BPAA Newsletter

Battle Point Astronomical Association, Bainbridge Island, WA

ISSUE 57: JULY - AUGUST 2003

JULY – AUGUST - SEPTEMBER CALENDAR

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

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 17: Mars at edge of gibbous Moon 12:42 a.m.
July 19: **BPAA Open House & Star Party Battle Point Park – 3 p.m. to midnight**. (See article on p.2)
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 28: New Moon 11:54 p.m.
July 31 – August 3: Mt. Bachelor Star Party www.mbsp.org

August

August 5: First-quarter Moon 12:29 a.m.
August 11: Full Moon 9:49 p.m.
August 16: Star Party Battle Point Park. Beginner session 8 p.m.
August 19: Last-quarter Moon 5:49 a.m.
August 20: Viking 2 landed on Mars at Utopia (1976)
August 27: New Moon 10:27 a.m.; Mars 34,646,418 miles from Earth
August 28 – 31: Oregon Star Party www.oregonstarparty.org

September

September 3: BPAA Board Meeting 7 p.m.; First-quarter Moon 5:35 a.m.
September 10: Member Meeting 7 p.m.; Full Moon 9:37 a.m.
September 14: Galileo spacecraft closest approach to Jupiter (1999)
September 18: Last-quarter Moon 12:04 p.m.
September 20: Star Party Battle Point Park. Beginner session 7 p.m.
September 25: New Moon 8:10 p.m.

Calendar Notes:

Mars will take a leading role in the summer sky this year. It will shine bright in the south throughout July and August and will steadily increase in magnitude to -2.7 in late August. On July 17, we will be treated to a spectacular sight. At around 1:00 a.m., Mars will be near the edge of the Moon. This is a rare coupling. Let's hope the weather cooperates and provides clear skies for viewing. Then, on August 27, there's a chance of a lifetime. On this date, Mars will be closer to Earth than at any time in approximately 60,000 years. The last time Mars was this close to Earth was in 57,617 B.C., according to calculations performed by an expert in computational celestial mechanics. See *Sky and Telescope,* June 2003, p. 94. But don't get too excited: Mars gets almost this close to Earth every 15 to 17 years. It happens whenever Mars passes closest to Earth within a few weeks of the date it is also nearest the Sun. *Sky and Telescope,* June 2003, p. 93. (Cont. on p. 2)

The summer sky offers many other highlights. Mercury joins Jupiter in the western sky in late July. In August, Saturn shines in Gemini. The Summer Triangle of Vega, Deneb and Altair will dominate the sky, star-wise, into early autumn. If you can travel to dark skies, a binocular scan of the summer Milky Way will bring you back to your childhood, that is, if you've lived long enough, and grew up in a rural area. The center of the Milky Way galaxy is close to the tip of the spout on the Sagittarius teapot, but 300 times farther away.

Take advantage of our local star parties to view the summer sky, or organize one of your own. Last-minute star parties can be scheduled via our email yahoogroup. Any member who plans 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)

BATTLE POINT ASTRONOMICAL ASSOCIATION
Ritchie Observatory Open House
Place: Battle Point Park, Bainbridge Island
Theme: Tools of Astronomy
Date: Saturday, July 19,2003
from 3:00 p.m. until midnight

The Battle Point Astronomical Association will hold an open house at its Ritchie Observatory located in Battle Point Park on Bainbridge Island on Saturday, July 19, 2003 from 3:00 p.m. until midnight. The Open House, open to the public, will provide tours of the facilities, examples of activities, and a star party at night, weather permitting, featuring this year's outstanding performance by a planet. Mars is scheduled to arrive about 11 p.m. This year Mars will be at its closest to Earth in our recorded history.

Outline of activities:

Sunspots: Safe viewing of sunspot activity.

Solar Prominences: We have a new filter which allows solar prominences to be seen at the edges of the disk.

Spectroscopy: A tool for identifying chemical elements.

Sundials: Make a cardboard sundial.

Archeoastronomy: What did the early inhabitants of Western North America view?

Telescopes and Mounts: A chance to see various telescopes and mounts used by amateurs. A tour of the observatory dome which houses a 271/2-inch telescope.

Robotics: We have a active group of students who are building robots. Who can forget Sojourner, the little robot that journeyed on the surface of Mars?

Planet Walk: Take this walk to get a feeling for the dimensions of our solar system.

Tours of the Observatory

Picnic and/or Potluck Dinner: A potluck dinner and/or picnic will be held in the roofed picnic area from about 5:30 p.m. to 7:30 p.m.

