

The 21st Annual

Keck Northeast Astronomy Consortium

Undergraduate Symposium
on Research in Astronomy

November 5-6, 2010

hosted by

Colgate University

and including

**** Haverford College * Middlebury College ****
**** Swarthmore College * Vassar College * Wellesley College ****
**** Wesleyan University * Williams College ****

**2010 KNAC
Undergraduate Symposium
on Research in Astronomy
@ Colgate University**

SCHEDULE OF EVENTS

**Friday, November 5, 2010
White Eagle, The Grove**

5:30 – 7:30 p.m. Check-in, White Eagle Lodge and Wendt University Inn
5:30 – 7:30 p.m. Reception & Symposium Registration, White Eagle Lodge
7:30 – 9:00 p.m. Dinner, White Eagle Lodge
9:00 p.m. – ?? Party, Ho Tung Visualization Laboratory, 401 Ho Science Center
and Astronomy Lab, 404 Ho Science Center

**Saturday, November 6, 2010
Colgate University, 101 Ho Science Center**

7:30 - 8:30 a.m. Breakfast, White Eagle Lodge
9:00 - 10:30 a.m. Session I: Solar System and Stellar Hodgepodge
10:30 - 11:00 a.m. Coffee Break, Ho Science Center 2nd Floor Atrium
11:00 - 12:15 p.m. Session II: Galaxies, Quasars and The Universe
12:15 - 1:30 p.m. Lunch and Ho Tung Visualization Laboratory Viewing,
Ho Science Center 2nd Floor Atrium; Ho 401
1:30 - 2:45 p.m. Session III: Stars and Star Clusters
2:45 - 3:15 p.m. Coffee Break, Ho Science Center 2nd Floor Atrium
3:15 - 4:15 p.m. Session IV: Stars, and Extrasolar Planets and Disks
4:15 p.m. Adjourn

KNAC Symposium Schedule

Colgate University *** Saturday, November 6, 2010 *** 101 Ho Science Center

Session I: Solar System and Stellar Hodgepodge

9:00 - 10:30

Chair: Karen Kwitter

Matthew Hosek (Williams College), *"Image Analysis of Asteroids and Comets"*

Vivienne Baldassare (Hunter College), Connor Dempsey (Williams College) and Brian Kirk (Villanova), *"Planetary Nebulae: Narrators of Stellar and Galactic Evolution"*

Erin Boettcher (Haverford College) and Sarah Wilson (Williams College), *"Monitoring H-Alpha Emission in Be Stars"*

Yung Hsien Ng Tam (Williams College), *"Website on Stellar Occultations for Outer-Solar-System Studies"*

Session II: Galaxies, Quasars and The Universe

11:00 - 12:15

Chair: Fred Chromey

Timothy Taber (Vassar College), *"The Arecibo Galaxy Environment Survey (AGES) - HI Observations of the Isolated Galaxy UGC 2082"*

Justin Rupert (Vassar College), *"Optical Variability and Exponential Outbursts of Quasar 3C 345"*

Michael T. Lam (Colgate University), *"Time Series Analysis of the Quasar PKS 1749+096"*

Alyssa Barlis (Williams College), *"SolidWorks, Soldering, and Show Tunes"*

Session III: Stars and Star Clusters

1:30 - 2:45

Chair: Frank Winkler

Muzhou Lu (Williams College) and Craig Malamut (Wesleyan University), *"High-Resolution Imaging of the 2010 Total Solar Eclipse at Easter Island"*

Tzitzlaly Barajas (CSULA), *"The Massive Magnetic Star HD 176582"*

Jared Stensland (Middlebury College), *"Searching for Massive Star Clusters around Luminous Blue Variables"*

Adam Michael (Wesleyan University), *"On the Excitation of "Quasi-thermal" Lines of Methanol"*

Session IV: Stars, and Extrasolar Planets and Disks

3:15 - 4:15

Chair: William Herbst

Sara M.K. Dwyer (Williams College), *"Data Compilation and Analysis of Stars in the Orion Nebula Cluster"*

Marshall C. Johnson (Wesleyan University), *"First Results from the Wesleyan Transiting Exoplanet Program"*

