

Meeting Agenda



Friday, 28 September 2007

- 1:00** Open for Poster Setup & Registration
1:45 Welcome and Opening Remarks/Announcements
2:00 Invited Oral Session
Well, It Was Big When We Built It
Virginia Trimble, University of California-Irvine
HST Polarization Observations of the Crab Nebula
Jeff Hester, Arizona State University
GLAST: Exploring the Extreme Universe
Robert Naeye, NASA Goddard Space Flight Center
- 3:20** Break
3:45 Contributed Oral Session
The Role of Synchrotron Cooling in Modeling the Dynamic Wisps of the Crab Nebula
Joe Foy, Hampden-Sydney College
Unveiling the Properties of the Young Object V645 Cyg
Anatoly Miroshnichenko, UNC-Greensboro
A Side of Mercury Not Seen by Mariner 10
Gerald Cecil and Dmitry Rashkeev, UNC-Chapel Hill
- 4:30** Adjourn for Dinner & Independent Discussion
7:00 Public Lecture
The Dark Side of the Universe: Beyond Stars and the Starstuff We Are Made of
Michael Turner, University of Chicago

Saturday, 29 September 2007

- 9:00** Open for Poster Setup & Registration
9:30 Welcome and Opening Remarks/Announcements
9:40 Invited Plenary Session
Cosmic Acceleration: New Gravitational Physics or Mysterious Dark Energy
Michael Turner, University of Chicago
- 10:30** Break
11:00 Invited Oral Session
The Mars Phoenix Lander Mission
Prasun Desai, NASA Langley Research Center
- 11:30** Announcements
11:45 Lunch
1:00 Panel Discussion
The past 10 years in Astronomy and a Look to the Coming Decade
Moderated by Robert Naeye (NASA Goddard)
Panel: Jay Bergstralh (NASA Langley), Bruce Carney (UNC-Chapel Hill), Prasun Desai (NASA Langley), Virginia Trimble (U. Cal.-Irvine), Michael Turner (U. Chicago), John Wood (NASA Goddard)
- 2:30** Break
3:00 Contributed Oral Session
DIRV - Dedicated Interferometer for Rapid Variability
David Moffett, Furman University
Distances and Ages of the Open Clusters Dolidze 27 and NGC 6645
Rosalie McGurk (University of Washington-Seattle, PARI), Michael Aubrey (UNC-Chapel Hill, PARI), and Michael Castelaz (PARI).
Skynet/PROMPT Update
Kevin Ivarsen, UNC-Chapel Hill
- 4:00** Adjourn

Oral Presentations – Friday & Saturday

Invited – Friday, 28 September 2:00-3:20 p.m.

1.1 *Well, It Was Big When We Built It* Virginia Trimble, University of California-Irvine

A large fraction of major astronomical discoveries, from lunar mountains to gamma ray burst optical counterparts, were made with telescopes that now seem derisorally small. They were, however, very often the largest and/or best engineered available at the time. The talk will highlight a few specific cases and outline others, with lots of pictures from Tycho and Galileo onward, including a few of the "hopeful monsters" that were the largest of their generations but never really found anything.



1.2 *HST Polarization Observations of the Crab Nebula* Jeff Hester, Arizona State University

Recent work on the Crab Synchrotron Nebula has led to a clear picture of an axisymmetrical pulsar wind nebula, with an axis running SE to NW through the nebula. This axis is seen in an equatorial torus, polar jets, and even in the structure of the supernova ejecta that has been swept up and compressed by the expanding PWN. Polarization maps of the Crab, however, show a very different picture, with an axis of symmetry running at 45 degrees to the pulsar axis. The problem is that net polarization measurements represent line integrals through the nebula, rather than the polarization associated with physically discrete features.

We have used the HST ACS to obtain very high resolution polarization images of the Crab. By isolating individual features from the nebular background and determining their polarization, we show that wisps and other features in the nebula are in fact flux tubes with the magnetic field running along their length. Polarization of these discrete features nears the theoretical maximum. The overall magnetic topology of the remnant will be discussed as well.