At 8:00 p.m. Observatory Rotunda: Find out what's up in the summer sky. Then, go outdoors to watch the stars and planets come out; view them by eye, through telescopes and binoculars, and marvel at the view through the 271/2-inch large telescope.

Jim Young

NEWS BRIEFS

Thanks to **Bainbridge Island Broadcasting (BIB)** for posting the notices of our meetings on their calendar of events. Check it out on TV Channel 6.

An interesting **AstroConcepts Survey** is being circulated on the web by the Astronomical Society of the Pacific (see http://fs8.formsite.com/astrosociety/AstroSurvey/index.html) While the ASP says it may take half an hour to answer the questions, several BPAA members have found that they could complete it more quickly. Also if we can get 15 of our members to respond, we can find out how our club matches up to others. There's a second incentive: participants have a chance to win a gift certificate worth $100.00 to the ASP catalog.

The **Science Friday Hour**, formerly broadcast by KUOW, is still available on the net at npr.org or sciencefriday.com. There is some hope that KUOW will reinstate it soon.

Three missions to Mars are or are going to be launched soon as our Planet catches up to our outer neighbor. (Opposition will be in August).

Here are the stories:
http://www.cnn.com/2003/TECH/space/06/01/mars.mission/index.html
http://www.cnn.com/2003/TECH/space/05/28/mars.rover.ap/index.html
http://www.cnn.com/2003/WORLD/asiapcf/06/01/space.mars.reut/index.html

Here is NASA's Mars page:
http://mpfwww.jpl.nasa.gov/

ARTICLES AND REPORTS

President's Message

Paul Below

There are several news items to mention in this issue, but first, a story:

This spring, Cathy and I spent two weeks in Hawaii. One hot afternoon on the east shore of Kauai, I took my cold drink and found a bit of shade under a small tree on the beach. As I sat there and watched the ever-changing waves and clouds, I realized that there was a heavy rainstorm some miles out at sea. As time passed, it slowly dawned on me that the line of clouds was growing higher in the sky. It was at that moment that I remembered Paul Middents' lecture on the Polynesian navigators (from this year's wonderful lecture series) and the fact that at the latitude of Hawaii the trade winds do blow from the east during most of the year. I immediately rose and walked back to our room, making it back just in time to avoid a really heavy afternoon shower and a complete drenching. Proof positive that astronomy lectures have a practical application!

We were on Kauai when this spring's total lunar eclipse occurred. Unlike those of you in Kitsap that missed it due to clouds, we had mostly clear skies. However, due to our longitude, the Moon rose after the umbral eclipse had already ended. The Moon was still in the Earth's penumbra, however, when I took the following picture.

I promised some exciting news. First, please welcome Malcolm Saunders to the BPAA Board. Malcolm has agreed to join us as Telescope Director, where his main focus will be on the operation of the Ritchie Telescope! He has already arranged several working sessions, and we have made progress on both collimation and on devising better ways to operate the scope. Many of you have expressed a desire to see this scope in operation. If you would like to learn the operation of the scope, and help us run it, please contact Malcolm.

Second item, the club has a new Hydrogen-Alpha (H-A) Solar Filter, and we have obtained a motorized (one axis) German Equatorial Mount that is specifically for it. Most of you have looked through a sunspot filter that allows us to safely observe the Sun's Photosphere, where the Sun appears to have a "surface" upon which are seen sunspots and, on the limb, faculae, and, very rarely, white light flares. The new H-A filter allows us to view the Sun's Chromosphere, which is just above the Photosphere. We will now be observing prominences that are emissions that project beyond the limb of the Sun and filaments where the prominences occur on the side of the Sun facing toward Earth. For more on this topic, see this web site:
http://www.icstars.com/HTML/SolarSection/HAlpha/

Mike Walker has already used this filter with a school group, and if the clouds stay away I intend to operate it in Winslow during the Fourth of July festivities. We will also be taking the filter with us to Table Mountain.

Speaking of Table Mountain, we will be going up on Wednesday, July 23, on a mid-morning ferry. Anyone who is able to go on that day, let Dave Warman or me know and we can arrange to meet so we can camp together. For those that are coming up later, we once again intend to have our scopes set up on the south end of the main telescope field. Please join us! Bring your scope over and we can observe together.
You can get directions and advice on what to bring at the Table Mountain web site: http://www.tmspa.com

One more news item, the club has received a generous donation of $5,000, thanks to a childhood friend of John Rudolph. This money is designated for use toward a planetarium. So, with this starting planetarium fund, we believe it is time to once again work on our plans.

