Cataclysmic variables (CVs) are binary star systems that contain a white dwarf primary star and a less massive red dwarf secondary star. CVs are special because the outer layers of the secondary star are more gravitationally attracted to the white dwarf than to the actual star to which they belong; this matter is sucked through an equipotential gravitational point and is transferred to the white dwarf, forming a disk of material around the primary star.

CVs in which the white dwarf contains a substantial magnetic field — around a few mega-Gauss (this is a million times stronger than the Sun's magnetic field!) — comprise a special class of CVs, known as intermediate polars (IPs). The gravitationally controlled matter transferred from the secondary star to the white dwarf comes to a point in which gravity loses out to the competing forces of the magnetic field. Here, the matter becomes attached to, and follows along, the magnetic field lines, creating curtains of material extending from the disk up to the magnetic poles on the white dwarf surface. Traveling at velocities one-hundredth the speed of light, this material creates a violent collision with the surface of the white dwarf, producing X-ray and extreme ultraviolet (EUV) emission. The emission properties of IPs are a great attraction for astronomers: IPs can be seen in every wavelength regime from infrared to X-ray.

We have exploited these emission properties in a recent multi-wavelength campaign of the IP EX Hydrae, in which we obtained data from a combination of six satellites and four ground-based observatories, ranging from infrared to X-ray. One million seconds of observing time with the Extreme Ultraviolet Explorer Satellite allowed us to measure the properties of the hot (10 million degrees K) material surrounding the magnetic poles on the white dwarf surface, while optical and ultraviolet photometry and spectroscopy enabled us to probe the physics of the accretion disk and accretion curtain. The scope and extent of the data set enabled us to obtain several results (to appear in a series of papers in the Astrophysical Journal) important to our current understanding of IPs. We have discovered that it is likely that the magnetic field pulls material from the outer edge of the disk, as well as the inner edge, resulting in a very messy accretion scenario. While it would seem one million seconds of observing time is enough to master an understanding of the observed object, we have only scratched the surface. EX Hydrae has proved to be a worthy subject for this extensive observational campaign and the detailed observations have allowed us to further our knowledge of this system. Only through higher time and wavelength resolution observations will we truly be able to discover the hidden secrets of the intermediate polars.
THIS ISSUE’S MARS PICTURES:
"DEBRIS APRONS"

by William K. Hartmann and David A. Crown
PSI Mars Group

In previous issues we’ve emphasized that many older features on Mars seem to show evidence for flow. Some of these features are believed to be caused by glacier-like ice flow. In this issue we show an additional type of Martian surface feature called a debris apron, believed to be a mixture of ice and rocky debris.

Figure 1 is a mosaic of Viking Orbiter images showing a series of debris aprons near the Reull Vallis canyon system. The white box shows the area of Fig. 2. In the left part of Fig. 1’s white box you can see a large apron on the north side of a mountain range. This is the apron that is shown in more detail in Figs. 2 and 3. Fig. 1 also includes several other aprons, including an especially dramatic isolated one to the left of the white box; another larger example is below the white box at the bottom of the mosaic.

The typical appearance is a mountain mass, at the foot of which is an apron of debris that seems to have flowed out in lobes onto the surrounding plains, leaving the mountain with sharp peaks and ridges. The classic view of Martian terrain softening is that most of it happened early in Martian history when the available water made ice deposits that flowed like glaciers. An exciting new finding from our group is that the images from Mars Global Surveyor, such as Fig. 3 (see opposite page), show low numbers of impact craters on the surfaces of the aprons, which highlights the idea that some of these features are very young and could potentially still be flowing. PSI Research Assistant Dan Berman has made crater counts on these surfaces, suggesting that many of them have surfaces no older than a few million years.

David Crown and his former student Timothy Pierce have just finished a paper on these features, arguing that the main masses may be initiated by avalanches or collapses involving ice deposits in the mountains, and that individual lobes then merge together and continue to flow. At the same time, their surface textures and features evolve as ice sublimes from the apron material, collapse pits form, wind blows away loose debris, and other processes act at small scale.

