The Newsletter of the Friends of Pine Mountain Observatory Summer 2008

Visitors: Welcome to Pine Mountain Observatory!

Pine Mountain Observatory, operated by the University of Oregon, welcomes families and groups to view the Moon, planets, and deep-sky objects through a variety of telescopes every Friday and Saturday night through the summer.

Although Pine Mountain Observatory is a working astronomical research observatory, the Observatory is open for drop-in tours Friday and Saturday evenings from dusk until after midnight from Memorial Day weekend (May 23 and 24) through Sept. 26 and 27.

Weather permitting, you'll view celestial objects through one of the Observatory's research telescopes (the 24-inch Boller and Chiven's reflector) located in the classic aluminum hemispherical dome. In the area around the dome, tour guides set up portable telescopes that sometimes offer views that are just as good as the big observatory telescope!

Visitors tell us that they especially enjoy looking though "Big Eyes," our nickname for our huge 20x140 mm naval binoculars that are perfect for stargazing. And don't forget you can just plain look at the stars!

When to arrive...

In the early evening, while the sky is still light, you can attend an informal talk in the visitor's tent. A tour guide will speak on a current astronomical topic, such as the latest about the planet Saturn, how stars recycle themselves, or the origin of the galaxies.

Viewing begins when it gets fully dark–around 10:00 p.m. in June and July, and somewhat earlier later in the year. To help defray costs, we appreciate your donation of $5 per visitor.

Even in the summer months, the temperature on the 6200-foot mountaintop can dip below freezing. Be sure to dress warmly! You won't regret having warm pants, a thermal parka, a hat, and insulated gloves as you gaze at the wonders of the starry night.

Because you'll be walking on open ground in the dark, bring a small flashlight covered with red cellophane (or you can purchase a red flashlight at the gift shop before your tour). Bright white lights are not allowed because they severely impair night viewing. It takes about 20 minutes to regain your "night eyes" after you see a bright light!

Feel free to bring your own water and snacks, and lawn chairs if you'd like. You're also welcome to bring your own binoculars and telescopes.

Activities and programs are geared for families with children over the age of six.

Tour Guides...

Your tour guides are experienced amateur astronomers. They can help you identify the bright stars and constellations, and they're always ready to show you star clusters, nebulas, and galaxies through the portable telescopes. When the Moon and planets of our solar system are in the sky, you'll have the opportunity to see them, too.

Tour guides will also explain modern astronomical technologies and new discoveries. The talks in the tent include what you might be seeing through the telescope, astronomical events of particular interest, the planet Saturn, double stars, planetary nebulas, or how we are made of star-stuff – just to name a few.

The Greeting Center...

As you walk toward the Observatory, you'll see the Greeting Center, an astronomical information center and gift shop. You can ask questions about the Observatory and get warm with a logoed Pine Mountain tee-shirt or hoodie! All proceeds go to Friends of Pine Mountain Observatory, the dedicated organization of volunteers who make educational tours possible. Visa and MasterCard are accepted.

Above: Every Friday and Saturday through the summer is a star-party night at Pine Mountain Observatory. Using a green laser beam, tour guide Greg Hogue points out the location of the globular star cluster in Hercules. Then it's just a few steps to the telescope for a view through the eyepiece. When the Moon shines brightly, visitors view planets, double stars, and the Moon (of course!) and on clear, dark-sky nights, views of "deep-sky objects" are unforgettable.

Left: The night sky is full of wonders! At the upper left you can see the globular star cluster in Hercules, a vast swarm of stars. In the middle above is the Lagoon Nebula, a star-forming region in the constellation Sagittarius. And directly left is a spiral galaxy called Messier 33 in the constellation Triangulum.

When sky viewing isn't at its best, the Friends of Pine Mountain Observatory will host sci-fi nights in the tent. Bask in the glow of the full moon, howl at it if you prefer, or come to the tent for a classic sci-fi fix:

Sat, June 21: The Day the Earth Stood Still (1951)
Sat, July 19: The Thing (1951)
Sat, Aug. 16: Forbidden Planet (1956)
Sat, Sept. 13: The Man Who Changed His Mind (1936)

Camping and hiking on Pine Mountain...

Adjacent to the Observatory is a primitive Forest Service campground. No reservations, no fees, and no water! You must take any trash you accumulate with you. Please comply with Forest Service fire precautions.