Now, back to the Islands. We moved over to the Big Island of Hawaii for our second week of vacation, and on our mandatory planetary geology pilgrimage to Kilauea we were able to walk in to an area where the lava flows were active. The picture on the next page is a close-up of an active, sluggish flow (luckily!). For (Cont. on p. 4)

scale it spans an area of the roughly 5 feet across. The hike in and out was not easy. Ask Cathy if you want to hear about that!

In closing, let me remind you of our current membership rates. The rate is $20 per year for an individual, and $30 per year for a whole family. There is an extra $5 per year charge if you want to receive the newsletter via first class mail (as opposed to downloading it from the Web). You can print a membership form from our web site, or pick one up at the observatory. Also, the IRS recognizes BPAA as a non-profit, so donations are tax deductible.

Thank you, and clear skies!

BPAA Financial Statement for May 2003

BALANCE SHEET:	**$**	
Current Assets	16,669	
Fixed Assets	246,167	
Total Assets	**262,836**	
Liabilities	-0-	
Equity	262,836	
Total Liability/Equity	**262,836**	
PROFIT & LOSS:	**$ May**	**$ YTD**
Income:		
Contributions	-0-	3,590
Membership Dues	145	1,280
Other	429	2,780
Total Income	**574**	**7,730**
Expense:		
Administration	-0-	876
Program	1,365	4,125
Utilities	398	583
Total Expenses	**1,763**	**5,584**
Net Income (Loss)	**(1,189)**	**2,146**

Eric Cederwall, Treasurer

Astrobiology: Was it Ever Warm(er) and Wet on Mars ?

Mars is getting very close attention right now because of that planet's extraordinary proximity to Earth, plus the unprecedented information which space missions have been sending back. This is the third article I've written in the past twelve months about water on Mars, because liquid water is essential to life as we know it, the starting point for *astrobiology*. The earlier columns (May '03 & July '02) summarized data from spacecraft suggesting that a sort of permafrost (roughly 50% ice by volume) may lie just beneath the dry surface soil of much of the frigid planet today.

Since the Viking missions in the '70s, images from orbiting cameras have shown Martian surface features that would be interpreted as evidence of erosion by flowing water if they were found on Earth. Debate continues as to whether these were carved by fluvial run-off (in a rainy climate*)* or by a process, called **sapping**, in which spring water eats away at the rock face where it emerges from the ground (in a cold-dry climate).

Mars Global Surveyor, which arrived at Mars in 1997, carries a laser altimeter (MOLA) that has bounced light off almost 700 million spots on the planet's surface and generated topographic maps accurate to within a few meters of altitude. Scientists at the Lunar and Planetary Institute in Houston fed the MOLA data into a model which "drizzles computational rain on a terrain and watches the virtual run-off." Surfaces previously eroded by running water, such as unglaciated terrains on Earth, show patterns quite unlike lunar surfaces, never touched by water. It looks like Martian topography lies between terrestrial and lunar landscapes. "Maybe there was some rain on Mars, to a small degree; it's a mix of fluvial erosion and cratering, but there was never enough sustained rainfall to dominate the heavy cratering of 3.9 billion years ago."

Planetary scientists at Cal Tech and MIT find that "the shapes of the main channels of Martian drainage basins are flatter and less concave than rain-fed channels on Earth and have frequent abrupt drops that indicate flowing water did not have a chance to thoroughly reshape the initial form of the land." However, they are still inclined to interpret the data as supporting a limited amount of precipitation, rather than just erosion by sapping. Others report that some Martian valley networks appear to originate near ridge crests and crater rims, where it's unlikely that enough underground water could accumulate to create springs. However, **there seems to be little support for any prolonged warm-wet period**. (Cont. on p. 5)

The news report in *Science* (June 6, pp. 1496-7), from which I composed this synopsis, includes speculations about how intervals of precipitation and liquid water-flow might have been initiated in the course of Martian history by asteroid impacts, by planetary tilting, and/or other events. I'd be glad to provide anyone interested with a copy, and the journal *Science* is also available at the Bainbridge library.