Alice Bennett (Middlebury College), *"J and H-Band Photometry of KH 15D"*

Joshua Sokol (Swarthmore College), *"Near-infrared spectroscopy of KH 15D"*

ABSTRACTS

Planetary Nebulae: Narrators of Stellar and Galactic Evolution

Vivienne Baldassare, Hunter College '12
Connor Dempsey, Williams College '13
Brian Kirk, Villanova '11
Advisor: Karen Kwitter, Williams College

The study of planetary nebulae can not only improve our knowledge of the stellar aging process but also develop our understanding of galactic evolution. Using Balick's Planetary Nebula Image Catalogue (PNIC) we developed a new morphological classification scheme with six different categories: round, elliptical, barrel, hourglass, spool, and cloud. Of the 619 nebulae in the PNIC, well-determined abundances and distances were available from the work of Kwitter and Henry for 114 objects. To better understand what types of stars produce specific types of planetary nebulae, we studied these 114 nebulae to investigate how properties such as elemental abundances and distances are related to the core morphologies.

The Massive Magnetic Star HD 176582

Tzitzlaly Barajas, CSULA '12
Advisor: David Cohen, Swarthmore College

Bp type stars are known to harbor large-scale magnetic fields. If the magnetic and rotational axes are offset from one another, these stars' photometric variability can be modeled according to the Rigidly Rotating Magnetosphere model. Conversely, the photometric variability of a star can be used to constrain this offset between the axes, as well as its rotational velocity and angle of inclination. The massive magnetic star, HD 176582, was observed over the course of five nights at the Peter van de Kamp Observatory at Swarthmore College. Combining our new data with Hipparcos photometry, preliminary results show HD 176582 to have a period of 1.58 days and photometric variability on the order of about 0.13 mag. The lightcurve suggests a rotation axis inclination of between 50° and 80° and a magnetic field obliquity of between 20° and 70°.

SolidWorks, Soldering, and Show Tunes

Alyssa Barlis, Williams College '13

Advisors: David Chuss and Paul Mirel, NASA Goddard Space Flight Center (GSFC)

The Primordial Inflation Polarization ExploreR (PIPER) is a mission of the Observational Cosmology Laboratory at NASA's Goddard Space Flight Center (GSFC), in collaboration with Johns Hopkins University, the University of British Columbia, and the National Institute for Standards and Technology. PIPER is a balloon-borne instrument dedicated to the investigation of the polarization of the Cosmic Microwave Background (CMB), and is scheduled to begin a series of flights in 2012. Because the signals PIPER aims to detect are extremely faint, the instrument must be cryogenically and magnetically cooled to a temperature of 1.5 K to minimize instrumental interference. All elements of the detector are carefully designed and tested to ensure that they will function properly at cryogenic temperatures. One part of this project involved retrofitting the lab's test dewar with new wiring and electrical connectors for more reliable tests of material properties. The second part was the construction of a sample polarization grid using a machine shop milling machine.

J and H-Band Photometry of KH 15D

Alice Bennett, Middlebury College '11

Advisor: William Herbst, Wesleyan University

In the spring of 2010 KH 15D was observed in the J and H-bands so that we might better understand how the star appeared and behaved in the near infrared. We performed J and H-band photometry on twenty-nine nights of images and ultimately produced J and H-band light curves of KH 15D in 2010. Through comparing this photometric data with J and H-band magnitudes of KH 15D in 2003-5 we will attempt to determine how the system's near infrared light curves have evolved.

Monitoring H-Alpha Emission in Be Stars

Erin Boettcher, Haverford College '12

Sarah Wilson, Williams College '13

Advisor: Steven Souza, Williams College

We investigated the feasibility of, and established methods for, a long term monitoring program of Be stars in open clusters in order to better understand variations in their H-alpha emission lines. The Hopkins Observatory's 0.6 m telescope, a CCD camera, and on-band (656 nm) and off-band (645 nm) filters were used to image six open clusters. Aperture photometry was used to find the on-band to off-band ratios of both B and Be stars in these clusters. In our preliminary data, Be stars are easily distinguishable from baseline B stars, and we estimate that we can detect variations in the ratios as small as 1.5%.