Pine Mountain offers several excellent hikes along dirt roads and trails. Hike to the top of the mountain above the Observatory, then across the hogback to the south. To the north, you may spot hang-gliders hovering in the thermals. Bird life is abundant in wooded areas, and the air scented with Ponderosa pine.

How to make Group Reservations...

Pine Mountain Observatory hosts tours for school groups, scout groups, and groups of adults. To make reservations for a group larger than eight people, to request tours for Sundays or weekdays other than Friday, or for more information...

Phone Mark Dunaway, Observatory Manager and Tour Scheduler, at 541-382-8331.

Or email Mark at markpmo@oregon.uoregon.edu.

Driving to Pine Mountain...

To reach Pine Mountain Observatory from Bend, drive east on state highway 20, to milepost 26, where you'll see the Millican general store on the south side of the highway. Immediately past Millican, turn right (south) at the green mailbox onto a dirt road. You will see a large green University of Oregon sign on your right. Follow the dirt road 8 miles up the mountain. You will pass through three cattle guards. If you're arriving at dusk, near the top of the hill, dim your headlights and park in the Observatory parking lot.

See you on Pine Mountain this summer!

–Monica Geraths

Pine Mountain Observatory NEWS

The Greeting Center before the winter snows melted.

Observatory Report

Over the winter 2007-2008 we prepared the Observatory for the summer visitor season. With the new Greeting Center completed, we made plans for a tent for talks and lecture, and corrected the electrical problems with the 24-inch telescope. The new Greeting Center is located to the left of the gate as you walk up to the observatory. The building gives us 160 square feet of space for exhibits and gift sales, and including a roomy 6×16-foot cedar deck in front. We will place picnic tables between the new building and the Kiosk for folks for resting and picnicking.

The Greeting Center location is perfect. Visitors can stop in and get information before they walk up to the observing area. It also frees up the area below the 24-inch telescope, so that observatory staff can once again use it as a work station.

The shell of the building was made by Outbuilders, a local company that specializes in small storage buildings. Last summer, Ken Robbins drove from Sisters to the Observatory over 30 times to work on the building. The finish work was done by Ken Robbins, Kent Fairfield, Alan Chambers, and several other volunteers. The interior has electricity, insulation, flooring, shelves and storage areas.

In addition to the regular gift shop selection, Kent Fairfield has spent the past few months researching observatory gift shops all over the US. He has ordered new gift shop items for visitors. Dave Haffy, a long-time observatory supporter, provided some fantastic glass display cases from his jewelry store.

FOPMO member Ken Robbins paid for the entire Greeting Center project. Thanks to everyone for all the hard work, and special thanks to Ken Robbins for making it all possible with his generous donation.

The other major upgrade to our visitor program is a new canvas "lecture hall." Again, thanks to Ken Robbins, PMO is now the proud owner of a 30×30-foot circus tent made by Ohenry, a long-time manufacturer of "big top" tents. The tent will be set just across the drive from the Greeting Center.

Once the snow melts, we will scrape and level an area large enough for the tent. There will also be a power box installed for operating our projectors and AV equipment. Internet will be from a WAP in the astronomer's residence. After we add a couple of truck loads of gravel and run a roller over it to compact it, we will set up the tent.

The lecture hall increases our seating capacity from the present seating capacity of 25 to 30 in the 32-inch telescope dome to at least 75 to 80 visitors. The placement of these new facilities will provide visitors with a focal point upon arrival. Instead of wandering around in the dark, visitors can get oriented before they get to the viewing areas, providing them with a more enjoyable experience.

In February Dan Gray came to Pine Mountain and trouble-shot the 24-inch telescope's drive system. He and Alan Chambers found some minor electrical problems and repaired them. Although a minor problem remains in RA movement, Alan will soon have that resolved. We fully expect the 24-inch telescope will be up and running like its old self for the summer season.

Finally, we're planning to mount the "Big Eyes" binoculars on a permanent pier this season. With the help of a Tour Guide, visitors will be able to see splendid wide-field views as they survey the sky.

–Mark Dunaway

The "X15" Imaging System

A powerful electronic imaging system consisting of a telescope, mounting, and CCD camera now occupies the venerable 15-inch telescope's building. This means that the Friends of PMO will soon be able to produce research-grade digital images for astronomers, graduate students, and high-school level talented and gifted students. The original 15-inch telescope has been removed and is now securely stored in the ground floor storage area beneath the 24-inch telescope.We expect to put the imaging system into operation during summer 2008.