Bill O'Neill (biophil@bainbridge.net)

A Close brush with our Arean neighbor

Cathy Koehler

Opposition is one of the ways in which Earth can line up with the Sun and another planet in the solar system. Conjunction is another way in which a lineup can occur. In the case of inner planets, the lineup can occur when the planet—say Venus—closer to the Sun and moving faster, passes Earth on its inside orbit. Then that planet will be directly between us and the Sun (an inferior conjunction, when the planet makes its closest pass to Earth); as the planets continue their respective revolutions, after the inside planet passes, it moves quickly around the Sun (from the point of view of the outside planet) until it is exactly on the far side of the Sun from us (a superior conjunction). In either case, to find that planet, we would have to look directly toward the Sun, which generally makes it impossible to see another planet, except in special circumstances. A recent example was when Mercury made a transit of the Sun, i.e., passed directly in front of the solar disk, which is observable with special equipment (solar filter). But most of Mercury's inferior conjunctions are not transits; since its orbit is tilted significantly relative to the Earth's orbital plane, Mercury usually passes above or below the Sun. Then, in order to see Mercury, we need a solar eclipse. Mercury transits only happen during inferior conjunctions in May or November, when Earth's orbital plane crosses Mercury's. Like Mercury, Venus has superior and inferior conjunctions, and some of the latter are transits.

The outer planets—Mars, Jupiter, Saturn, etc.—also align with the Earth and the Sun in two possible ways: When the planet is on the opposite side of the Sun from us, this is also called a conjunction, and is difficult (or impossible) to observe, since you have to look toward the Sun to see the planet, which is at its farthest—and dimmest—point from the Earth. With the outer planets, however, halfway between the conjunctions another kind of lineup occurs, when the Earth, which in this case is closer to the Sun and moving faster, approaches, overtakes and passes the slower-moving outer planet. The point of lineup, when Earth is directly between the planet and the Sun, is called *opposition*—because the planet is *opposite* to us from the Sun. Opposition is generally the most favorable time to view these planets because it will be our closest pass to the planet until the next opposition. The planet will therefore be brighter than usual, and it will be up all night (being opposite the Sun), being highest in the sky around midnight (which occurs at about 1 a.m., if you are on Daylight Savings Time).

Well, Mars' next opposition is this coming August 28th. But, this opposition is being touted as very special, as Mars will be so close—reports claim Mars will be closer than it's been to Earth in 60,000 years. How significant is this and why are some oppositions closer than others?

The interval between Mars oppositions averages about 780 days—though the exact interval varies depending on where in the orbit we pass Mars. Why is that? Mars, like all the planets, has an elliptical orbit; Mars' orbit is, in fact, somewhat more elliptical than Earth's. Earth's orbit is fairly close to circular; at the closest point from the Sun, or perihelion (which is occurring in January), Earth is .98 Astronomical Units (AU) from the Sun; at the farthest, aphelion, Earth is 1.02 AU from the Sun. Note that the AU is a unit based on the (average) distance from the Earth to the Sun; 1 AU is approximately 93,000,000 miles. So, AU is a more convenient unit to use when speaking of interplanetary distances.

In comparison, Mars' distance from the Sun varies from 1.38 AU at perihelion to 1.67 AU at aphelion—a significant difference. When opposition occurs near Mars' perihelion, we pass closer to Mars than at other oppositions. A webpage that lists dates and distances of Mars oppositions can be found at http://www.uapress.arizona.edu/online.bks/mars/appends.htm#1. The page lists the dates, Right Ascension and declinations and Earth-Mars distance for all Mars oppositions from 1901 through 2035, as well as dates and distances for the perihelic oppositions going back to 1608. About every 7th or 8th opposition is considered perihelic, in that it's closer than the oppositions directly before and after it. Though Mars oppositions occur in any month, during the last 400 years perihelic oppositions always occur in July, August and September, and occur at 15 or 17 year intervals. I also noticed a cyclic pattern of 79 years, during which 37 oppositions occur; actually, the cycle is 79 years and 4 days. For example, two of the perihelic oppositions occurred on September 24, 1909, and September 28, 1988. After 79 years, the same cycle repeats, with each subsequent opposition being 4 days later than the one of 79 years previously.

One close perihelic opposition occurred in 1877 (See p. 9: Paralax); many eyes and telescopes (Cont. on p. 6)

were trained on Mars for that event, leading to the discovery of Mars' two tiny moons, Phobos and Deimos, and also to a notorious event in the history of areology—Italian astronomer Giovanni Schiaparelli's announcement about *canali*. Probably, he meant that he observed grooves or channels, but the word was mistranslated into English as canals, and came to be understood that what he saw were like canals that people have built on Earth. Percival Lowell was so enamored of this idea that he dedicated his fortune and life to the study of Mars, founding the Lowell Observatory in Flagstaff, Arizona. Lowell made many observations and detailed maps of the "canals," and there was much speculation in many circles about the intelligent Martians that had constructed the canals, apparently in a failed attempt to transport water from the polar ice caps, thus saving their civilization from dying from extreme drought, not to mention all the literature that arose out of the idea. However, many scientists were skeptical about Lowell's canals, and by the 1970s, close-up observations had proved that there were no canals. Apparently, it was a trick of the eye (and the brain) that caused Lowell to "see" canals. Still, we got much good literature, and the Lowell Observatory, out of all this, so it wasn't a total waste.