Data Compilation and Analysis of Stars in the Orion Nebula Cluster

Sara M.K. Dwyer, Williams College '11
Advisor: William Herbst, Wesleyan University

Nine surveys of the Orion Nebula Cluster are combined into one master catalog where all reference numbers of the same star from these surveys are listed in a single row. Having all the data for each star easily accessible allowed for a comparison of I magnitude data across time to look for significant magnitude changes. At this time no potential FU Orionis events have been discovered, however a comparison of magnitudes from 2002 and 2009 indicates there have been significant changes in magnitude for a few dozen stars.

Image Analysis of Asteroids and Comets

Matthew Hosek, Williams College '12
Advisors: Dr. William Cooke and Dr. Rob Suggs, NASA Marshall Space Flight Center

The Space Environments Team and Meteoroid Environments Office at the NASA Marshall Space Flight Center (MSFC) plans to begin an observing program targeting asteroids and comets using a 0.5 meter telescope located at New Mexico Skies Observatory, in Mayhill, NM. We developed the observing and image analysis procedures for the system, and proceeded to analyze observations of comet C/2008 FK75 and main belt asteroid (20453) 1999 KL6. We also analyzed observations of main belt asteroid (664) Judith obtained with the Global Rent-a-scope (GRAS) 0.25 meter telescope also located at New Mexico Skies Observatory. We conclude that C/2008 FK75 did not exhibit a comet outburst during the time of observation, and present the lightcurves and synodic rotational periods of (664) Judith and (20453) 1999 KL6.

First Results from the Wesleyan Transiting Exoplanet Program

Marshall C. Johnson, Wesleyan University '11
Advisor: Seth Redfield, Wesleyan University

We present the first results from the Wesleyan Transiting Exoplanet Program (WesTEP). The 24" Perkin Telescope at Wesleyan University's Van Vleck Observatory (VVO) has been used to observe a selection of transits of known exoplanets beginning in 2010 July. We have experimented with methods to improve the quality of the data, including defocusing the telescope during observations and manual guiding (as autoguiding is not available). These procedures have allowed us to achieve a minimum photometric RMS of ~1 mmag. We use the data to search for evidence of transit timing variations (TTVs) and refine the ephemerides of newly-discovered planets. In particular, we present observations of two new transits of WASP-3b to look for TTVs recently reported by Maciejewski et al. (2010) and caused by the unconfirmed planet WASP-3c.

Time Series Analysis of the Quasar PKS 1749+096

Michael T. Lam, Colgate University '11
Advisor: Thomas J. Balonek, Colgate University

In 2007 and 2008, the quasar 1749+096 underwent two outbursts at levels never before seen in optical. We analyze these two outbursts using a variety of statistical techniques to discern the timescales of variability within this object. A software package developed at Colgate University, QUI, provides effective computation of three time series functions for analyzing underlying trends present in generic, discrete data sets. We apply this to 1749+096 as a test bed for use on over 20 years of observations of over 20 quasars at Colgate University.

High-Resolution Imaging of the 2010 Total Solar Eclipse at Easter Island

Muzhou Lu, Williams College '13
Craig Malamut, Wesleyan University '12
Advisor: Jay M. Pasachoff, Williams College

The focus of our research this summer was the solar corona. In order to study the solar corona, we traveled to Easter Island to take high-resolution photographs of the total solar eclipse. Using images taken throughout totality, we hope to better understand certain features of the corona.

On the Excitation of “Quasi-thermal” Lines of Methanol

Adam Michael, Wesleyan University '11
Advisor: Vladimir Strel'nitski, Maria Mitchell Observatory

We revisit the problem of the excitation of “quasi-thermal” lines of methanol in dense molecular clouds. Our analysis is based on the observations of 13 clouds in the four rotational lines of E-methanol ($J_0 - J_{-1}$; $J = 1-4$) at 157 GHz using the 12-m ARO telescope on Kitt Peak (AZ) and on comparison of the results with the steady-state solutions for the level populations in a LVG simulation of radiative transfer. Most of the sources demonstrate strong deviations from the thermal population distribution with a single excitation temperature. A number of them can be divided into two groups showing the signatures of either “Class I” or “Class II” pumping.