Three key components comprise the imaging system: a 14-inch telescope, a computer-controlled mounting, and a large-area CCD camera. The telescope is a 14-inch aperture *f*/10 Meade Instruments LX200R with high-transmission coatings. The mounting is a Software Bisque Paramount 1100S GEM on indefinite loan to the Friends of Pine Mountain Observatory from Portland State University. It provides precision pointing and tracking capability for the telescope. The imager is an Apogee U9000 CCD camera. In addition, a small piggyback telescope and CCD camera will be used for precise guiding.

Although the building and dome were designed for a somewhat different telescope, with the addition of a custom-made extender atop the existing pier, we were able to raise the mount and

The new X15 imaging system is housed in the building and dome that formerly housed the 15-inch telescope.

telescope high enough to reach the horizon around a full 360 degrees. The computer-controlled mount will be able to point the telescope anywhere in the sky.

The imaging system will cover a field of view somewhat over one-half of a degree, that is, a piece of sky somewhat larger than the Full Moon. The field of view depends both on the size of CCD in the CCD camera and the focal length of the telescope. The Apogee U9000 has a 3056×3056 array of 12-micron square pixels, and the nominal focal length of the telescope is 3556 millimeters. The active area of the CCD is 36.6 millimeters on a side, giving a field of view is just over 35 arc minutes (the Moon is 30 arc minutes diameter).

We plan to add an Apogee filter carousel with RGB color filters plus a set of photometric filters. This will allow us to make beautiful color images of celestial objects, and to collect scientific data as well.

At present, the dome must be moved manually. This summer, therefore, observers must be present in the dome when operating the telescope. Our immediate goal is to equip the dome with motors for fully robotic operation, and ultimately we expect to support remote computer-controlled imaging.

Since the 14-inch telescope is now on a high pedestal and has a CCD camera at its focus, the imaging system won't be available for visual observing. Moreover, it will obviously takes a fair amount of training to learn how to use the hardware and software that control the telescope and CCD camera. But everyone can enjoy the beautiful images we expect to make this summer. Watch for images from the "X15" telescope on the Friends website and in the Pine Mountain OBSERVER!

--Kent Fairfield

Getting ready for imaging at the ITS2007 summer teacher workshop. Left to right: Brian Montgomery, Kent Fairfield, Rosa Hemphill, and Greg Hogue.

Summer Teacher Workshop Imaging the Sky 2007

Last summer's Imaging the Sky Conference was an intensive hands-on workshop for teachers, from July 22 to 25. Participating teachers were Robert Black, Jim Earley, Rosa Hemphill, and Brian Montgomery, with Kent Fairfield, Greg Hogue, Rick Kang, and Richard Berry.

At dusk each day, we strung extension cords and then set up telescopes, computers, and lawn chairs in the gravel area behind the 32-inch dome. Our goals were to explore and experience planning an observing program, target selection, telescope and CCD camera setup, acquiring CCD images, calibrating CCD images, extracting data from images, displaying time-series data, and interpretation of data.

The workshop was a learning experience for the students and instructors both. We encountered many problems and overcame most of them. By the second morning we had images to examine, and on the third night, we acquired photometry of the variable star W UMa.

If there is sufficient interest, we may repeat the workshop, possibly with students as well as teachers. Those interested should contact Rick Kang at rkang@efn.org.

–Richard Berry

The Astronomical Mystery of Mexico's Teotihuacán

In April 2007, with my wife Ann and other family members, I toured the prodigious pyramids and temples in the ancient city of Teotihuacán. Teotihuacán is located approximately 30 miles northeast of Mexico City; the huge archeological site occupies roughly eight square miles. During the height of its civilization, between 125,000 and 200,000 people lived at Teotihuacán, which made it the largest city in the Western Hemisphere and at least the sixth largest in the world. The Teotihuacanos dominated their region for a longer span of time than the half-millennium Roman Empire.

Unlike the Maya of southern Mexico, the people of Teotihuacán left no written historical record of their lengthy rule. It is estimated that the great building phase at Teotihuacán began in the second century A.D. Although the details of the demise of Teotihuacán in the seventh century A.D. are not well known, it is thought that the area was overrun by people from the north of Mexico.

The astronomical mystery of Teotihuacán is embedded in the layout of the city. The orientations of the principal street and the two main pyramids (Pyramid of the Sun and Pyramid of the Moon) demonstrate a high degree of sophistication and planning by the residents of this ancient city.