So, is the upcoming perihelic opposition of Mars going to be particularly spectacular? Well, at the closest, Earth will pass within .373 AU of Mars. According to the webpage, we've been .373 AU from Mars several times in the last 400 years—notably at the oppositions of 1640, 1766, 1845, and 1924. Apparently, someone has taken the calculation to more significant digits than 3, in order to come to the conclusion that this opposition will be the closest in 60,000 years. Probably, Mars won't appear noticeably brighter than it did, for example, in 1924, assuming anyone remembers that one particularly well. (In fact, I suppose the viewing was generally better then, since there was a lot less light pollution on Earth.)

Just how bright will Mars be? By the date of opposition, Mars will be magnitude –2.9, six times brighter than it was on June 1st, when it was magnitude –1.0. For reference, our brightest star is Sirius, at –1.46 magnitude. Another interesting—and for a long time, puzzling—feature of planetary oppositions is retrograde motion. Although the planets generally travel in one direction through the constellations of the zodiac—west to east—as Earth catches up to and passes an outer planet, the Earth's faster speed causes the outer planet to appear to slow down and even reverse direction for a while. It will be interesting to watch as Mars brightens and backs up, eventually slowing down its retrograde motion and moving west to east as usual, several weeks after Earth has passed by. As far as telescopic viewing, since Mars is nearing perihelion, you may be able to see changes in the size of the polar ice cap; however, at opposition, though Mars will be bright, you probably won't be able to make out much surface detail, since Mars will be "full" from our point of view, with the Sun shining directly down on it, limiting shadows.

Mars is a fascinating place, and I can hardly wait till we get to go there, but for now we have to make do with looking through telescopes from 35 million miles away (at the closest). Just don't expect to see any canals!

Internet sources about this event:

From NASA:
http://science.nasa.gov/headlines/y2003/18jun_approachingmars.htm

From *Sky and Telescope*:
http://skyandtelescope.com/observing/objects/planets/article_970_1.asp

Book sources:

Chaisson, Eric & Steve McMillan, *Astronomy Today*, Prentice Hall, 1993 (a basic general astronomy text).

Beatty, J. Kelly, Carolyn Collins Petersen & Andrew Chaikin, editors, *The New Solar System*, 4th edition, Sky Publishing, 1999.

SEEING STARS — Astronomy 0.001

Anna Edmonds

How can you tell a friend exactly where to find a star besides pointing at it? Well, it's a bit complicated, but then what isn't about the Earth?

Astronomers once used the constellations to help them say, for instance, that Altair is in the constellation Aquila. Then they needed to be more precise. Using a system analogous to the geographic survey points on Earth, they located the stars by points north-south and east-west in the sky.

If you're a boater, you probably know that Bainbridge lies between 122º 28' and 122º 36'W and 47º 34' and 47º 43.5'N, or about 122 degrees west of Greenwich, England and 47 degrees 37 minutes north of the equator. If you are setting up a telescope, you know your location down to the mini-seconds of the degrees. Similarly the location for a star, bright Altair for instance, is at RA 19^h 50.47^m DEC +08º 52'.

What does this cryptic language for the star mean?

The lines that divide the Earth east and west we call longitude. Longitude is a convention that established the starting point at the Royal Observatory in Greenwich, England in 1884. In the sky, the base line runs in a great circle from due north through the point (Cont. on p. 7)

and time at which the Sun has crossed the celestial equator at the spring equinox to the celestial south pole, through the point of the fall equinox, and back to due north. Astronomers call this analogue of longitude **right ascension (RA).** The point of the vernal equinox is noted as RA 0^h 0.0^m; the fall equinox is at RA 12^h 0.0^m. The celestial sphere is divided east-west into twenty-four hour segments, and that's subdivided into minutes and seconds. (Because the Earth's axis on which it rotates moves **(precesses)** very slowly, RA 0^h is not now the exact point of the spring equinox. Astronomers check the **ephemera** listing for a star's current location.

