SEATTLE ASTRONOMICAL SOCIETY

The

Webfooted Astronomer

June 2002

Micrometeorites and Giant Comets

By George Best

> ### June Meeting
> Monika Kress
> Astrobiology Post-Doctoral Scientist
>
> University of Washington
> Astronomy Department
>
> Wednesday, June 19
> 7:30 p.m.
>
> Physics-Astronomy Building
> Room A102
> University of Washington
> Seattle
>
> Come early at 7 p.m. for coffee and to visit with your fellow members.
>
> Bring your slides to show after the program.

THE speaker for our June 19 regular meeting will be Monika Kress, who will talk about how micrometeorites and giant comets give us clues to the origin and early evolution of life.

Monika is an Astrobiology Post-doctoral Scientist at the University of Washington. Her group determines the origin, evolution and distribution of life in the universe.

Dr. Kress received her PhD in theoretical physics from Rensselaer Polytechnic Institute. From 1992 through 2000 she worked at Ames Research Center in Mountain View, California, on the effect of giant comet impacts on the climate of habitable places

Prior to the speaker, SAS President Mary Ingersoll will discuss the board's future plans for the use of the bunker at Sandpoint (Magnuson Park). After which members will have an opportunity to vote on whether to give the board permission to proceed or not.

The Seattle Astronomical Society meeting will be held Wednesday, June 19 at 7:30 p.m. in room A102 of the Physics/Astronomy building.

Dark Skies Northwest will hold its monthly meeting prior to the SAS meeting from 6:30-7:30 p.m. in room A216 of the Physics-Astronomy Building.

Seattle Astronomical Society

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A Tropical Mountain High

By Laurie Moloney

WHEN John Waters and I decided to go to Hawaii last March, it didn't take us long to decide which island to visit. Hawaii island, the Big Island, is home to Mauna Kea and the largest telescopes in the world. There are 11 telescopes on Mauna Kea operated by 11 different countries. Nine of the scopes are for optical and infrared astronomy, and two of them are for submillimeter wavelength astronomy. They include the largest optical/infrared telescopes in the world (the Keck telescopes) and the largest submillimeter telescope in the world (the James Clerk Maxwell Telescope). I wanted to go up Mauna Kea and see these observatories, particularly the Keck.

We decided to stay in Kona on the dry, sunny side of the island, which is further from Mauna Kea than the largest town, Hilo. Hilo gets 300 inches of rain per year. We can get rain at home, so we chose the sunny side.

At the Kona airport, we picked up our bright red Jeep Wrangler. The rental car agency warned us not to take it on Saddle Road or on any 4-wheel drive roads for that matter. "What's the point of getting a four-wheel drive vehicle then?" we asked. The Saddle Road is a barely paved road that cuts across the island and the only road to Mauna Kea.

We decided to go up the mountain with the University of Hawaii's (UH) Institute for Astronomy, which leads a tour every Saturday and Sunday with visits to Keck I and the UH 2.2 meter scope. Before September 11, they also toured the NASA Infrared Telescope. Unfortunately, there are no plans to reopen that facility to tours. After the tour, the UH offers observing from the visitor's information station at 9,300 feet, weather permitting. They require four-wheel drive vehicles for the summit tour.

Friday night before we visited Mauna Kea, I watched the local weather report, which predicted a cold front would hit the next day. The Aloha-shirt-clad weather man said that temperatures could reach as low as 65 degrees! I had to chuckle at that comment, while I wondered if this meant snow on Mauna Kea.

The next day dawned warm and sunny in Kona. We packed our warm coats, hats, mittens, and John's 90 mm spotting scope into our Jeep and headed out at about 10 a.m. We had to meet at the

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Mauna Kea *(Continued from page 3)*
visitor's center by 1 p.m. From Kona, we gained altitude quickly as we drove on Hwy 190 towards Waimea (a beautiful little town near the largest ranch in the U.S.). A couple of miles before Waimea, we turned onto Saddle Road

The Army built Saddle Road quickly during World War II, and it hasn't been improved much since. Even so, it was very drivable, and any passenger car could navigate it fine. The sides of the road have broken down making it bumpy, but if you drive in the middle, it's a smooth ride. The road goes through the saddle between Mauna Kea and Mauna Loa, two of the most massive mountains in the world. I couldn't see either one of them as they were both shrouded in clouds. Saddle Road reaches an elevation of 6,600 feet.