1.3 *GLAST: Exploring the Extreme Universe* Robert Naeye, NASA Goddard Space Flight Center

NASA's Gamma-ray Large Area Space Telescope (GLAST) is the next-generation gamma-ray observatory. This international observatory will address fundamental questions in astronomy, physics, and cosmology, shedding new light on our universe's most extreme processes and environments. Besides studying supermassive black holes, pulsars, and gamma-ray bursts, GLAST may reveal the nature of dark matter and unveil new laws of physics. It will open a new window on the high-energy cosmos, possibly revealing new types of exotic objects. GLAST is scheduled to launch in early 2008.



Contributed – Friday, 28 September, 3:45-4:30 p.m.

2.1 *The Role of Synchrotron Cooling in Modeling the Dynamic Wisps of the Crab Nebula* Joe Foy, Hampden-Sydney College

Models of the Crab synchrotron nebula include energy losses by radiative and adiabatic expansion, but neglect the effect of radiative losses on the flow itself. The standard approach of all such models to date is to calculate a post-shocked flow and modify only the energy equation while assuming steady state flow dynamics. Even the most recent efforts at simulating the synchrotron emission from the Crab continue to adopt this approach. Typically, these authors argue that since the radiated power is only about 10 percent of the pulsar's spin down luminosity, radiative losses should have only negligible effects on flow dynamics. This argument implicitly assumes a spherically symmetric nebula: the estimate can be as high as 20--30 percent for a more realistic wedge geometry, for example.

We present a new, time-independent model of the Crab synchrotron nebula that incorporates radiative cooling for the first time. Specifically, we derive and solve the full set of relativistic magnetohydrodynamic (MHD) flow equations with radiative energy losses fully coupled to these equations from the start. The results of model calculations give plausible agreement with observations of the Crab Nebula. It is demonstrated that, for the particle energy and magnetic field values typical of the Crab, synchrotron cooling has too significant an effect upon the flow structure to be ignored. The possibility that the dynamic "wisps" observed in the nebular flow of the Crab are due to synchrotron cooling instabilities is discussed.



**2.2 *Unveiling the Properties of the Young Object V645 Cyg*
Anatoly Miroshnichenko, UNC-Greensboro**

V645 Cyg is a variable hot emission-line object with a very strong infrared excess. It was discovered about 70 years ago and observed in a wide spectral range (optical through radio) so well that the amount of information about it was called embarrassingly rich. Nevertheless, there is still no consensus about the properties of the star and its gaseous and dusty envelope. I'll briefly review the existing data and those we obtained recently in order to unveil the true nature of the object.



**2.3 *A Side of Mercury Not Seen by Mariner 10*
Gerald Cecil (OR Dmitry Rashkeev), UNC-Chapel Hill**

The sharpest few dozen "lucky" images of 60,000 taken of Mercury on two mornings by SOAR show 2/3 of the hemisphere not imaged by Mariner 10. A few topographic features are visible near the terminator plus many rayed craters at higher sun angle. Roughly half of this hemisphere has been imaged by radar but not previously by lucky imaging, so we correlate the radar and optical images. A dark region extends over much of the northern mid-latitudes, and extends into the Mariner imaged hemisphere. Its sharp southern boundary sometimes coincides with changes in radar texture, suggesting that it is not due to enhanced insolation or other space weathering. NASA's MESSENGER mission will image part of this hemisphere in mid-Jan, so we'll know what's up then.



Public Lecture – Friday, 28 September, 7:00 p.m.



**3.1 *The Dark Side of the Universe: Beyond Stars and the Starstuff We Are Made of*
Michael Turner, University of Chicago**

The sky is filled with hundreds of billions of galaxies, all lit up by their stars. But, stars account for less than one percent of the material in the Universe, and galaxies are held together by a new form of matter – dark matter -- that accounts for 1/3 of the stuff in the Universe. The other 2/3 exists as in an even more mysterious form -- dark energy -- and is causing the expansion of the Universe to speed up, rather than slow down. In astronomy today, the dark side is where the action is!