The line that divides the Earth in half north and south we call the equator. The lines parallel to it north and south indicate latitude. Astronomers have projected in imagination into the sky the same line directly overhead above the equator; this is what the Sun traces on the days in spring and fall when the Sun rises due east and sets due west. This line is called the **celestial equator.** In astronomical terms latitude is identified as **declination** (DEC), or the base line to which anything that "declines" north or south of the celestial equator is related. It divides north and south into 90 degrees with the North Pole at DEC 90º 0.0'N, or +90º.

Star locations are given by the places in the sky where these imaginary lines of right ascension (RA) and declination (DEC) cross. These are the exact arrangements, or **coordinates**, of the stars.

Right ascension is usually given in hours (^{h}) and minutes (^{m}). The distance is divided this way because the Earth's circumference can be measured in 360 degrees, and because the sky turns around us every 24 hours. Each hour, or one hour of right ascension, is equal to 15 degrees in that turning.

Declination is measured in degrees (º) and minutes ('); south is often indicated with a "-" sign, north with a "+" sign. Relating this to the coordinates for Altair, the star is at RA 19^h 50.47^m DEC 08º 52'. Another way of saying this is that Altair rises almost 20 hours after the point of the spring equinox.

In the next issue we'll say something about another celestial line, the **ecliptic.**

Paul Hodge's *Higher than Everest*

Cathy Koehler

The June member's meeting (Wednesday, June 11th) featured guest speaker Paul Hodge, professor of astronomy at the University of Washington. Paul gave an entertaining talk based on his 2001 book *Higher than Everest: An Adventurer's Guide to the Solar System*. For adventurer-tourists who have already exhausted Earth's supply of extreme treks, including Mount Everest, or armchair-adventurers wishing to explore beyond the confines of our terrestrial orb, this is an entertaining speculative tour of the rest of our solar system, based on news of the last few decades when we've been privileged to have ever more close-up images beamed to us from many spacecraft and missions. This book was actually inspired by a class that Paul has taught for several years.

Although Mars it not our closest neighbor, we have sent a lot of craft there, even robots that rove around on the surface of the planet, and we know a lot about Mars' geography. In some ways Mars is our nearest neighbor, in that its geologic history is more similar to Earth's than the other planets are. Plus, Mars has some amazing features to tackle, great questions to answer; and probably will be technologically relatively accessible in the not-so-distant future. Therefore, our solar system tour begins on Mars. Our first trek is a climb of the solar system's largest volcano—the most massive mountain we know of anywhere in the universe (so far). Olympus Mons in some ways resembles the shield volcanoes of Earth, of which the Hawai'ian chain are examples. The island of Hawai'i is home to Earth's most massive mountain, the shield volcano Mauna Loa—also our highest mountain measured base to peak, since it starts on the ocean floor and rises from there 20,000 feet to its summit. The volcanoes of Mars appear to have formed the way the Hawai'ian volcanoes did, except for one important detail. In both cases, the volcanoes form as the planet's crust is pushed up above a particularly hot spot in the mantle layer. This hot spot is stationary, but Earth's crustal plates are drifting (tectonics), in the case of the Pacific plate on which Hawai'i formed, toward the northwest. As a volcano is pushed up over the hot spot, it grows and is active for a while, but eventually that volcano drifts northwestward, and a new part of the crust slides over the hot spot; a new volcano forms to the southeast of the most recent one. The Hawai'ian volcanoes are pretty impressive, especially the most recently formed (and still active) ones. (Later, when the volcanoes are no longer active, they are subject to erosion, begin shrinking, and finally sink back down below sea level, leaving a coral atoll.) In contrast, Mars has no plate tectonics, or very little of it so Mars' crust remains fixed and doesn't flow. Over the hot spot, the volcanoes just keep growing over millions, even billions of years, until they reach altitudes unheard of on Earth. Olympus Mons actually rises from a large plateau that averages about 10,000 feet above "sea level" (or what corresponds to it on Mars). Climbing Olympus Mons will pose several difficulties, in contrast to the challenges faced on Earth-based climbs. For one thing, Olympus Mons is very large, compared to say Mount Everest. Although Everest's altitude is 29,000 feet, as it rises from the high Himalayan plateau, vertical

(Cont. on p. 8)

ascent is about 13,000 feet from Everest's base, about 9 horizontal miles from the summit.