Known as the Avenue of the Dead, the 2.5-mile-long principal street is oriented approximately 15.5 degrees east of north. The massive Pyramid of the Sun is situated on the eastern side of the Avenue of the Dead, and the Pyramid of the Moon is located at its northern terminus. The Pyramid of the Sun looks across the Avenue of the Dead, facing the setting sun. Significantly, however, its orientation is not precisely west, but instead it faces an azimuth of 285.5 degrees, or 15.5 degrees north of west.

The Pyramid of the Sun is a massive building. The length of each side at the base is approximately 700 feet, comparable to dimensions of the pyramid of Cheops in Egypt. On the western side, facing the Avenue of the Dead, some 240 steps lead to its top. The steps cut from rough stone are narrow, steep and irregular. As I contemplated the climb ahead, I observed a blind woman with a walking stick descending this ancient pyramid.

Her remarkable example convinced me that I too could climb to the top. The apex of the pyramid is faced with stone and has no other architectural features. From this perch, I could observe the layout of the entire city built on a wide valley surrounded by mountains. Both the underworld and heavens constituted an important part of the belief system of the ancient people of Mesoamerica. Under the Pyramid of the Sun is a multi-chambered cave with an opening on its western face. It is thought that the cave played a part in the religion of the Teotihuacanos. Unfortunately, the cave is not accessible to the general public.

At the north end of the Avenue of the Dead and at a slight angle from the apex of the Pyramid of the Sun sits the Pyramid of the Moon. Viewed from the Avenue, its shape fits aesthetically into the dark contours of Cerro Gordo looming behind it.

From the remaining physical evidence, it is clear that the planners used great care in establishing the alignment of their city. Adjacent to the Pyramid of the Sun is a marker in the floor of a building consisting of two concentric rings with a cross in the center. It appears that this marker served as the analogue of a modern surveyor's benchmark. Another marker was found about three kilometers to the west of Teotihuacán on a small rock outcrop on Cerro Colorado by members of the Teotihuacán Mapping Project, when they conducted a painstaking survey of the entire site over thirty years ago.

These two markers establish an east-west axis for Teotihuacán with an orientation of about 15.5 degrees north of west. This east-west baseline makes a nearly perfect right angle to the Avenue of the Dead. Near the top of Cerro Gordo, another marker has been located about seven kilometers to the north of the Pyramid of the Sun. Its location is consistent with the north-south axis of the city. Considering the distances involved, and that it must have been accomplished solely with naked eye observations, this is a remarkable feat of surveying. The astronomical mystery at Teotihuacán is why the planners oriented the city's grid as they did. Why did they not simply follow the cardinal directions of north-south and east-west? In other words, what was so special about 15.5 degrees?

I have an interest in the history of science and in particular the history of astronomy. In 1974 I visited Teotihuacán and was enormously impressed by the magnitude of the city and its marvelous pyramids and temples. Before traveling to Mexico in 2007, I read articles and books regarding the physical layout of Teotihuacán's principal street and its pyramids, and the likelihood that the ancient city planners used astronomical considerations in establishing the orientation of their enormous pyramids. A fascinating scholarly work that includes an analysis of Teotihuacán is Anthony F. Aveni's *Skywatchers of Ancient Mexico* (University of Texas Press, 1980). A revised and updated version of the book was published in 2001. *Skywatchers* (University of Texas Press, 2001). Aveni, who received his Ph.D. in astronomy from the University of Arizona, is now a professor of astronomy and anthropology at Colgate University. In *Skywatchers*, Aveni proposes that the Pleiades played a role in the axial orientation of Teotihuacán.

Professor Aveni assumes that the principal layout of Teotihuacán and the orientation of the Pyramid of the Sun were established by the city's planners around the time the city was built, i.e., around 150 A.D. At the latitude of Teotihuacán, the sun passes directly overhead at noon on two days each year. On those days, objects cast no shadows. The first of those days is May 18.

The Pyramid of the Moon stands at the north end of the Avenue of the Dead. Behind the pyramid, in the distance, stands the mountain Cerro Gordo.

Professor Aveni notes: "The Pleiades underwent heliacal rising on the same day as the first of the two annual passages of the sun across the zenith, a day of great importance in demarcating the seasons." (*Skywatchers of Ancient Mexico*, page 225). "The day is approximately May 18. The appearance of the Pleiades served to announce the beginning of this important day, when the sun at high noon cast no shadows." This day would also herald the beginning of the rainy season (June through August) and the time to prepare the ground around Teotihuacán for planting.