Invited – Saturday, 29 September, 9:30



**4.1 *Cosmic Acceleration: New Gravitational Physics or Mysterious Dark Energy*
Michael Turner, University of Chicago**

In 1998 astronomers discovered that the expansion of the Universe is speeding up and not slowing down as was expected. Today the evidence that the expansion is accelerating is overwhelming, and the riddle of "cosmic acceleration" is one of the most profound puzzles in all of science. It touches upon a number of deep questions in both cosmology and elementary particle physics: What is our cosmic destiny? How much does the quantum vacuum weigh? How are Einstein's theory and quantum mechanics to be reconciled? Are their weird forms of energy with repulsive gravity? and Is string theory the theory of everything or nothing?

Invited – Saturday, 29 September, 11:00

5.1 *The Mars Phoenix Lander Mission* Prasun Desai, NASA Langley Research Center

On August 4, 2007, the Mars Phoenix Lander was successfully launched from the Kennedy Space Center. Phoenix will be the first mission to explore the northern pole region of Mars. It will arrive at Mars on May 25, 2008. One of the main challenges of Phoenix with regards to entry, descent, and landing is that it will perform a "soft" landing. That is, unlike the rovers Spirit and Opportunity which used airbags to cushion the landing during all the bounces that occurred, Phoenix will fire retro-rocket engines starting at approximately 800 meters above the surface and continuously fire them to slow its descent to achieve near zero speed at landing. Phoenix will not carry a rover. Phoenix is designed to study the history of water and habitability potential in the Martian arctic's ice-rich soil. In the continuing pursuit of water on Mars, the poles are a good place to probe, as water ice is found there. Phoenix will land on the icy northern pole of Mars between 65 and 75 deg North latitude. During the course of the 150 Martian day mission, Phoenix will deploy its robotic arm and dig trenches up to half a meter (1.6 feet) into the layers of water ice. These layers, thought to be affected by seasonal climate changes, could contain organic compounds that are necessary for life. To analyze soil samples collected by the robotic arm, Phoenix will carry an "oven" and a "portable laboratory." Selected samples will be heated to release volatiles that can be examined for their chemical composition and other characteristics. This data may provide important answers to the following questions: (1) can the Martian arctic support life, (2) what is the history of water at the landing site, and (3) how is the Martian climate affected by polar dynamics? This presentation will provide an overview of the Phoenix mission.



Invited Panel Discussion

6.1 *The past 10 years in Astronomy and a Look to the Coming Decade*



Moderated by Robert Naeye (NASA Goddard)

Panel: Jay Bergstrahl (NASA Langley), Bruce Carney (UNC-Chapel Hill), Prasun Desai (NASA Langley), Virginia Trimble (U. Cal.-Irvine), Michael Turner (U. Chicago), John Wood (NASA Goddard)

To celebrate ten years of education and outreach, the Cline Observatory has received a Foundation Grant allowing us to invite our past Astronomy Day speakers back to GTCC to take part in this conference to participate in a panel discussion about the important developments in the last decade in astronomy and astrophysics. During the ten years that the Cline Observatory has served as the Triad's top astronomical resource, the field of astronomy has undergone dramatic transformation. Hundreds of planets have been found around other stars, we are actively exploring the surface of Mars, our understanding of the age, content, and behavior of the universe as a whole has been transformed, the most powerful explosions in the universe are now regularly observed and generally understood, and new multi-wavelength telescopes have joined the Hubble Space Telescope in orbit. It is an exciting time in astronomy, and with the support of the GTCC Foundation and the astronomers who have visited us during our first decade, we are happy to share that excitement by arranging a lively discussion of what we have learned and what is likely to happen next.



