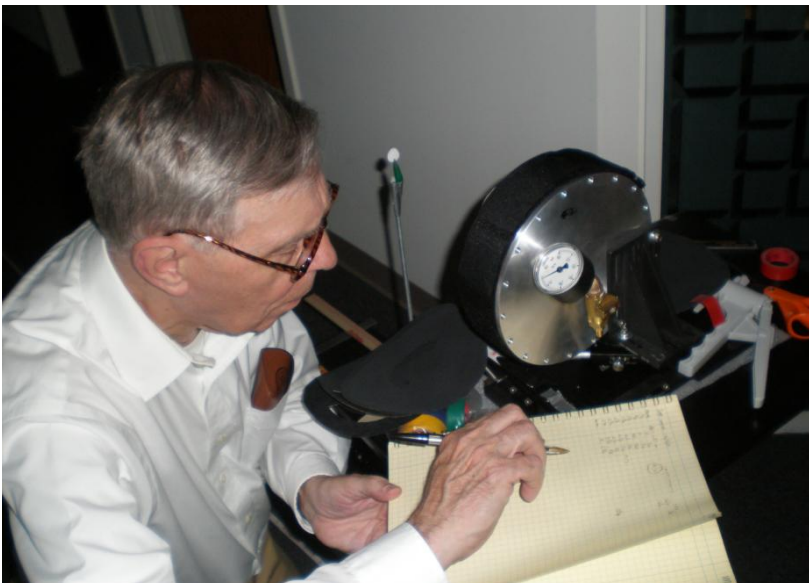
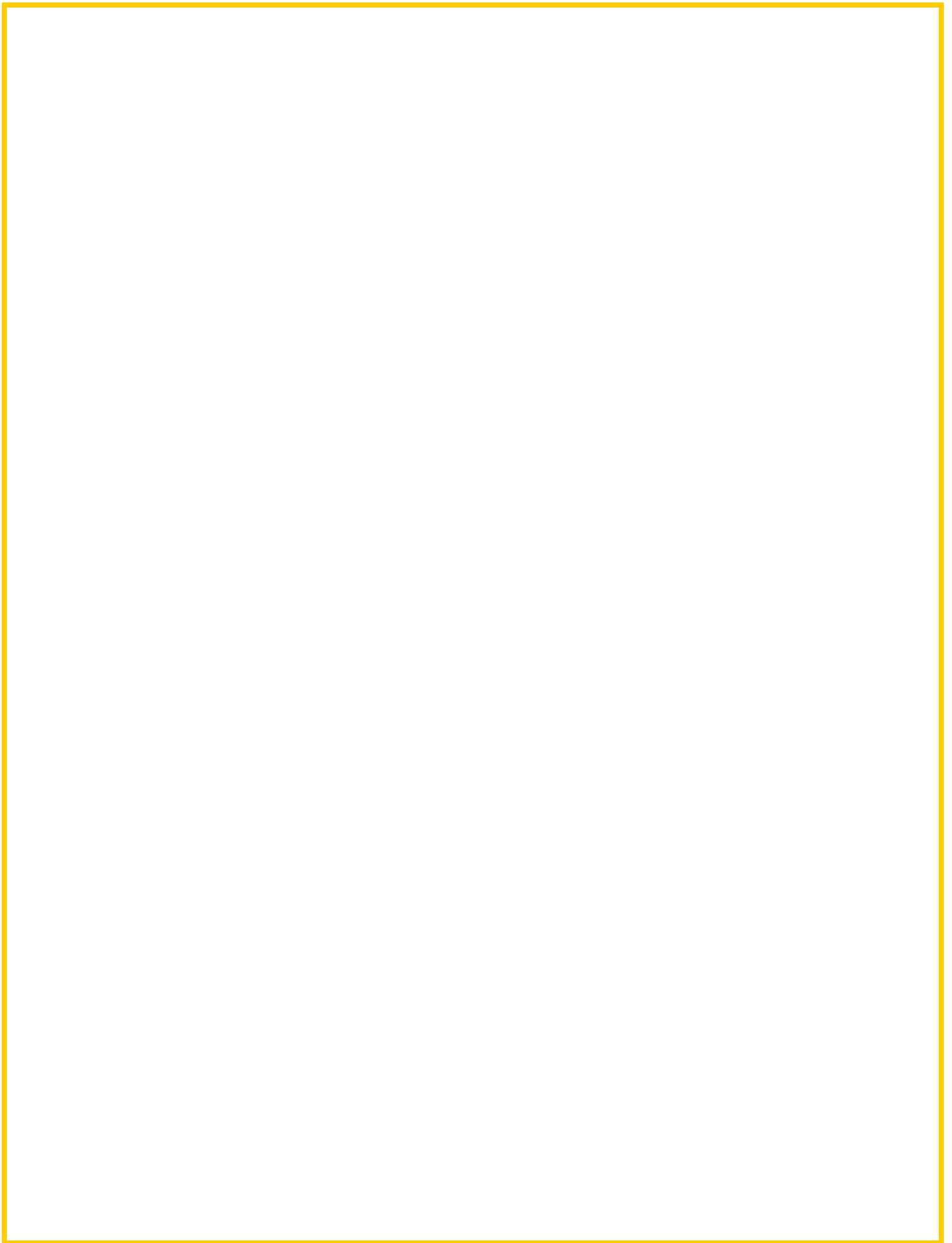




