

# *The Kirkwood Society*

*A Newsletter for Alumni and Friends of the  
Astronomy Department at Indiana University*

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This has been another busy and productive year for the department. Our undergraduate major program remains strong, with nine graduating in May. The WIYN Observatory remains our primary instrument for graduate research and continues to provide world-class performance for image quality and multiple-object spectroscopy. Research activities have taken our students and faculty to Venezuela, Italy, Germany, and Japan, as well as other global locations this past year. These travels, along with current graduate students from Greece, Venezuela, and China, remind us daily of how astronomy has become a truly international enterprise. Be sure to visit our newly revised Web site at [www.astro.indiana.edu](http://www.astro.indiana.edu) to learn about these and other programs of the department.

## ***Kirkwood Observatory:***

Renovation of the Kirkwood Observatory has finally begun! Work on the building and dome, performed by a professional historical renovation contractor, will retain the 1900-1950 look and feel. The functions of the telescope and observatory will be preserved insofar as Wednesday Public Night and use of the telescope for viewing the moon and planets by students in our descriptive astronomy classes. As seen in the photo, damaged portions of the wooden dome are being replaced this summer and we hope to save some of the dome pieces for souvenirs.



The renovation of the telescope itself is being done by the Astronomy Department. The telescope is now nearly completely disassembled for repair and refurbishment. With new paint, clean optics, and polished brass, we think the telescope will look very similar to when it received the majority of its use this past century. The Kirkwood 12-inch telescope was used extensively in our Observational Techniques class for our undergraduate majors. That function will now be assumed by two new 14-inch telescopes on the rooftop of Swain Hall West, whose domes are seen in the photo.

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These new telescopes are equipped with modern CCDs and spectrographs. This computer-controlled equipment will better serve our majors in providing a modern introduction to observational astronomy.

### ***Kirkwood Chair Funded:***

Since 1985 Frank and Margaret Edmondson contributed regularly to an endowment fund for establishing a Kirkwood Chair or Professorship. In 2000 Professor Edmondson completed the Professorship gift through a charitable gift annuity. Later that same year an anonymous donor added \$500,000 to the endowment to convert the Professorship to a fully endowed Chair (as well as the creation of an endowment to help keep the WIYN Observatory productive). We are extremely grateful to both parties for making the Kirkwood Chair a reality. Daniel Kirkwood was the most distinguished astronomer to be associated with Indiana University and it has long been a dream of many to see his name permanently associated with a named Chair.

### ***Research Highlight: Simulations Of The Solar Nebula***

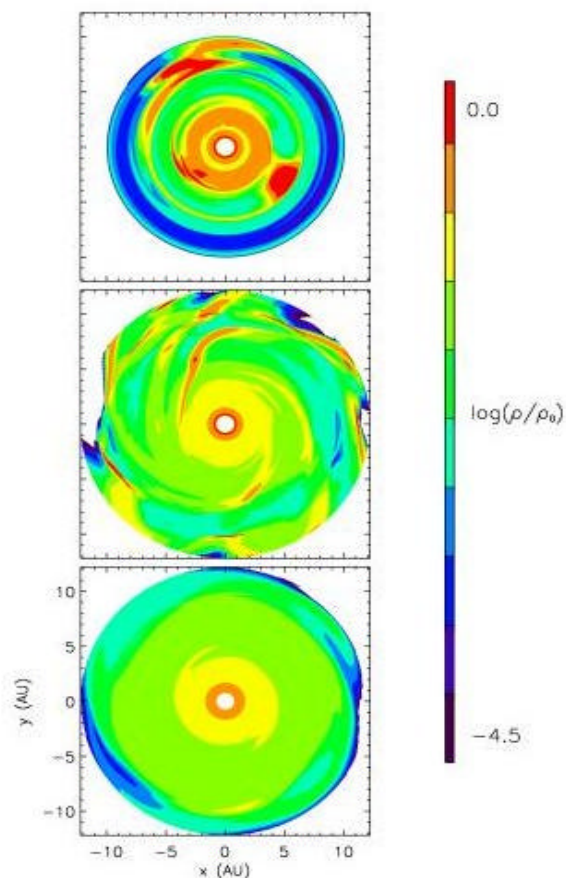
The term "Solar Nebula" refers to the hypothetical disk of gas and dust around the young Sun from which its planetary system presumably formed. The formation of Jupiter, which contains most of the Solar System mass outside the Sun, remains a critical yet largely unresolved problem. The standard and most widely accepted theory is called the "core accretion" model. The slow accumulation of solid asteroid-like "planetesimals" leads to the formation of a planetary core. Once this core reaches a critical mass of perhaps 10 to 20 Earth masses, it then rapidly accretes a gaseous envelope from the surrounding Nebula. The mechanism has been shown to work. The main difficulty is that the time scale necessary for the accumulation of a large solid core may be significantly longer than the expected lifetime of the Solar Nebula itself, which is, at most, several million years. Additionally, many of the dozens of extrasolar planets so far discovered have masses considerably greater than Jupiter's, and so would presumably require even more time to form in this way.