Contributed – Saturday, 29 September, 3:00-4:00

7.1 *DIRV - Dedicated Interferometer for Rapid Variability* David Moffett, Furman University

We present an overview of the DIRV project, and a status report of its development, currently under way at the Pisgah Astronomical Research Institute.



7.2 *Distances and Ages of the Open Clusters Dolidze 27 and NGC 6645* Rosalie McGurk (University of Washington-Seattle, PARI), Michael Aubrey (UNC-Chapel Hill, PARI), and Michael Castelaz (PARI).

Dias et al. (2003) published a catalog of 1,756 open star clusters. Where data is available, the catalog lists positions, diameters, E(B-V), age, mean proper motion, estimated number of stars, radial velocity, and Trumpler type. 731 open clusters have no information other than position and Trumpler type. We have started a program to measure distance and age of these poorly studied clusters using the collection of objective plates at the National Plate Center at PARI and PROMPT and PARI/PARSEC telescopes. We report on the results of our measurements of Dolidze 27 and NGC 6645.



7.3 *Status Report and Demonstration of PROMPT and Skynet* Kevin Ivarsen, UNC-Chapel Hill

The University of North Carolina operates the six PROMPT telescopes at CTIO in Chile. These telescopes are part of a telescope network developed by UNC called Skynet, which has been operational since January 2006. Skynet's top priority is to perform rapid simultaneous observations of GRB afterglows. However, the majority of the network's time is spent on observations submitted by researchers, astronomy students, high school students, and the general public. I will give an update on the status of these projects and demonstrate some features of the system.



Display Presentations

The Signature of Kelvin-Helmholtz Instabilities in Supernovae Enrique Gomez, Western Carolina University

Stars with masses greater than eight times the Sun's explode as supernovae when they fail to extract energy from nuclear fusion. Some of these supernova progenitors shed their outermost hydrogen envelope and acquire high rates of rotation at their cores before they explode. During a supernova collapse phase these stars form a dense disk of material around a degenerate core, which in turn powers energetic jets that propagate through the stellar atmosphere outwards. These jets soon acquire bulk speeds close to the speed of light. We performed a detailed analysis of numerical, hydrodynamic simulations of these jets to determine their stability to pressure waves that grow as Kelvin-Helmholtz modes from the interface between the jet and the stellar medium. When we follow the jets in supernova numerical simulations as they break out, we calculate that they become relativistic winds that carry within them enhancements in their pressure and velocity, which can develop into internal shocks. We present a test of this model for emission from those shocks to model gamma-ray bursts from supernovae.

Pisgah Astronomical Research Institute
Don Cline, PARI

The Pisgah Astronomical Research Institute (PARI) is a not-for-profit public foundation dedicated to providing hands-on educational and research opportunities for a broad cross-section of users in science, technology, engineering and math (STEM) disciplines. The PARI campus was initially developed by NASA in 1962 as the east coast facility to track satellites and monitor manned space flights. Located in the half-million acre Pisgah Forest about 30 miles southwest of Asheville, North Carolina, the PARI campus is a well-protected site for astronomy and should remain so for generations to come. PARI is continuously involved with research and education programs with a number of universities in a multi-state area, and serves as the host campus for the Pisgah Astronomical Research and Science Education Center (PARSEC), which is administered by UNC-Asheville for the benefit of each university within the 16-campus University of North Carolina system. Scientific instruments at PARI include: two 26 meter radio telescopes, a 12.2 meter radio telescope housed in a radome, a 4.6 meter radio telescope (dubbed "Smiley" and operated remotely by high school students), a high frequency Jupiter-Io/Solar antenna, eight optical telescopes on the PARI Optical Ridge, three weather and atmospheric monitoring stations, and various environmental monitoring instruments.