*Stars, Companions, and their Interactions*  
*A Memorial to Robert H. Koch*

**Conference Program**  
*August 10-12, 2011*







## ***Stars, Companions, and their Interactions A Memorial to Robert H. Koch***

***August 10-12, 2011 Villanova, PA USA***

***WELCOME!***

Our conference, *Stars, Companions, and their Interactions: A Memorial to Robert H. Koch*, honors the many contributions of Robert H. Koch (1929-2010) to the field of stellar astronomy. The list of presentations includes ground and space-based studies of binary systems, stellar evolution, instrumentation, and extreme mass ratio systems. The Department of Astronomy and Astrophysics at Villanova University is our gracious host. We sincerely hope that you enjoy the conference and activities!

Sincerely,

*Scientific Organizing Committee*

Michael F. Corcoran (Chair), Universities Space Research Association

Edward J. Devinney, Jr., Villanova University

Nicholas M. Elias II, National Radio Astronomy Observatory

Edward Guinan, Villanova University

Bruce J. Hrivnak, Valparaiso University

Tony Hull, University of New Mexico

Edward Sion, Villanova University

*Local Organizing Committee*

Bruce D. Holenstein (Chair), Gravic, Inc.

Carol Ambruster, Villanova University

Edward Guinan, Villanova University

Javad Siah, Villanova University

Edward Sion, Villanova University

Conference website: [www.gravic.com/RHKochConference](http://www.gravic.com/RHKochConference)

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# Agenda

## *Stars, Companions and their Interactions: A Memorial to Robert H. Koch*

Wednesday, August 10, 2011 Mendel Hall, Room 154

8:45 Welcome SOC & LOC

### **Session I. Interactions** Chair: Ed Devinney

9:00 *The Power of Eclipses: Impacts on the Development of Science - from Binary Stars, Exoplanets, and Cosmology (INVITED)* Ed Guinan

9:40 *Accreting White Dwarfs in Cataclysmic Binaries (INVITED)* Ed Sion

10:20 *BREAK & Poster Viewing*

10:50 *BINSYN, A Program Suite for Analysis of Binary Stars With or Without Optically Thick Accretion Disks (INVITED)* Al Linnell

11:30 *Interactions in Massive Colliding Wind Binaries* Mike Corcoran

11:50 *X-ray Modeling of Eta Carinae and WR140 from SPH Simulations* Chris Russell

12:10 LUNCH

13:30 *Interactive Binaries/CVs* Stella Kafka

14:00 *The Search for Binaries in Post-AGB Stars: Do Binaries Shape Planetary & Proto-Planetary Nebulae?* Bruce Hrivnak

### **Session II. Surveys** Chair: Tony Hull

14:30 *Low Mass Binaries in the SDSS (INVITED)* John Bochanski

15:00 *Finding Low-Mass EBs in Synoptic Surveys (INVITED)* Cullen Blake

15:40 *Stellar Archeology: What White Dwarf Stars Tell Us about the History of the Galaxy (INVITED)* Terry Oswalt

16:10 *BREAK & Poster Viewing*

**Session III. Modeling** Chair: Ed Guinan

16:40 *Under-developed and Under-utilized Capabilities in EB Light Curve Modeling (INVITED)* Bob Wilson

17:20 *Binary Models in the Kepler Era* Ed Devinney

17:50 *Binary Star Research at Eastern University* Dave Bradstreet

18:20 *ADJOURN*

**Banquet**

19:30 *Garey Hall Café  
The Sky over Babylon: Astronomy in the Ancient Near East* Mathieu Ossendrijver