At mile post 28, we turned onto the road to Mauna Kea, which climbed 2,700 feet in just 6.2 miles to the Visitor Information Station. The 17 percent grade worked the Jeep's 6-cylinder engine. I almost put it in four-wheel drive, but that would not have been good for the drive train since we were still on pavement.

We arrived at the Visitor Information Station of the Onizuka Center for International Astronomy (named in honor of Ellison Onizuka, an astronaut from the Big Island who died in the 1986 *Challenger* disaster) a few minutes before 1 p.m. The weather was cold and foggy, and I could feel the effects of the altitude. My body didn't like climbing from sea-level to 9,300 feet in just a couple of hours. I felt light-headed and short of breath. John felt slightly nauseas and headachy.

The tour began with an hour-long video on the history of astronomy at Mauna Kea. The video had two purposes—education and

Keck I before the cold front hit.

allowing people time to adjust to the elevation. After 45 minutes, both John and I felt fine. The visitor's center had some displays on astronomy and a small gift shop. There were also several amateur telescopes, which the center uses for public observing every night, weather permitting. They had a Meade LX-200 16-inch Alt-Az, a 14-inch Celestron (on an AstroPhysics German equatorial mount) and an 11-inch Celestron (on the Losmandy German equatorial mount).

After the video, we all climbed into our 4X4s and lined up behind the leader. We were instructed to put our rigs in four-wheel drive. The tour leader went to each rig and verified one-by-one that we did. As the caravan of about 20 vehicles set out on the paved road, I was thankful this wasn't my Jeep. Four-wheel drive on pavement puts a lot of tension on a drive train. Ah well, it was rented.

No tours have been offered at the NASA Infrared Facility since September 11.

Less than a mile up the road, we passed Hale Pohaku where astronomers observing on all of the radio and optical telescopes on Mauna Kea eat their main meals and sleep. The 8-mile drive up to the 13,796-foot summit was steep and foggy. Suddenly at the top, we broke through the fog into the sunshine. I could see the many bright white and silver observatories straight ahead. We're here!

We drove to the Keck first. The W. M. Keck Observatory consists of two 10-meter telescopes constructed and operated by Caltech and the University of California. The stark white round domes looked bright against the red, barren landscape and deep blue sky. Beautiful! It does look like Mars up here. The temperature was about 25 degrees, so I put on a few more layers.

We could really feel the altitude now. I walked slowly and breathed deeply, but I found it difficult to concentrate on many of the details our tour guide told us. For example, he told us that Mauna Kea has some of the best seeing anywhere—down to 0.25 arc seconds. He said the UH leases 11,000 acres above 12,000 feet from the state, so the university gets 12% of the telescope time on each of the observatories on the mountain. In ad-

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Mauna Kea *(Continued from page 5)*
dition, the Keck has a $35,000 electricity bill each month for cooling the observatory to night-time ambient temperatures. At least that's what I think he said. John can't remember either. Next time, I'll take some paper.

We went into the Keck I's lobby, which was a small no frills space with restrooms (thankfully). Half the group went into the telescope's observing gallery at a time, which was little more than a cage about 8 feet square. The telescope itself looked like a bunch of girders. It was so huge, that I couldn't tell what was what. The mirror was high above us, so I couldn't see it. But that didn't matter. I was looking at the largest telescope in the world. It was exciting!

When we came out of the Keck, it was windy and snowing. I guessed this was the cold front I had heard about. The visibility was drastically reduced. I took some pictures of the Keck's dome, but I couldn't discern the dome from the white sky.

Next we drove to the UH's 2.2-meter telescope. This is the bigger of their two telescopes on the mountain. At this observatory, we could go inside the dome right next to the telescope, which had a closed tube design. A few of us ventured out onto the catwalk around the outside of the dome, but we saw nothing but a white from blowing snow.

