—an easy way to identify these planets this spring—a better way is to know their locations relative to the constellations. That means learning to find the constellations and then to hop around among them.

You probably already know several constellations. The Big Dipper (with its Pointers), the Little Dipper (with the North Star), and the lopsided “W” that makes the chair for Cassiopeia are always visible in our sky. (However, the Big Dipper does get low in the north in the fall evenings.) The planets are never so far north, but we can use these constellations to help find where to look for planets.

For instance, in May Jupiter will be with the constellation Cancer, moving towards the southwest as the spring progresses. A quick way to find Cancer (which is not a spectacular grouping of stars) is to pretend you can grasp hold of the handle of the Big Dipper. Then bang the bottom of the Dipper’s bowl straight down on the constellation Leo. You’ll know Leo because it has the 1st magnitude star Regulus, and the distinctive-looking circle of stars that makes a sickle or the lion’s mane. Having found Leo, look to the left for Cancer. By now you should easily have spotted bright Jupiter. With good binoculars you may be able to see four of its moons.

Saturn is farther on to the left between the constellations Gemini and Taurus. Gemini is marked by its two large, almost “twin” stars, Castor and Pollux. Saturn will be getting lost in the haze around the setting Sun by the end of May, so now is the time to look for it. If you have a telescope, you should be able to see its band of rings. They are tipped now relative to Saturn, making the width of the rings visible.

This spring looking at Mars is for people who are night owls. It will be rising around midnight way down in the East in the constellation Capricorn. As the year goes on Mars will rise earlier and earlier and grow brighter until at the end of August it will come closer to the Earth than it has ever been in recorded history. That will be the time to see it at its best.

Mars’ current constellation Capricorn, like Cancer, is not distinguished by any bright stars. You may need to do a bit of “star hopping” to get to it. For instance, from Cassiopeia in the northeast around midnight you can look farther east to see the Great Square of Pegasus. (Probably you already know Pegasus.) Then from Pegasus, looking about the same distance farther southeast you should be able to pick out Mars by its color. Mars will help you identify Capricorn, rather than the other way around.

So now you can use a couple of constellations that you knew already to hop around among other constellations and find other objects. Here’s wishing you clear skies as you see your stars and planets!

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