An alternative to core accretion, called the Giant Gaseous Protoplanet (GGPP) scenario was first proposed fifty years ago and has been recently revived by Alan Boss at the Carnegie Institution of Washington. In this picture, instabilities due to the self-gravity of the Solar Nebula lead directly to the early and rapid (orbital time scale) formation of clumps, which eventually evolve, into the Jovian planets. Since the mechanism allows for rapid formation of objects more massive than Jupiter, it may also be important for the formation of brown dwarfs and massive extrasolar planets. I.U. Astronomy Professor Richard Durisen and I.U.

graduate students Annie Mejia and Kai Cai are part of a team of astronomers exploring how gravitational instabilities may have affected the Solar Nebula-like disks that are known to exist around young stars. Among their interests is whether such instabilities ever lead to the formation of GGPP's. Collaborators include alumnus Brian Pickett (Purdue University Calumet), Pat Cassen (retired, NASA's Ames Research Center), and Dorothy Woolum (California State University Fullerton). The group conducts high-resolution three-dimensional hydrodynamics simulations on various supercomputers, including Indiana University's new 64-processor SUN Enterprise 10000. Among the most important results from the group's work in the last three years is the demonstration that disk thermal processes ultimately govern the outcome of gravitational instabilities. To date, most numerical simulations have relied upon rather idealized assumptions of the disk's thermal physics. It has been shown, for example, that the condition of local isothermality, in which the disk temperature is considered to be independent of time, is particularly conducive to the fragmentation of a protostellar disk. In fact, simulations of the Solar Nebula reported by Boss in 1997 and 1998 seemed to show that this condition by itself was sufficient for the production of two GGPP's, near the current orbits of Jupiter and Saturn, on a time scale of several hundred years.

Last year, simulations by Pickett, Durisen, Cassen, and Mejia demonstrated, for a Solar Nebula model similar to Boss's, that permanent GGPP formation only occurred in Boss's simulations due to an artificial and unphysical constraint he imposed on his nebular gas motion. With the constraint removed, the disk did condense into transient spiral arcs of high-density material, but no long-lived condensations survived thermal and tidal disruption. In a still more realistic simulation, the constant temperature assumption was dropped and the Nebula's internal thermal energy was explicitly calculated, including heating that would occur in shocks. Although the Nebula was still unstable to the growth of spiral arms, no condensations formed at all. Instead, the model Solar Nebula expanded vertically and radially. The implication of these simulations is that a careful treatment of the energetics of the Solar Nebula is required to determine whether condensations can form by gravitational instabilities and whether these condensations are long-lived protoplanets. Professor Durisen's group is now involved in a multi-year effort to conduct extremely high-resolution

simulations that include progressively more realistic thermal physics, such as a proper equation of state, shear and bulk viscosities, radiative energy transport within the disk, and irradiation of the disk surface by the central proto-Sun. Current simulations by the group are examining the dynamical effects of a new, more realistic nebular equation of state (Pickett, Cassen, Woolum), the inward transport of disk resolution material onto the proto-Sun due to gravitational instabilities in the Nebula (Mejia); and a detailed analysis of the propagation of the spiral waves induced by gravitational instabilities (Kai).