Future research questions concern the abundance of ice in these features, and whether they are still active or stabilized long ago. They exist primarily at mid-latitudes, and there have been suggestions that during cycles of axial tilt change and climate change on Mars, surface conditions were favorable for the accumulation and flow of ice-rich deposits. Answers to these questions may reveal whether there are cycles of water abundance on Mars, which could have ramifications for the possibility of life there.
Figure 3. Mars Global Surveyor close-up of the surface of a debris apron, showing its downhill "front" edge covering the adjacent plains (top of image). The lineations seem to indicate a pattern or direction of flow, fanning out at the leading edge. A new paper by Pierce and Crown discusses different interpretations of debris apron surface textures, including these lineations. MOC image E01-01294 courtesy of MSSS/JPL/NASA.

**Genus Envy**

An asteroid naïve and bumptious,

Loved a comet both flip and presumptuous.

But it ended in quarreling,

When the comet said, “Darling,

Your lightcurves are far from voluptuous.”

Anne Raugh, 2002

This meeting will address how physical observations of craters, both on Earth and on other solid bodies of the solar system, can be combined with the results from modeling of impact cratering for a better understanding of the impact cratering process.

The main goals of the workshop are to reconcile physical observations with theoretical and experimental modeling of impact processes, and to point out areas that future studies should focus on to improve the observation/modeling connection.

**Sponsored by:** Lunar and Planetary Institute

**Conveners:** Dr. Elisabetta Pierazzo (PSI) and Dr. Robert Herrick (LPI).

**Scientific Organizing Committee:**
Bevan French, Natural History Museum
Kevin Housen, Boeing Corporation
William McKinnon, Washington University
Michael Zolensky, NASA Johnson Space Center

**Website:** www.lpi.usra.edu/meetings/impact2003

Note: Please look for Director’s Notes in the next issue as Dr. Davis was on travel at time of publication.
Journey through the Solar System, 2001-2002
by Dick Kenealy, 
Field Trip Program Director

The Institute's 2001-2002 school year science education program concluded in June with virtually the same number of students as the previous year, 2,112 compared to 2,126 for 2000-2001. The number of visitations increased from 36 to 41 as we attempt to limit the class size to the low 60's. With ten activity stations, we have found that ten groups of six students work better than larger groups. The other limitation is the number of parents available to work as supervisors; we need one adult at each station.

Again we have tabulated the teacher evaluations. Upon comparison of the past three school years, I am pleased to report that the 2001-2002 evaluation scores have improved once again.

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The first lecture will be shortened somewhat in the upcoming 2002-2003 school year as teachers have indicated that their students, particularly third-graders, have shorter attention spans. Various adjustments will also be made to some of the activities. We tabulated the teacher evaluations of favorite and least favorite activities of the ten activities offered and the Rainbow Glasses activity is the overwhelming favorite. Second place is a very close split between the TV Color Bars Activity Table and the Phases of the Moon. Third place goes to the Telescope with Sunspots, which inched out the Solar System in 3-D activity.

The remaining activities, the Oscilloscope and Microphone, St. Louis Motor and Magnetism, Vibrating String and Constellation Viewers, Finding the Planets, and Student Telescope, all serve to round out the California State Board of Education Science Content Standards requirements. Of the lectures, the student favorites are the demonstrations, especially those involving liquid nitrogen, the Tesla coil with the handheld light bulb, and the pop-rocket firing at the end of the program.

The Camino Real Playhouse in San Juan Capistrano will once again be the site for the program. I would like to express special thanks to B. J. Scott for allowing our continued rental of the facility. The location is ideal and this past school year there were five visits from local schools where the students walked to the field trip. Additionally, the adjacent park provides a wonderful area for many of the attendees to enjoy lunch after the event. I would also like to acknowledge our regular volunteers, Muriel Gustin and Connie Christensen, for their time spent with the students during the activity portion of the program and to Muriel for helping with the equipment setup on the mornings of each field trip throughout the school year.

One Tuesday Morning
by Muriel Gustin, 
Field Trip Volunteer

It was a Tuesday morning in the fall of 1999 and I was in the lobby of the Camino Real Playhouse Community Theater in San Juan Capistrano, waiting for a meeting to begin. I had retired in 1989, after 30 years in the Aerospace industry, and settled in San Juan, where I became a docent at the Mission and sat on the Board of the Theater. Little did I know that arriving early that particular morning would make such an impact on my life. I could hear someone speaking, but no other sounds, so I went into the auditorium to find a man on the stage surrounded by scientific equipment of all kinds, as well as a large television set, talking to an audience of what appeared to be completely engrossed third graders. I sat on the steps of the theater for the next hour as quiet and attentive as a third grade student. As it turned out, the gentleman on the stage was Dick Kenealy, and thus began my love affair with the San Juan Capistrano Research Institute, which is now known as the Planetary Science Institute.