At about 4:30 p.m., the tour guide left us with instructions to leave the summit by 30 minutes after sunset (around 6:30 p.m. that day). The sunsets are beautiful there we were told. But all we could see was snow. He also told us that we could observe in the summit's lower parking lot after dark. This was about one mile down the road from the summit. But all we could see was snow. We waited at the top for a break in the weather. We finally gave up and headed down the mountain. This is where the four-wheel drive became critical. In four low, the engine slowed our decent enough that we didn't have to use—and overheat—our brakes.

As we headed down, several vans with the various observatories' logos on their doors were heading up with their astronomers. I thought they were a bit optimistic, but Mauna Kea has 360 clear nights per year because of a tropical inversion cloud layer at about 8,000 feet that isolates the upper atmosphere from the lower moist maritime air, ensuring that the summit skies are clear.

Back at the visitor's center, the sky was socked in with fog and rain. No one was observing that night. In fact, we had clouds all

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Optical Engineering Group Hosts Astronomy Day at PSC

THE International Society for Optical Engineering will be hosting an “Astronomy Day” at the Pacific Science Center in Seattle on July 11, 2002, from 3:30 p.m. to dusk.

Volunteers are needed to bring telescopes for a star party after the event. In addition the SAS will need people to staff a booth.

The day will include workshops and lectures from world renowned speakers:

- Brian Lula - Renowned CCD imager
- George “Pinky” Nelson - Former Astronaut
- Ryan M. Hannahoe - Fireball to bring youth in to astronomy
- Gloria Putnam - Kodak; CCD inventor
- Dr. Terry Huntsberger - Head of Mars Rover Program - NASA
- Dr. Phil Larid - Floating Mirrors
- Dr. Richard Hoover - Astrobiology - NASA

For more information, see http://spie.org/Conferences/Programs/02/am/astronomyws.html or call (610) 926-6638. Please let SAS President Mary Ingersoll know if plan to attend and or bring a telescope at 206-246-0977 or missioncontrol13@juno.com.

Classifieds

For Sale

4.5-inch Deluxe Telescope, Orion Skyview Newtonian reflector with EQ mount, 17-months old, hardly used, f/8, 25mm and 9mm Plössl 1.25-inch eyepieces, doubler, moon filter, 6x30 achromatic finder scope, alignment scope built into mount, exc. condition, moved, no room must sell, Paul J. Peterson, 425-827-7314 9 am to 9 pm, paul2594@oz.net, $350 obo.

Help Wanted

Looking for someone to collimate my Meade 4-inch catadioptric spotting scope. Will pay for service. Scope seems somewhat out of focus. Contact Aaron Lowin, alowin@earthlink.net (in Seattle).

Summer Star Parties

As summer approaches, it’s time to start planning for summer star parties. Here are the details on the two major Northwest star parties.

Table Mountain Star Party

This year’s Table Mountain Star Party (TMSP) will be held July 11, 12 and 13 on Table Mountain near Ellensburg, Washington. Registration packets were sent out on May 10 to the addresses provided by local clubs. The registration forms are to be postmarked and returned by June 14. After June 14 each person will be charged an additional $10 late fee. For complete information please see the web site at http://www.tmspa.com or contact SAS’s representative Frank Gilliland at tmspfrank@earthlink.net.

Oregon Star Party

The Oregon Star Party is scheduled this year for August 8–11. As in the past, speakers, food and telescope equipment vendors, on site showers, daily kids activities and a swap meet highlight the daytime fun. The night skies of Central Oregon's high desert country in the Ochoco National Forest are the real attraction, however. Over 800 attended last year's party. The Rose City Astronomers invite SAS members to join them once again in this premiere NW star party event.

See http://www.oregonstarparty.org/for more information on this year’s event and an opportunity to sign up as a volunteer. Online registration will be up and running very soon. Contact Bill Jensen at Oregonstarparty@aol.com.

Check Out SAS Books and Telescopes

The SAS has both books and telescopes available for check out. Contact the persons listed below for more information.