Olympus Mons is vastly larger than this, rising to an maximum altitude of 80,000 feet and is 500 miles in diameter. The climb technically is not too challenging, just long. Oh, and you'll need oxygen. Even if you could get to the top of Everest without oxygen (an extremely difficult challenge), you'd need it on Mars—in fact, you'd need it everywhere on Mars which has a very thin atmosphere of mostly carbon dioxide. Aside from the fact that there's no oxygen in the atmosphere, the pressure is not great enough, so I think you would need a pressurized suit just so you can breath oxygen at a great enough pressure to keep you from passing out and dying. Of course, you'd need a pretty good environment suit anyway because it is so cold on Mars, even in the tropics (where Olympus Mons is), even in the summer. But, aside from the environment suit, the climb should be not too difficult—and Mars' much smaller gravity will certainly help in carrying all that heavy equipment.

Olympus Mons will still be quite a trek, and the view will appear quite strange. The mountain is surrounded on most sides by a steep, high ridge that would be technically infeasible, but Hodge's class have found an area where landslides or lava flows cover the steep bits, making for an easier ascent. Still, from base to summit, it's 150 horizontal miles, with a rise of more than 60,000 feet—not generally terribly steep, but a good long hike. Figure a little over a month to get there and back. And be sure to do sightseeing and side trips and take notes on the way—there's a huge impact crater that promises to be interesting, and the summit is a complex system of huge calderras (a calderra is a depression that forms when a volcano erupts and then collapses; on Earth, there'd usually be a lake there). For this first mission, we won't plan to explore the calderra system extensively, though we'll allow a couple days to make little excursions partway down into it.

There are actually volcanoes on Mars that are higher than Olympus Mons (but they rise from a higher base, on the same plateau region from where Olympus Mons rises). The plateau is about the size of North America. Olympus Mons is about 200 million years old, but some of the other peaks are at least 2 billion years old—they've been sitting on the same hot spot all that time. I asked our esteemed president, my husband (who likes to believe he is a geologist) why Mars doesn't have plate tectonics. His answer: good question. Well, apparently this is why we must go to Mars. While we're exploring Olympus, we also must try to figure out what's up with that high steep ridge that runs most of the way around it, with all the strata exposed so conveniently (for the geologists). There is nothing analogous on Earth. Was the mountain suddenly pushed up, breaking it away from the surrounding material and exposing the strata, or were they exposed by erosion after the mountain had reached its present height? Is something else going on? What's with all the huge cracks around that whole area of the planet—and the canyon that cuts like a gash across the face of Mars nearby, running for hundreds of miles near the equator? Mars' canyon dwarfs the Grand Canyon—and since there's no water on Mars—no water erosion—we haven't a clue, really, what process could have formed it. Yes, Mars is so similar to Earth—and yet, so different.

Paul and his class have come up with many more treks and adventures throughout the solar system. Subsequent chapters cover sites on Earth's Moon, on Mercury, on Venus and on several satellites of the outer planets.

After five Martian adventures, three lunar treks, two on Venus and one on Mercury, our tour heads for the outer solar system. We'll stay a while at Jupiter, since there are many interesting things to see here, beginning with a descent into Jupiter's atmosphere, made challenging by the radiation, magnetic field, and charged particles that we must protect ourselves from. Jupiter's second Galilean moon, Europa, is also quite interesting and provides a kind of adventure. Europa is covered with water—well, on the surface it's frozen—but beneath the icy crust, Europa is sure to have a liquid ocean. Who knows what we may find in that dark ocean, so far from the sun? Perhaps, life may be found there—like the chemisynthetic bacteria that live near the hydrothermal vents in Earth's oceans, far from sunlight and not dependant on it.

Another suggested adventure is snowboarding through Saturn's rings, which promises to be, um, exciting; and our whirlwind tour also includes a stop on Saturn's major satellite, Titan, the most earthlike place we've seen yet—but only in terms of atmospheric density and composition. Unfortunately, it's very, very cold there, so I guess we'll still need some kind of environment suit. What other surprises Titan may hold, we can only guess. Titan's surface is a mystery. A high, sheer, vertical ice cliff on Uranus's moon Miranda and a visit to Neptune's moon Triton to see the geysers round out our tour, though surely there will soon be lots more to see in the solar system we've only just begun to explore.

Paul Hodge generously donated a copy of *Higher than Everest* to the BPAA; if anyone is interested in checking out this book, give me a call or email me, and I'll put you on the list. See also Hodge's website for more information about his suggested and challenging adventures and the research he's been involved in at the University of Washington: www.astro.washington.edu/hodge/.