Thursday, August 11, 2011 Mendel Hall, Room 154

**Session IV. Evolution** Chair: Ed Sion

9:00 *Formation and Evolution of Contact Binaries (INVITED)* Peter Eggleton

9:40 *Intermediate-Luminosity Red Transients: Evidence for Catastrophic Binary Mergers? (INVITED)* Howard Bond

10:20 *BREAK & Poster Viewing*

10:35 *Seeking the Binary Progenitor(s) of Type Ia Supernovae* Doug Leonard

11:05 *Using Planetary Nebula Central Stars to Study Close Binary Star Evolution* Todd Hillwig

11:35 *Mass Transfer and Eccentric Accretion Observed in a Neglected Interacting Binary Star* Phill Read

12:00 *LUNCH and Group Photo*

**Session V. Geometry** Chair: Carol Ambruster

13:30 *Imaging Nearby Circumstellar Disks to Diagnose Young Exoplanets* John Wisniewski

14:00 *Constraining the Mass Loss Geometry of Beta Lyrae* Jamie Lomax

14:20 *Full-Stokes Interferometric Imaging of Stars* Nick Elias



14:50 *Optical Observations with Milliarcsecond Resolution of Stars, their Environments, and Companions* Jason Sanborn and Bob Zavala

15:20 *BREAK & Poster Viewing*

**Session VI. Extremes** Chair: Nick Elias

15:40 *A Search for Exoplanets in Short-Period Binary Star Systems* Ron Kaitchuck

16:20 *Cepheids* Scott Engle

16:50 *The Alpha Cen System* Larry DeWarf

17:20 *Modeling Gamma-Ray Emission from High-Mass X-ray Binaries (INVITED)* Stan Owocki

18:00 *ADJOURN*

19:00 *NOSTALGIA RECEPTION: The Mixx, 789 E. Lancaster Ave, Villanova, PA Phone: +1.610.527.0700*

Friday August 12, 2011 Mendel Hall, Room 154

9:00 *Are the Einstein Crossing Times of Galactic Microlensing Events Bimodal?* Mitch Struble

**Session VII. Instrumentation** Chair: Mike Corcoran

9:30 *Pierce-Blitzstein Dual Photometer* Carol Ambruster and Tony Hull

10:00 *Robert H. Koch's Work on Medium Aperture Mirrors* Bruce Holenstein and Rich Mitchell

10:30 *The Pennsylvania Polarimeters* George Wolf, Tony Hull, Nick Elias, Bruce Holenstein, and Rich Mitchell

11:00 *BREAK & Poster Viewing*

**Session VIII. Memories of RHK** Chair: Bruce Holenstein

11:20	<i>Amherst Days</i>	Al Linnell
11:50	<i>RHK at Penn</i>	Mitch Struble
12:10	<i>RHK at Penn</i>	Ken Lande
12:30	<i>RHK at Home</i>	Jim Koch
12:50	<i>Closing Remarks</i>	Joanne Koch and Ed Guinan
13:00	ADJOURN	

**Posters**

<i>Full-Stokes Interferometric Imaging of Stars</i>	Nick Elias
<i>Eclipse and Collapse of the Colliding Wind X-ray Emission from Eta Carinae</i>	Kenji Hamaguchi
<i>TBD</i>	Villanova Students



## Conference Participants

Carol Ambruster	Villanova University
Cullen Blake	Princeton University
John Bochanski	Penn State University
Howard Bond	Space Telescope Science Institute
Dave Bradstreet	Eastern University
Michael Corcoran	USRA & NASA-GSFC
Edward Devinney	Villanova University
Larry DeWarf	Villanova University
Peter Eggleton	Lawrence Livermore National Lab
Nicholas M. Elias II	NRAO
Scott Engle	Villanova University
Anthony Galatola	West Chester University
Edward Guinan	Villanova University
Todd Hillwig	Valparaiso University
Bruce Holenstein	Gravic, Inc.
Bruce Hrivnak	Valparaiso University
Tony Hull	University of New Mexico
Stella Kafka	Carnegie Institution-DTM
Ronald Kaitchuck	Ball State University
James Koch	University of Wisconsin, Oshkosh
Joanne Koch	RHK's Spouse
Ken Lande	University of Pennsylvania
Douglas Leonard	San Diego State University
Albert Linnell	University of Washington
Sarah Lippincott	Swarthmore University
Jamie Lomax	Denver University
Richard Mitchell	Gravic, Inc.
Edward Olson	University of Illinois, Urbana-Champaign
Mathieu Ossendrijver	University of Tuebingen
Terry Oswalt	Florida Institute of Technology
Stan Owocki	University of Delaware
Phill Reed	Kutztown University
Chris Russell	University of Delaware
Jason Sanborn	Lowell Observatory
Ben Shen	University of Pennsylvania
Edward Sion	Villanova University
Mitchell Struble	University of Pennsylvania
R. E. Wilson	University of Florida
John Wisniewski	University of Washington
George Wolf	Missouri State University
Bob Zavala	US Naval Observatory