This picture above is a comparison of Solar Nebula simulations. The figure shows representations of the equatorial mass density for three representative simulations of the Solar Nebula. The scale spans four and half orders of magnitude in density; density is normalized by  $\rho_0 = 4 \times 10^{-9} \text{ g cm}^{-3}$ . Top panel: Solar Nebula simulation under the artificial conditions used in Boss (1998). A 34 Jupiter-mass object forms at 5.4 AU and completes more than three orbits by the end of the simulation at 180 years. Middle panel: High resolution Solar Nebula simulation under the locally isothermal condition, but without the conditions imposed in the top panel. The disk structure is now considerably more complex, and no stable condensations survive even one quarter of an orbit. The image corresponds to 66 years, or about 2 rotations at 10 AU. Bottom panel: nonisothermal Solar Nebula simulation after 180 years. Heating stabilizes the disk against fragmentation, and induces radial and vertical expansion of the disk.

## AAS Meeting

With the help of donors to the department, a number of astronomy students were able to attend and present papers at the 197th Meeting of the American Astronomical Society in San Diego in January. Among the IU alumni we saw in San Diego are Dave Alexander (Ph.D. '72), Robert Berrington (Ph.D. '00), Paul Bode (Ph.D. '94), Ed Churchwell (Ph.D. '70), Frank Edmondson (A.B. '33), Arne Henden (Ph.D. '85), John Kolena (Ph.D. '78), Arlo Landolt (Ph.D. '62), Robert Milkey (Ph.D. '70), Paul Mutschlecner (M.A. '54), Terry Oswald (A.B. '74), Larry Ramsey (Ph.D. '76), Terry Rettig (Ph.D. '76), Angela Sarrazine (B.S. '94), Eric Schlegel (Ph.D. '83), Tom Steiman-Cameron (Ph.D. '84), John Wang (B.S. '95), Jay White (Ph.D. '93), and Rebecca Winnick (B.S. '95). This was a very large meeting and it is certain that many other former IU students were also in attendance.

At the AAS banquet in San Diego Frank Edmondson was presented with a "Special Award" in recognition of his attendance at AAS meetings over a span of seventy years. Professor Edmondson's first AAS meeting was at the Perkins Observatory near Columbus, OH in 1931. He has attended many AAS meetings since then, as well as most of the IAU General Assemblies. Frank will celebrate his eighty-ninth birthday later this year. We are delighted that he keeps regular office hours in the department, working mostly on topics in the history of astronomy. Below are pictures of two Indiana students with their papers at the summer AAS Meeting in Pasadena.



Aaron Steinhauer, Graduate Student



Laura Hainline, Undergraduate Student

## ***Kitt Peak 36-inch telescope:***

The WIYN Consortium submitted a successful bid to acquire use of the 36-inch telescope at Kitt Peak. This telescope is adjacent to WIYN and has a very wide one-degree field-of-view which matches the WIYN multi-object-spectrograph field. The KPNO Mosaic CCD camera will be shared between the KPNO 4-meter and the 36-inch, providing a one-degree imaging capability for those projects needing such a large field. At other times the 36-inch will be equipped with a smaller CCD imager for photometry.

The existing control system on this telescope is very outdated. The first task has been to install a new modern control system, which we hope will be operational by the fall of 2001, at which time the telescope is expected to begin regular operations. The emphasis is on CCD imaging and especially on synoptic observations of time-variable phenomena. The telescope will be especially useful for student observing projects

We expect students will learn to use the telescope during a summer visit, and mostly use remote observing during the academic year to acquire their data. As with the 3.5-meter WIYN telescope, Indiana has a 17% share of the observing time on the 36-inch.