But, I am getting ahead of my story. I graduated from Mount Saint Mary’s College with a B.S. in Chemistry and Math in 1947 and for the next 20 years devoted all my time to raising three sons. In the late 1960’s, it was necessary to put my degree to use, and with the help of a couple of friends, I found a position with Ford Aeronutronic in Newport Beach. When our project was delivered, I joined my friends who set up a consulting firm that later became Planning Research Corporation. I spent the next 10 years with them in Washington D.C., mostly at the Pentagon. In the early 1980’s, I was recruited by Hughes Aircraft Space and Communications Division and returned home, where I retired in December 1989. Fast-forward to 1999 and my seat on the stairs of the Camino Real Playhouse.

I finally approached Dick Kenealy and Pam Byrd and asked them if they could use help setting up the field trip program equipment. I knew I had found a new home along with a new pride in being part of the team. I also enjoy helping during the activity portion of the program, supervising various activities such as the Phases of the Moon, the Solar Telescope and Binoculars, and the TV Color Bars and Activity Table. The most gratifying part of my work with the Institute is not only recognizing the great strides that basic science has taken, but more importantly, the opportunities being made available to school students at an early age with programs such as the “Hands-On” activities that the field trip offers. To see the joy on their faces when they actually SEE the sunspots through the telescope, or watch their pop–rocket be the first one to “blast off” is to know the world is in good hands.
From Conferences to Field Trips

By Connie Christensen,
Field Trip Volunteer

Since November 1992, I have been volunteering at the Institute, helping with science conferences. My job includes assisting with registration, and preparing an endless array of food. Conference participants complain jokingly that they gain five pounds per conference! I fondly remember that Doug Nash had a strict rule to which I, of course, adhered: we could only answer questions if we knew the answers. Additionally, I learned how to say “Good Morning” in six different languages. At the first conference I attended, called the Discovery Workshop, NASA’s Dan Goldin spoke about dinosaurs, ghosts, and space. He said he felt that teachers today are not comfortable teaching science. All in all, it was a very interesting conference.

For the past two years I have been volunteering at the education program, where I introduce the telescope and binoculars during the activity portion of the field trip. Most of the students have never looked through a large telescope and they are quite impressed. When the sun is shining, we are able to look at sunspots through the telescope. We use a solar filter that blocks out 99.999% of the visible and UV light so that the eyes are protected during viewing. My background is in biology so the transition from microscope to telescope was seamless.

The students are very enthusiastic about astronomy. On Valentine’s Day 2002, my next-door neighbor, sixth-grader Alex Dohn, attended our program. He got “so jazzed” after attending the field trip that he picked astronomy as his Boy Scout science project for their science fair. I helped him with advice, review of our program materials, and items for his display. His version of the Alka-seltzer pop-rockets, which we do at the end of each field trip, was a real crowd pleaser at his event. Alex earned his merit badge, and his troop took first place among the several hundred troops that participated. Volunteering at PSI has enriched my life and has allowed me to contribute to science education.

Youth Expo 2002

By Pam Byrd

We had an exciting opportunity to spread the word about the California Division’s “Journey through the Solar System” Science Education Field Trip Program this spring. On the weekend of April 19-21, the Orange County Fair and Exposition Center in Costa Mesa sponsored their annual Youth Expo event, with a new twist: the first-ever fully staffed “Teacher Resource Center”, which over 1,000 teachers attended. The Youth Expo is held to honor teachers and recognize the positive accomplishments of school students.

PSI had a prime location for its display case of various Institute items: Moon, Mercury, and Mars globes, simulated lunar soil, astronomy posters, and other items. An adjacent table provided teachers with information about the Institute; literature about our field trip program and other PSI flyers were distributed. An “opportunity drawing” for teachers was held on the final day of the event and PSI donated an Estes Air-Powered Rocket System for one lucky winner.

I would like to express my sincere thanks to the Youth Expo Director, Kim Aguirre, and the Teacher Resource Center Coordinator, Janet Brown, who helped make this event a huge success. We look forward to participating again next year.

Volunteers Needed!

The California Division has an immediate need for volunteers for the Science Education Field Trip Program to supervise students at activity stations. No scientific knowledge required. Please call (949) 582-2727.

Fourth-grader Nicole Hinds from Anaheim enjoyed the Youth Expo exhibit as well as the face painting.
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