### ***Koch Family Attending Activities Include***

Joanne Koch (spouse)  
Jim Koch (son) and his son James  
Patricia Budlong (daughter), her spouse Steve, and their children Drew and Ashleigh  
Elizabeth (daughter), her spouse Murray, and son Mark

## Abstracts

### **Session I. Interactions**

#### **The Power of Eclipses: Impacts on the Development of Science - from Binary Stars, Exoplanets, and Cosmology (INVITED)**

Edward Guinan (Villanova University)

From ancient times up to the present, eclipses and related occultations & transits have been pivotal in the development of Astronomy and in the advancement of our understanding of the physical world. As discussed here, in modern astrophysics eclipsing binaries and exoplanet transiting systems play major roles by returning a wealth of new fundamental data about the physical properties of stars and new planetary systems. Also the study of these systems provides vital tests of stellar structure and evolution, binary dynamics, accurate distances, as well as fundamentally new information on planets outside of our solar system - including exploring the suitability of these planets for life. The recent advances in the studies of eclipsing binary stars and transiting planet-star systems are briefly discussed. New techniques that span the electromagnetic spectrum from X-ray to gravity waves will be addressed. Results from ultra-high precision spectroscopy ( $< 2$  m/s) and ultra-high precision photometry (e.g. now available from the Kepler Mission) will be evaluated as well as the new astrophysical information obtained from the expected millions of new eclipsing binary star systems, and from the thousands of transiting planetary systems that will be discovered from all sky surveys such as the LSST, GAIA, PLATO and JWST missions. What new astrophysical information will be gained? What new discoveries await us? And what new problems will be uncovered? Also discussed are some strategies (such as using Artificial Intelligence methods) that need to be developed to fully exploit these rich data sets. This paper is dedicated to Dr. Robert Koch - PhD thesis advisor, colleague and friend.

#### **Accreting White Dwarfs in Cataclysmic Binaries (INVITED)**

Edward Sion (Villanova University)

Hubble Space Telescope, FUSE and IUE far ultraviolet spectroscopy, along with X-ray and EUV spectroscopy using HUT, Orfeus, Chandra, XMM-Newton, EUVE, EXOSAT, ROSAT and ASCA have led to a windfall in our knowledge of the underlying white dwarfs in cataclysmic variables and how they are affected by the accretion process. These space observatories have made it possible to detect numerous underlying white dwarf accretors in non-magnetic systems and magnetic systems in the wavelength domain where they emit most of their energy (between 3Å and 2000Å). For the white dwarfs in CVs, space observations are obtained when the luminous accretion disks or bright accretion columns are absent or very faint during quiescence/low states of non-magnetic systems and low states of magnetic CVs. Thus, it has become possible to determine many poorly known basic physical properties of these systems

both above and below the cataclysmic variable period gap, an orbital period range between two and three hours in which very few systems are found. Among the newly determined physical properties are surface temperatures  $T_{\text{eff}}$ , mass accretion rates, gravitational redshift masses, gravity  $\log g$ , rotational velocities  $V_{\text{ini}}$ , chemical abundances, the accretion energy budget and how accretion and thermonuclear runaways can drastically alter the structure, evolution and atmospheric chemistry of the accreting WD over time. I will review progress to date and new questions which have arisen.

### **BINSYN, A Program Suite for Analysis of Binary Stars With or Without Optically Thick Accretion Disks (INVITED)**

Albert Linnell (University of Washington)

BINSYN has been developed over a number of years. It includes facilities for simulating traditional binary star systems and calculating multicolor differential correction solutions as well as simulating Cataclysmic Variables with optically thick accretion disks. BINSYN interfaces with the Hubeny TLUSTY and SYNSPEC programs to generate synthetic spectra of the complete system as well as individual stellar components. The suite has recently been ported to a Linux operating system. We illustrate the suite performance with a range of applications.