Books

The SAS library has more than 200 books available for you to borrow. The library is located at Karl Schroeder’s home. Check the SAS web site for the books available, or contact Karl at 206-362-7605 or kschroe225@aol.com.

Telescopes

The SAS also has several telescopes available for check out. The telescopes are at Brian Allen’s home. To check out a telescope, contact Brian Allen, 206-517-5599, bri@brizone.com.

June 2002

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4	5	6	7	8 Poo Poo Point Star Party
9	10 Partial solar eclipse	11	12	13	14	15 Green-lake, Cromwell Park Star Parties
16 Father's Day	17	18	19 SAS Meeting	20	21 Summer Soltice	22 Tele-scope Makers
23	24 SAS Board	25	26	27	28	29
30	1	2	3	4 Fourth of July	5	6

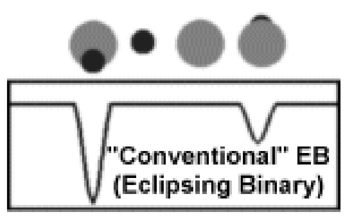
Minutes

EBs, CVs, Dwarf Novae & Polars

By Greg Donohue

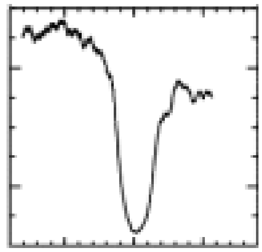
DR. Albert Linnell, Michigan State University Professor Emeritus of Astronomy and Astrophysics and University of Washington Visiting Scholar, addressed the membership at May's general meeting. In April 2001, we also had the privilege of hearing Dr. Linnell's presentation on binary star systems (April 2001, "Double Your Pleasure, Double Your Sun", *Webfooted Astronomer*, q.v.). He is now investigating a special class of binaries known as "cataclysmic variables" (CVs), in collaboration with University of Washington Astronomy Professor Dr. Paula Szkody (November 2000, "Cataclysmic Variables", Webfooted Astronomer, q.v. See also http://www.astro.washington.edu/szkody.)

Conventional eclipsing binaries (EBs) occur when two stars orbit about one another in a plane close to the observer's line of sight. A typical example of such a conventional EB is zeta Phoenicis, with an orbital period of 1.67d, in which one star is larger and hotter (see diagram for light curve at three different orbital positions). When the smaller star eclipses the bigger one, a larger loss of light is produced than when the larger star eclipses the smaller, dimmer component.



But the light curves of cataclysmic variables (CVs) are far more complex than conventional EBs. The first known CV was UX Ursae Majoris, with an orbital period of 4h 46m. This is extremely fast, and indicates that at least one of the stars cannot be very large. As can be seen in the next diagram, prior to the main dip of the eclipse in the light curve, there is a gradual rise in brightness. The eclipse itself is somewhat similar to that of a conventional EB, except for the small standstill glitch on the rising side of the dip. Notice also the bumpiness of the curve upon exit from the eclipse valley.

Minutes (Continued from page 10)



Another CV, U Geminorum (period 4h 15m) shows an even stranger and more erratic light curve. Z Camelopardalis, another CV with a 6.95h orbital period, produces an even more bizarre, irregular light curve. Finally, below is a small portion of the light curve of SS Cygni, a prime example of a dwarf nova. It shows long quiescent periods punctuated every 49.5 d (on average) by a 3.5 magnitude (25x) increase in brightness.

Though the light curve of SS Cygni seems quite different than that of a CV, it is now known that this is a binary system with an orbital period of just 6.6h. It is in fact a cataclysmic variable. What's more, we now know that *all* dwarf novae are CVs.

All this raises a number of interesting questions: What produces these strange light curves? Why do CVs have such short orbital periods? Why are all dwarf novae actually cataclysmic variables (and therefore binary stars)? And how can binary systems produce light curves so seemingly "out of synch" with their orbital periods?

Both stars in a binary system form at the same time from the same protostellar nebula (binary formation via capture is a virtual impossibility). But the stars may be of unequal mass. The more massive component will evolve more quickly, moving off the HR main sequence to become a red giant. For a binary to eventually become a CV, its more massive star must start out between 0.95–10 times the mass of our own Sun, and the lower mass companion must orbit somewhere between 130–2,000 solar radii.