The Astronomical Photographic Plate Center
Don Cline, PARI

The Astronomical Photographic Plate Center (APPC) was established at the Pisgah Astronomical Research Institute (PARI) in 2004. The goal of the Center is to help preserve astronomical photographic data, first by serving as a repository for astronomical plate collections and eventually by digitizing these plates along with the log information material. The APPC is developing archiving methods compatible with the Harvard Smithsonian Center for Astrophysics scanning project for use by the National Virtual Observatory. In the three years of existence the Center has received over 38,000 plates. The largest collections are CTIO 4-m plates, CTIO and Warner and Swasey direct and objective prism Schmidt plates, and University of Michigan spectra. Preliminary catalogues of the plates are available on line. A small source of funding has been secured to support this work. A workshop is planned for November 1-3, 2007 at the National Plate Center at PARI.

Summer 2007 at PARI
Michael Castelaz, PARI

PARI operated three K-12 student summer programs and hosted seven undergraduate research students. The K-12 summer programs included the Duke Talent Identification Program Summer Field Study in Astronomy with 22 high school students from around the country doing research. Twenty-seven high school students participated in the Space Science Lab, funded by the Burroughs-Wellcome Fund. And, 150 6th graders in the ROBOTS program came to PARI for the first ROBOTS Symposium, part a larger program funded by the NSF. Undergraduates from UNC-Asheville, Furman, UNC-Charlotte, and UNC-Chapel Hill enjoyed a summer of research that included astronomy, engineering, and radio telescope development.

A GRB Optical Afterglow Automatic Response Telescope on Skynet
Adam B. Smith, D. B. Caton, L. Hawkins -- Appalachian State University

We are developing a telescope for automated response observations of Gamma Ray Bursts. The instrument is composed of a Celestron14 on a Paramount, and an Apogee U47 CCD, JMI electronically controlled focuser, and DFM Engineering FW-82 filter wheel containing Omega Optical UBVR filters. The system will run under the control of the Skynet system developed at UNC-Chapel Hill as part of the PROMPT system. Maxim DL and Software Bisque's The Sky are the interface to the Skynet Terminator program that connects to Skynet. The Ash dome will be opened for the night on any clear night with provided by inverted 12V from a solar-charged battery. Rotation control will be provided by software control. Weather monitoring is provided by online data from a Davis Vantage Pro weather station, a Boltwood cloud sensor and an SBIG All-sky ("meteor") camera. In the "idle mode" the telescope may be used by any Skynet user. Much of the idle time will be used primarily in a program to search for transits of exoplanets. Support for this project was provided by the North Carolina Space Grant, the Appalachian State University Research Council, and the NSF through award AST-0520812 and AST-0722491.

An Increase in Stellar Activity in the Eclipsing Binary CM Dra
Ty Nelson and Daniel Caton, Appalachian State University

CM Draconis is a system of interest for many reasons. It is one of the few known M-dwarf eclipsing binary systems. Although these types of systems may form a large percentage of stellar systems in our galaxy, their low luminosity limits their detection to nearby systems. Thus, study of these few systems may provide insight into an important subset of the stellar population. As a UV-Cet type system, CM Dra is prone to violent flare activity. UV-Cet stars can produce flares 10-1000 times as energetic as solar flares and can occur at a rate greater than 2 flares/hour. Presented in this poster are six such flare events, observed at Appalachian State University's Dark Sky Observatory in May 2006, as part of a transiting exoplanet search program. Support for this project was provided by the North Carolina Space Grant, the Appalachian State University Research Council, and the NSF through award AST-0520812 and AST-0722491.

Public Outreach at Appalachian State's Dark Sky Observatory Cline Visitor Center
Daniel Caton, Appalachian State University

Appalachian State University's Dark Sky Observatory is ideally located to provide public outreach programs. At an elevation of a kilometer in the Blue Ridge Mountains of western North Carolina, the facility is only 1.5 miles off the Blue Ridge Parkway, a multi-season tourist travel route. We are developing a public program to be held at the soon to be completed Cline Visitor Center, which will offer regular public nights, drop-in opportunities on science nights, and a telescope for use by small groups. The DSO Cline Visitor Center has been proposed to funding sources as a member of a consortium comprising the Blue Ridge Science Education Outreach Center, with PARI as the other member. We gratefully acknowledge the support of Don Cline in developing this program.