In addition, to marking the onset of the rainy season, the Pleiades also served an important role in the star lore of the Teotihuacanos. In 150 A.D., the Pleiades set on the western horizon of Cerro Colorado at an azimuth of 284.6 degrees. Thus, the direction of the Pleiades on the western horizon, directly facing the Pyramid of the Sun, is very close to the east-west axis of 285.5 degrees established by the ancient monuments.

Professor Aveni's hypothesis does face a few potential problems. He acknowledges: "the precessional motion of the Pleiades is so rapid that a mistake of 100 years in the dating of the baseline is equivalent to a shift of 1 degree in the azimuth of the setting point."

Professor Vincent H. Malmstrom of Dartmouth College has also studied the orientation of Teotihuacán in considerable detail. In his paper, "A Reconstruction of the Chronology of the Mesoamerican Calendrical Systems," (*Journal for the History of Astronomy*, Vol 9, pages 105-116, 1978) Professor Malmstrom notes that on the days that the Sun passes directly overhead at Teotihuacán, sunset occurs at an azimuth of 290.8 degrees. This does not correspond to the axial alignment of Teotihuacán, but Professor Malmstrom offers an alternative theory.

His hypothesis is based upon the so-called Long Count system for recording time in Mesoamerica that was used by the Maya and may have originated with the Olmecs who predated both the Maya and the residents of Teotihuacán. Under the Long Count system, time began on August 13, 3114 B.C. "Although the year is clearly fictitious, the month and day probably are not, for 13 August marks the southward transit of the vertical Sun just south of the 15th parallel of north latitudean astronomical fixpoint which could scarcely have gone unnoticed even by the most primitive of peoples."

The anniversary date of the beginning of time, Professor Malmstrom contends, is also a critical date for Teotihuacán. On August 13, the sun sets on the western horizon of Teotihuacán over Cerro Colorado at an azimuth of 285.7 degrees, corresponding almost exactly with the axial baseline of the Pyramid of the Sun. Because Teotihuacán was a religious center above all else, it is plausible that the orientation of its principal feature would be associated with the anniversary of the beginning of time. As a result of extensive field work, Professor Malmstrom has identified other ancient structures in the Mexican plateau, Yucatan, and Oaxacan regions with azimuth alignments of approximately 285 degrees.

One problem with Professor Malmstrom's theory is the limited historical record demonstrating extensive cultural and religious contacts between the Maya and the residents of the Teotihuacán valley prior to the planning of this immense city. Professor Aveni's theory enjoys a practical advantage that connects the position of the Pleiades to the beginning of the annual rainy season in the highlands of Central Mexico as well as the agricultural growing season.

Several other theories have been advanced for the physical orientation of Teotihuacán, and Professor Aveni has summarized many of them in *Skywatchers*. All of these theories are probably best classified as informed speculations. I have simply chosen the two hypotheses that intrigued me the most. The true meaning of the orientation of Teotihuacán and its pyramids may always remain an enigma.

There is a final interesting feature regarding the layout of Teotihuacán. If one draws a line from the top of the Pyramid of the Sun to the top of the Pyramid of the Moon, that line is oriented due north-south. This orientation could serve as a meridian, which would have allowed the ancient priests of Teotihuacán to establish the time of noon with great accuracy.

I left Teotihuacán in 2007 as I did in 1974 marveling at the enormous pyramids and temples that were constructed by an ancient civilization without benefit of transits or lifting equipment. Not only did the Teotihuacanos construct massive monuments that have stood the test of time but they also created beautiful pottery and other works of art. Many of these colorful artifacts are now on display at the National Museum of Anthropology in Mexico City. At the south end of the city is an enormous public square known as the Ciudadela or Citadel where as many as 50,000 Teotihuacanos would have gathered. I spent the last part of my day in this forum looking at the Temple of the Feathered Serpent and wondering what real life was like in the ancient city of Teotihuacán.

by John R. Bakkensen

COLLEGE OF ARTS AND SCIENCES

University of Oregon

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AS0108

On February 20, 2008 the Full Moon rose while in eclipse. Dave Hill captured these images with his digital camera.