Parallax, Precession, and the Crucial Angles

Anna Edmonds

One of the first major questions that astronomers addressed was that of how big the universe is. Using parallax, in the 4th century B.C. Eudoxus estimated the distance from the Earth to the Moon; this was the beginning of a realistic idea of how really big things are. Two hundred years later Aristarchus came up with the distance to the Sun being nineteen times that of the distance to the Moon. (Actually it's about 20 times nineteen.) That was a very great jump in size, but astronomers weren't completely satisfied.

The distances were arrived at by using the theorem that angle-side-angle determines a triangle. Therefore two known angles and the distance between them on Earth should give the distance to the third angle. The problems for measuring the Sun's distance were accuracy in the crucial angles and the length of the side.

By the middle of the 17th century astronomers realized they could use not only the transits of Mercury or Venus across the Sun to get more accurate estimates of the distance, but also the oppositions of the outer planets. Finally, in 1877, and with the support of the British Royal Astronomical Society, the young David Gill and his wife Isobel set off to the South Atlantic to try his skill at solving the problem and thereby finding the relative distances to other objects in space.

The year was chosen because Mars was calculated to be closer to the Earth that September (as it will be this August) than it had been any time during the century. Gill hoped that the Island of Ascension west of Angola was where the weather would cooperate. His method was to record the angle of the planet in the evening when it was first visible and again in the morning as it faded from view, giving him the distance of the Earth's rotation as the side of his triangle. He was aided in his research by the use of a "Heliometer" that measured the critical angles better than anything before.

David Gill's account of his work is dryly and mathematically scholarly. He remarks, however, "If anyone desires to form an adequate idea of the difficulties of measuring the Sun's distance to a million of miles, *let him try to measure the thickness of a florin piece (*perhaps a half dollar*), looked at, edge on, a mile off."*

Gill had a second aid in his work, one not in evidence for any of the previous astronomers measuring sizes in space. This was his wife, Isobel, who in her words was responsible for attending "to more sublunary matters." *Ascension, An Unscientific Account of a Scientific Expedition* by Mrs. Gill was published by John Murray in London in 1878. Little of her own very real contributions to the study is apparent in the book. Rather, she creates a lively picture of their days, of life on the "cinder heap" (as she characterized Ascension), and of the people with whom they worked. As her husband said, this story is crisp because it was from her daily diary. It filled in the human side, often with genial good humor. She was both unassuming concerning her own role and open about her expectations and frustrations on the island (little fresh meat, servant problems, almost no water—to bathe, to cook, to drink), so the expedition continues to be known not only as a scientific success but also as a personal triumph over adversities. (All such expeditions would show a similar range of frustrations and minor daily troubles.)

Isobel Gill began her story of their adventure with two anecdotes. One described the accident that occurred to the Heliometer only ten days before they were to sail. A screw that determined the inclination of the instrument's axis gave way, bringing the whole thing crashing down, crushing handles, rods, the eye-end, and other attachments. Fortunately, said Isobel, the weakness was discovered in time and in a place where it could be repaired, rather than on Ascension.

The second story involved a learned gentleman and a lady to whom he was explaining the significance of the Earth's precession. With care, he had described how 4,000 years before, the North Star was not Polaris, and how because of the Earth's changing direction, in 4,000 years it no longer would be Polaris. The lady was impressed and made such comments as "Really!" and "How beautiful!" as he continued with more details.

In summation, he went on, "Now you see, by this change of the direction of the earth's axis, if we have any permanent record of an observation of the angular distance of a star from the Pole, we can calculate how long ago that record was made." "Of course!" "And in the Great Pyramid we have such a record." "Indeed! how wonderful!" "The entrance passage points to the north, and its angle of inclination corresponds with the lower culmination of the Pole star of 4,000 years ago."

"Here a little hand was laid on our friend's arm, and his feelings may be better imagined than described, when, in an anxious voice, the question was put, "And pray, Professor, *what is an angle?"*

David Gill determined the distance of the Sun to be between 92 8/10 and 93 3/10 million miles from the Earth, an accuracy greater than any previous calculation. (Today it is generally given as about 93 million miles, acknowledging the Earth's eccentric orbit.) Isobel Gill kept the running account of their days, joined him in recording some of his observations, and found on the barren island a beauty in its sky where "the Milky Way seemed like a great streaming veil woven of golden thread and sparkling with gems."

Quotations from Mrs. Gill's *Ascension, An Unscientific Account of a Scientific Expedition,* with thanks to Paul Middents for introducing the book to his class.

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