Website on Stellar Occultations for Outer-Solar-System Studies

Yung Hsien Ng Tam, Williams College '11
Advisor: Jay M. Pasachoff, Williams College

As part of an effort to educate the public about studying the outer solar system with the help of stellar occultations and specifically, the occultation research that is carried out at Williams College, I designed an easy-to-navigate website for this work. This website should prove not only to be a convenient resource but also a way in which to archive occultation work that has been done at Williams in the past. This paper gives an overview of the website's development.

Optical Variability and Exponential Outbursts of Quasar 3C 345

Justin Rupert, Vassar College '12
Advisor: Thomas J. Balonek, Colgate University

For the last twenty-two years, students and faculty at Colgate University's Foggy Bottom Observatory (FBO) have been monitoring the quasar 3C 345. As depicted by light curves created by previous researchers, 3C 345 exhibits variations in brightness that can last years (outbursts), months (flares) and even days to hours (micro-variability). Gibbons (2000) and Shively (2006) have already undertaken the challenge of finding some pattern to these variations by fitting exponentials to the light curves obtained at FBO. An extension of their light curves as well as some improvement on their fits verify that larger outbursts can be fitted by the equations for exponential rise and decay proposed by Valtaoja et al. (1999) for radio variations. These exponentials can also be used to determine the energy for each of these outbursts, and thus help to quantify some of the underlying characteristics of 3C 345 variations.

Near-infrared spectroscopy of KH15D

Joshua Sokol, Swarthmore '11
Advisor: William Herbst, Wesleyan University

We present 0.8 – 2.5 μm spectroscopy of the variable young stellar object KH15D at two stages of occultation by its circumbinary disk. We confirm the presence of molecular hydrogen emission at 2.12 μm , and report the discovery of He I emission at 1.08 μm . Flux measurements of these lines indicate that the He I emission is suppressed as the star sinks lower behind the disk, while flux from the more spatially diffuse molecular hydrogen remains constant. The spectra also show that KH15D reddens as it moves deeper into eclipse.

Searching for Massive Star Clusters around Luminous Blue Variables

Jared Stensland, Middlebury College '11
Advisor: Michelle Edwards, Gemini Observatory

We present a method to search for the massive birth clusters of Luminous Blue Variables (LBVs). Using theoretical absolute magnitudes of early-type stars, we calculated expected color and magnitude limits for candidate massive stars at the distance and reddening of the Pistol Star and FMM 362 in the Quintuplet cluster. We then applied these cuts to stars found in the 2MASS catalog surrounding the LBVs. By using a well-characterized cluster, we were able to confirm the method's effectiveness and determine the color and magnitude criteria that eliminated the highest number of false candidates while recovering the largest number of known massive cluster members. We then calculated and applied similar cuts to stars within a 1pc radius of WRA 751 to confirm its cluster, Teutsch 143a, discovered by Pasquali et al (2006) and later investigated by Froebrich et al (2008). We used our method to select 22 strong candidate massive cluster stars, 18 medium confidence candidates and 39 weak candidates, categorized based on their colors and magnitudes. These stars are prime candidates for follow-up spectroscopy to determine their spectral types and confirm cluster membership. We plan to apply a similar method to other LBVs without known birth clusters.

The Arecibo Galaxy Environment Survey (AGES) - HI Observations of the Isolated Galaxy UGC 2082

Timothy Taber, Vassar College '11
Advisor: Robert Minchin, Arecibo Observatory

The Arecibo Galactic Environment Survey (AGES) is a 21-cm neutral hydrogen survey being conducted at the 305-m radio telescope at Arecibo Observatory in Arecibo, Puerto Rico. I discuss the findings from the AGES field centered on the isolated galaxy UGC 2082. The data cube produced from the observations of the field is searched for possible HI sources. These radio sources are crosschecked with optical data from Sloan Digital Sky Survey and SuperCOSMOS giving us a list of follow-up sources. A low surface brightness, previously undiscovered, companion galaxy to UGC 2082 is also investigated.