### **Interactions in Massive Colliding Wind Binaries**

Michael Corcoran (USRA & NASA-GAFC)

Massive stars ( $>20$  solar masses) possess strong, radiatively driven stellar winds. In massive binaries, these winds collide furiously and produce a localized shock along the wind collision boundary. The shocked gas produced by the colliding winds generates strong X-ray emission and can also produce strong IR emission associated with dust formation. I'll briefly discuss how studies of these massive colliding wind binary systems can provide direct measures of the mass loss process, and aid our understanding of the production of astrophysical shocks and dust formation.

### **X-ray Modeling of Eta Carinae and WR140 from SPH Simulations**

Chris Russell (University of Delaware)

### **Interactive Binaries/CVs**

Stella Kafka (Carnegie Institution-DTM)

## **The Search for Binaries in Post-AGB Stars: Do Binary Companions Shape the Nebulae?**

Bruce J. Hrivnak (Valparaiso University)

Binary companions are often invoked to explain the axial and point symmetry seen in the majority of planetary nebulae and proto-planetary nebulae (PPNe). To explore this hypothesis, I have undertaken a long-term (20 year) study of light and velocity variations in PPNe. I will discuss the results from the light curves and, in particular, from the radial velocity curves for the seven brightest targets accessible from the northern hemisphere. The photometry has been carried out at the Valparaiso University Observatory 0.4-m telescope and the spectroscopy at the Dominion Astrophysical Observatory 1.2-m telescope. This work has been supported by the National Science Foundation (most recently by grant AST 1009974) and by the Indiana Space Grant Consortium.

## **Session II. Surveys**

### **Low Mass Binaries in the SDSS (REVIEW)**

John Bochanski (Penn State University)

Abstract: The Sloan Digital Sky Survey has provided a wealth of information on the properties of binary systems containing low-mass stars. Catalogs of thousands of binaries have now been identified using SDSS photometry and proper motions. The systems identified within these studies span a wide range of physical parameter space, including separations from a few AU to a few pc. I will detail the construction of these catalogs and highlight their utility for a wide range of astrophysical topics.

### **Finding Low-Mass EBs in Synoptic Surveys (REVIEW)**

Cullen Blake (Princeton University)

Synoptic surveys like LSST, PTF, and Pan-STARRS, will gather a staggering amount of data on low-mass stars. By observing a large fraction of the sky in multiple bands multiple times, these surveys will enable the identification of thousands of candidate low-mass eclipsing binaries. However, taking full advantage of this treasure trove poses a challenge because the candidates will be faint, and a significant amount of follow-up observation will be required. In many cases, the photometry from synoptic surveys is of modest quality and the time-sampling somewhat sparse. This makes it necessary to gather additional photometry to unambiguously determine the period and light curve shape of the binary star targets. Similarly, spectroscopy to determine velocities and measure masses requires large telescopes. The Sloan Digital Sky Survey (SDSS) Stripe 82 observations provide an excellent testing ground for data analysis and observing strategies tailored to synoptic surveys. I will describe how even a small number of photometric measurements from Stripe 82 can be used to reliably identify the large-amplitude, roughly achromatic signals characteristic of low-mass eclipsing binaries. I will also outline an effective

strategy for observing these candidates using a robotic telescope and a low-resolution spectrometer on a large telescope to measure masses and radii. Finally, I will demonstrate how a spectroscopic analog of these photometric time-domain surveys could be a powerful tool for measuring the overall statistical properties of multiple star systems.

### **Stellar Archeology: What White Dwarf Stars Tell Us about the History of the Galaxy**

Terry Oswalt (Florida Institute of Technology)

The Universe is 13.7 billion years old. This age is known to better precision than any single star's age other than the Sun. It's amazing that such an enormous age, spanning vastly more time than human beings have existed, can even be measured. The Hubble Space Telescope was designed to specifically to determine the age of the Universe. As it turned out, ground-based telescopes and dim nearby stars in our solar backyard played a critical role in pinning down this number. This presentation will address how astronomers measure the ages of stars in general and the role white dwarf stars, especially those in wide binary systems, have played in the search for the age of the Universe, determining the nature of dark matter, and the discovery of dark energy.