A Deep Chandra Observation of Kepler's Supernova Remnant: A Type Ia Supernova with Circumstellar Interaction
Stephen Reynolds, North Carolina State University

We present results of a 750 ks Chandra observation of the remnant of Kepler's supernova of AD 1604. The strength and prominence of iron emission, together with the absence of O-rich ejecta, demonstrate that Kepler resulted from a thermonuclear supernova, even though evidence for circumstellar interaction is also strong. We have analyzed spectra of over 100 small regions, and find that they fall into three classes. (1) The vast majority show Fe L emission between 0.7 and 1 keV and Si and S K alpha emission; we associate these with shocked ejecta. A few of these are found at or beyond the mean blast wave radius. (2) A very few regions show solar O/Fe abundance ratios; these we associate with shocked circumstellar medium (CSM). Otherwise O is scarce. (3) A few regions are dominated by continuum, probably synchrotron radiation. Finally, we find no central point source, with a limit about 100 times fainter than the central object in Cas A. The evidence that the blast wave is interacting with CSM may indicate a Ia explosion in a more massive progenitor.

Spitzer Survey of Magellanic Clouds Supernova Remnants: Dust Content in Core-Collapse Supernovae
Brian Williams, North Carolina State University

We present further results from a survey of supernova remnants (SNRs) in the Magellanic Clouds using the MIPS instrument on the Spitzer Space Telescope. We have previously analyzed dust content and destruction rates in type Ia SNe; here we present morphological comparisons of several SNRs from core-collapse supernovae at infrared, X-ray (Chandra), and optical (Magellanic Clouds Emission-Line Survey, MCELS) wavelengths. Because infrared emission in SNRs is dominated by thermal emission from dust grains collisionally heated by the X-ray-emitting plasma, we can predict emission from these dust grains using parameters fixed by X-ray modeling. This combined X-ray-IR analysis provides diagnostics on plasma conditions that neither could provide on its own. Infrared flux ratios can set limits on plasma conditions, such as post-shock density, while also providing estimates of the total dust mass. We provide such an analysis here for several core-collapse SNRs. We use plane-shock models to describe the X-ray-emitting plasma, and compare observed IR color ratios to those predicted by models that incorporate a distribution of dust grain sizes and relative abundances of silicate and graphite dust grains. Since X-ray analysis also provides estimates for the total amount of gas that has been swept up by the blast wave, we also provide values for the dust-to-gas mass ratio in these remnants. Preliminary results on three of these remnants are as follows. We report total dust masses of 0.031, 0.2, and 0.022 M_{\odot} and dust/gas ratios of 2.3×10^{-4} , 1.1×10^{-3} , and 6.4×10^{-4} for N132D, N49B and N23, respectively. We see no dust clearly associated with ejecta. In every case we have analyzed thus far, including our earlier analysis of four type Ia remnants, we see less dust than is expected based on typically assumed global dust/gas mass ratios for the LMC. We will explore possibilities for this discrepancy.

Doing Spectroscopy at a Small College
Jose D'Arruda, Jason York, and Michael Everhart, UNC-Pembroke

We will outline how we are using our new SBIG Deep Space Spectrograph (DSS-7) and show some first spectra we have taken with it and the Meade LX-200 telescope.

MonteCarlo Simulations of the Atmospheres of Mercury and the Moon
Dana Crider, Catholic University of America

We have developed a Monte Carlo model applicable to particles in the atmosphere of a surface bounded exosphere. It simulates the trajectories of particles under the influence of solar radiation and gravity given a source function, temperature profile, and sticking efficiency profile. It can be used to produce a variety of outputs, including column density, total atmospheric content, delivery efficiency to the cold traps, and the adsorbed surface density map. We present our simulations of volatiles in the exospheres of the Moon and Mercury. We investigate the differences between the Moon and Mercury. We also focus on how they vary with source function. We predict observables for the upcoming MESSENGER and LRO missions.