FOPMO Educational Outreach and Call for Volunteers

Outreach Programs for Schools

Teachers–we can bring the Universe to your classroom! In 2008, Rick Kang and Kent Fairfield will continue their visits classrooms around Oregon. We deliver data-driven science inquiry programs to all grade levels, plus special inquiry pedagogy training sessions for teachers.

Please feel free to invite either of us to your classroom. Contact either of us by email at:

Rick Kang: **rkang@efn.org**
Kent Fairfield: **tualatinkent@aol.com.**

We'll bring our laptops loaded with lots of current space images and lots of other space data for students to work with.

–Rick Kang

FOPMO Volunteers on MEETUP.COM

Volunteer workers and Tour Guides have been vital to our public outreach programs. This summer, as we add the new Greeting Center and Lecture Tent, we will more need volunteers to operate contemplated expanded programs.

If you are interested in volunteering, please join the Bend Astronomy Group (Pine Mountain) group on **meetup.com**. Meetup.com is turning out to be a way to rally new volunteers. As a result of newspaper advertising and Public Service Announcements on Bend radio stations, we gained some 18 meetup members.

To access the meetup site, just browse for meetup.com. At the home page, enter Astronomy as your interest and your zip code as 97701 to join the Bend Astronomy Group.

–Kent Fairfield

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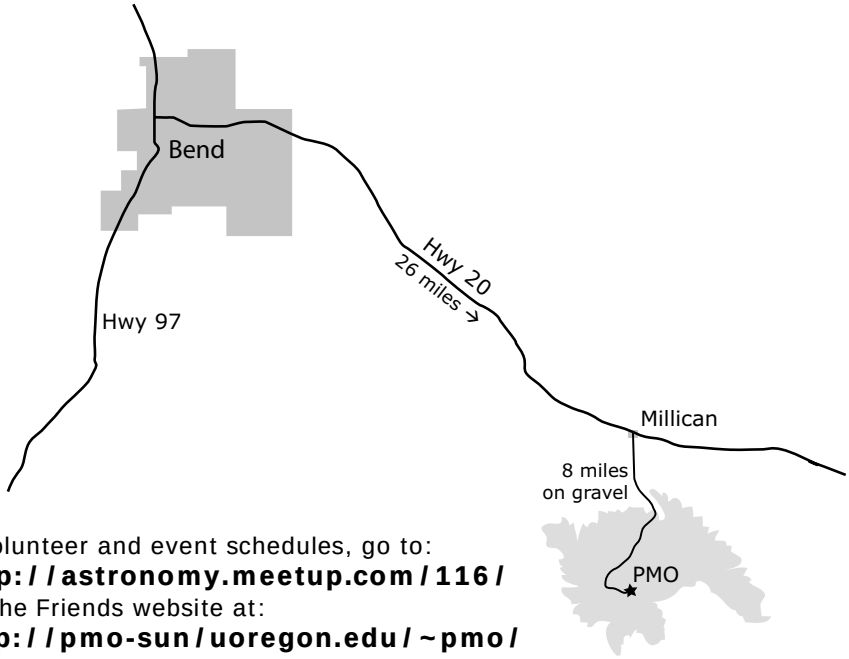
You're Invited to the PMO Star Party

The traditional PMO Star Party will be held **Thursday, July 31**, at the Observatory, beginning at 8:00 p.m.

The 2008 keynote address, "Galileo's Legacy," will be delivered by **Russ Genet**, Research Scholar in Residence at Cal Polytechnic State Univ., celebrating the remarkable contributions to science and astronomy still being made today by telescopes of modest aperture.

The cost of admission is $20. Seating is limited to 80 attendees and tickets are required. To RSVP call the College of Arts and Sciences at **(541) 346-3236**.



For volunteer and event schedules, go to:
http://astronomy.meetup.com/116/
Visit the Friends website at:
http://pmo-sun/uoregon.edu/~pmo/

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The Friends are citizens across the globe who help PMO by contributing voluntary labor, materials, and/or funds. You are welcome to join the more than 250 current Friends by mailing in the form on the reverse side of this page, with your check, to the address provided.

Notice of General Meeting

The next General Meeting and summer meeting of the Board of Directors is scheduled for Saturday, September 20, at noon, at the Pine Mountain Observatory. The meeting is open to all members.

Group Tours

FOPMO hosts tours for school groups, scout groups, and groups of adults. For groups larger than eight persons, or for days other than Friday or Saturday, reservations are required.

For more information, or to make group reservations, contact Mark Dunaway at (541) 382-8331, or email: markpmo@uoregon.edu.