## ***Student Awards:***

Graduate Student Aaron Steinhauer was awarded the Bernice Eastwood Covalt Memorial Scholarship by the College of Arts and Sciences. The scholarship was established by Dorothea Kroncke to honor the memory of Bernice Eastwood Covalt, (A.B., Home Economics '21) and is given to a Bloomington campus science student who has demonstrated high academic achievement.



From Left to right: Laura Hainline, Emily Freeland, Matt Bavender, Erica Raffauf, and Larry Kirby.

Senior Laura Hainline was awarded a Barry M. Goldwater Fellowship as well as a Chancellor's Scholarship for her senior year of study. Laura also won an NSF Fellowship for her upcoming graduate work, and received the Hollis and Grete Johnson Award and Honor Senior Thesis Award from the Astronomy Department.

Matt Bavender received the Honor Senior Thesis Award.

Emily Freeland received the 2001 D.J. Augus – Scientech Award for Most Improved Undergraduate.

Erica Raffauf received the Honors Senior Thesis Award.

Larry Kirby received the 2001 Astronomy Alumni Award and Honor Senior Thesis Award.

## ***Faculty News:***

Earlier this year Professor Emeritus Hollis Johnson learned that a paper he co-authored was selected by the Society for Sedimentary Geology as the 1999 Outstanding Paper in the Journal of Sedimentary Research. "Calculating Lunar Retreat Rates Using Tidal Rhythmites" by Erik Kvale, Hollis Johnson, Charles Sonett, Charles Archer, and Ann Zawistowski deals with extracting information on ancient Earth-Moon distances from tidal periods preserved in tidal sedimentation layers. They conclude that the lunar orbital retreat slowed sometime during the mid-Paleozoic. Professor Kvale is with the Department of Geological Sciences at Indiana University, and this interdisciplinary collaboration is a valuable addition to both departments.

During 2000 Constantine Deliyannis gave invited reviews on light element nucleosynthesis at the Subaru Workshop in Japan, at IAU Symposium 198 in Brazil, and at the Stellar Clusters conference in Sicily.

Press releases by the American Astronomical Society were recently provided on Michael Pierce's work on the local peculiar velocity field from nearby galaxies, on Constantine Deliyannis's work on Lithium test of Big-Bang Nucleosynthesis, and on Kent Honeycutt's results from long-term automated photometry of accretion disk systems.

Haldan Cohn and Phyllis Lugger are participating with University of Tokyo astronomers to install a new GRAPE-6 N-body supercomputer facility at Indiana. The current GRAPE machine at Indiana, provided through the same collaboration, has proven invaluable in computing the realistic dynamical evolution of globular clusters.

Stuart Mufson continues to work on two high-energy physics experiments aimed at particle properties relevant to astronomy and astrophysics. The MACRO experiment in Italy searches for magnetic monopoles and cosmic sources of neutrinos and muons, while the

MINOS experiment seeks to measure the neutrino mass through neutrino oscillations. Both the MACRO and MINOS detectors are located deep underground to minimize background contamination.

Richard Durisen is spending much of this summer in Germany as part of his Alexander van Humboldt Award. He gave an invited talk at the recent IAU Symposium in Potsdam on the formation of binary stars.

Liese van Zee will be joining our faculty this fall as Assistant Professor. Dr. van Zee was a Jansky Fellow at the NRAO and is currently a Research Associate at the Herzberg Institute of Astrophysics in Victoria, B.C. She received her Ph.D in 1996 at Cornell working with Professor Martha Haynes. Her research interests are galaxy evolution and element enrichment, with a current emphasis on the nature of low surface brightness dwarf galaxies.

Catherine Pilachowski is the inaugural Kirkwood Chair of Astronomy. Dr. Pilachowski received her Ph.D. at the University of Hawaii and has spent most of her career as an Astronomer at the National Optical Astronomy Observatories in Tucson. Her research interests are the origin of the chemical elements in the Milky Way, and stellar clusters and evolution. In addition to a very strong research record, Dr. Pilachowski has extensive experience in running observatories and a distinguished record in professional service to our discipline. She has served on the Council of the AAS, on the Board of the ASP, as Vice President of IAU Commission 37, and is President-elect of the American Astronomical Society.