As the higher mass star evolves and swells to become a red giant, it first fills, and then expands beyond, its Roche lobe. Some of the material is transferred onto the lower mass companion, and some is lost from the system altogether. Eventually the smaller star finds itself orbiting inside the atmosphere of the larger star, and friction causes it to spiral in toward it bigger sibling.

The smaller companion introduces a large amount of energy into the stellar envelope, ejecting it entirely from the system, eventually halting the tightening spiral. What's left is the denuded inert white dwarf (WD) core of the red giant, with its initially lower mass companion orbiting much closer. But the orbital period is still a few 10s of hours, so the system is not yet a CV. How does it finally become a cataclysmic variable?

Interaction of the late main sequence (MS) component's stellar wind with its magnetic field carries away some of its angular momentum, slowing its rotation. But the WD raises tides on the MS star that resist this slowing. The net effect is that angular momentum is lost from the system's co-revolution; that is, the orbital velocity is reduced, and so the stars move closer and orbit each other more rapidly. This process takes on the order of 100My.

As the separation distance decreases, so do the sizes of the stars' Roche lobes, until eventually the MS star fills its lobe. At that point, material from the MS star can transfer to its WD companion through the L1 Lagrange point. But conservation of angular momentum prevents this material from falling directly onto the WD. It instead goes into orbit within the confines of the WD's Roche lobe.

The material actually swings around the WD, out toward (but not beyond) the Roche lobe boundary, and then loops back in to impact material that continues to transfer into the system through the L1 point. A shock wave is formed by this collision, resulting in a localized hot spot on the accretion disk formed from material spreading out around the WD. Viscosity in the accretion disk (possibly due its own magnetic field) causes friction, so that material on the inner edge of the disk spirals down onto the WD. An enormous amount of energy builds up in the accretion disk, and is radiated away, so that the disk may end of glowing brighter than the WD itself. This system may eventually stabilize, so that the rate of material transferring through the L1 point matches the rate of material being deposited from the accretion disk onto the WD.

From this model, we can explain the light curve of UX Ursae Majoris. The slight rise prior to the eclipse is the bright hot spot on the accretion disk coming into view from behind the WD.

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Minutes (Continued from page 13)

And the valley is not due to the eclipse of the WD, but rather the accretion disk. And the so-called "standstill" on the rising side of the eclipse is due to an eclipse of the hot spot.

What about the periodic jump in brightness in dwarf novae? The currently accepted theory is the "disk instability" model. In these systems, the viscosity of the disk is dynamically changing. If the viscosity is low, material accumulates in the disk. The disk gets hotter, eventually leading to a rapid increase in viscosity due to ionization of the disk material. This sudden viscosity increase leads to a dramatic increase in the rate at which material drains from the inner disk onto the WD. The decrease of mass cools the disk, the ionized material recombines, and the viscosity suddenly drops again. This dynamic cycle explains the "blips" in dwarf novae like SS Cygni.

But some WD's have strong magnetic fields. If the field is strong enough, it can disrupt the flow of material in the accretion disk. If it is stronger still, it can prevent the formation of the disk entirely, leading to a class of objects called "polars." In these cases, the in-falling material flows along the WD's magnetic field lines onto its poles. This material impacts the surface at high speed, producing a pair of very bright hot spots. Dr. Linnell is collaborating with Dr. Szkody on the intermediate polar cataclysmic variable YY Draconis.

Cataclysmic variables not only offer explanations for several seemingly disparate phenomena; they also (as Dr. Linnell summarized) "present some of the most interesting and challenging problems in modern astrophysics."

***Mauna Kea** (Continued from page 6)*

the way back to Kona. I was disappointed that we didn't get to see the night sky from Mauna Kea, but we got to see the Keck and other observatories on Mauna Kea. All in all, it was a great trip!

For more information:

- Mauna Kea Visitor Information:
  http://www.ifa.hawaii.edu/info/vis/index.html
  (808) 961-2180
- University of Hawaii Institute for Astronomy:
  http://www.ifa.hawaii.edu/

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