## **Deaths:**

Ray Grenchik (Ph.D. '56) died September 28, 2000 in Baton Rouge, LA. While at Indiana he studied under the late Marshal Wrubel where his thesis was one of the earliest attempts to model the atmosphere of a white dwarf star. Most of his career was spent in the Department of Physics and Astronomy at LSU, from 1957 until his retirement in 1988. Dr. Grenchik was a member of the Kirkwood Society while at Indiana, the namesake for this newsletter.

Lynn Miller (Ph.D. '94) was struck and killed by a city transit bus in Harrisonburg, VA on May 16, 2001. Dr. Miller was Assistant Professor of Physics at James Madison University and had retained close ties with Indiana University since her graduation. She was a Postdoctoral Fellow in the High Energy Astrophysics Group (HEAP) at Indiana from 1994 to 1998 and continued to work closely with HEAP on the MACRO and MINOS experiments while at James Madison. Because of her continued close association with the department she will be greatly missed both personally and professionally by her Indiana colleagues and friends.

## **Alumni News:**

Dan Grosseohme (B.S. '85) is an Episcopal priest and Director of Pastoral Care at Children's Hospital Medical Center of Akron. He is the author of a recent book *The Pastoral Care of Children* and publishes regularly in the area of mental health and spirituality.

Jennifer Hoffman (B.S. '97) and Lynn Neakrase (B.S. '97) are both graduate students at Arizona State University, Jennifer in Physics and Astronomy and Lynn in Geology. These two are listed together, not because they are both at Arizona State, but because they were married June 17, 2000!

Roberta Humphreys (B.S. '65) was recently named Distinguished Professor in the Institute of Technology (IT) at the University of Minnesota, where she is also Professor of Astronomy. These positions are awarded for research, teaching and service and only 20 professors in the IT can hold this title at any one time. Professor Humphreys is the first astronomer and first woman to receive this honor.

Brian Pickett (Ph.D. '95) is an Assistant Professor in the Department of Physics and Astronomy at Purdue University Calumet. Brian continues to work closely with Bloomington astronomers in his research. He and Richard Durisen co-authored the "Research Highlight" contribution in this newsletter.

Arthur Poland (Ph.D. '69) is lead scientist for the Sun-Earth Programs at the NASA Goddard Space Flight Center. His work in advancing a network of satellites to monitor solar variability and the solar wind are the subject of an article in the July 28, 2000 issue of *Science*.

William Stein (Ph.D. '76) is Defense Intelligence Senior Leader at the National Imagery and Mapping Agency (NIMA). Currently he directs the advanced research and development program for the NIMA Physical Sciences program, and is involved mostly with the Shuttle Radar Topographical Mission.

Michael Weasner (B.S. '70) authored Chapter 9 entitled "The Mighty ETX" in the recent Springer book *Astronomy for Small Telescopes*. Details are available at his Web site [http://www.weasner.com/etx/book/small\\_telescope.html](http://www.weasner.com/etx/book/small_telescope.html)

James White II (Ph.D. '93) has accepted the position of chair of the Physics Department at Rhodes College in Memphis TN. In recent years Jay has been with the Astronomical Society of the Pacific (ASP), first as editor of *Mercury* magazine and later as Executive Director of the ASP.

### ***Gifts:***

If you would like to discuss a gift or bequest to Indiana University, please contact the Development Office in the College of Arts and Sciences, Susan Green, Director.

### ***Tell us about yourself:***

Pass along the latest about yourself for our newsletter. Contact either The Astronomy Department or, The Indiana University Alumni Association, P.O. Box 4822 Bloomington, IN 47402-4822.

### ***Website:***

Be sure to visit our Web site to keep updated on news and activities within the Department. We update our page daily. Visit [www.astro.indiana.edu](http://www.astro.indiana.edu).

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