## **Session III. Modeling**

### **Under-developed and Under-utilized Capabilities in EB Light Curve Modeling (REVIEW)**

R. E. Wilson (University of Florida)

### **Binary Models in the Kepler Era**

Ed Devinney (Villanova University)

### **Binary Star Research at Eastern University**

Dave Bradstreet (Eastern University)

## **Banquet**

### **The Sky over Babylon: Astronomy in the Ancient Near East**

Mathieu Ossendrijver (University of Tuebingen)

## **Session IV. Evolution**

### **Formation and Evolution of Contact Binaries**

Peter Eggleton (Lawrence Livermore National Lab)

Very recently V1309 Sco was seen to be a contact binary where the two components merged in 2008 and are now a single star. I will discuss aspects of the evolutionary processes by which

contact binaries, and hence such mergers, can be expected. I argue that these processes require a triple star at some early stage.

### **Intermediate-Luminosity Red Transients: Evidence for Catastrophic Binary Mergers?**

Howard Bond (Space Telescope Science Institute)

### **Seeking the Binary Progenitor(s) of Type Ia Supernovae**

Douglas Leonard (San Diego State University)

Despite intense scrutiny, the progenitor system(s) that gives rise to Type Ia supernovae remains remarkably unconstrained by direct observation. The favored theory invokes a carbon-oxygen white dwarf accreting hydrogen-rich material from a close companion until a thermonuclear runaway ensues that incinerates the white dwarf. However, direct observational evidence for this binary scenario remains surprisingly scant. In this talk I will review the current state of affairs from both observational and theoretical standpoints, with a particular focus on recent work involving the expected and sought-after polarization signatures that a nearby companion star should imprint on the early-time supernova light.

### **Using Planetary Nebula Central Stars to Study Close Binary Star Evolution**

Todd Hillwig (Valparaiso University)

The number of detected close binary stars in planetary nebulae has increased dramatically in the past several years and is now reaching the level at which statistically significant trends may be made discussed. Planetary nebula central stars occupy an important transitional phase in the evolution of close evolved binary stars. Using these systems to determine binary fraction of central stars, system classifications, binary parameters (such as inclination), and correlations between the binary and its surrounding planetary nebula will greatly improve our understanding of the evolution of close binary stars. I will discuss the current observational results for the sample of known close binary central stars of planetary nebulae and their relation to other close binaries with a white dwarf such as cataclysmic variables, supernova Ia progenitors, and double degenerate systems.

### **Mass Transfer and Eccentric Accretion Observed in a Neglected Interacting Binary Star**

Phil Reed (Kutztown University)

The eclipsing and interacting binary star R Arae is a very interesting system that has unfortunately been neglected. The few spectroscopic studies of the system report badly blended absorption lines that indicate mass transfer, but until now there has been no orbital period study to conclusively show a real period change resulting from mass transfer. In this study, new data are combined with those found in the available literature and in the database of the American

Association of Variable Star Observers to construct the first ephemeris curve for R Ara, which spans more than a century since its discovery in 1894. Average orbital period change and conservative mass transfer rates are presented. In addition, R Ara's mass transfer is modeled with an eccentric accretion structure that eclipses the primary star, producing outside-of-eclipse dips in its light curve.

## **Session V. Polarimetry and Geometry**

### **Imaging Nearby Circumstellar Disks to Diagnose Young Exoplanets**

John Wisniewski (University of Washington)

Circumstellar disks provide a useful astrophysical diagnostic of the formation and early evolution of exoplanets. It is commonly believed that young protoplanetary disks and transitional disks serve as the birthplace of planets, while older debris disks can provide insight into the architecture of exoplanetary systems. Spectacular ground-truth of this disk-exoplanet connection was provided by the recent successful direct imaging of exoplanets in the Fomalhaut, HR 8799, and Beta Pic systems. In this talk, I will discuss how one can use high contrast imaging techniques to spatially resolve circumstellar disk systems. I will focus on the initial results and future prospects from the Subaru Strategic Exploration of Exoplanets and Disks (SEEDS) project.

### **Constraining the Mass Loss Geometry of Beta Lyrae**

Jamie Lomax (Denver University)

Massive binary stars lose mass by two mechanisms: jet driven mass loss during periods of active mass transfer and by wind driven mass loss. Beta Lyrae is an eclipsing, semi-detached binary whose state of active mass transfer provides a unique opportunity to study how the evolution of binary systems is affected by jet driven mass loss. Roche lobe overflow from the primary star feeds the thick accretion disk which almost completely obscures the mass-gaining star. A hot spot predicted to be on the edge of the accretion disk may be the source of beta Lyrae's bipolar outflows. I will present results from 6 years of new and recalibrated spectropolarimetric data taken with the University of Wisconsin's Half-Wave Spectropolarimeter (HPOL) which have implications for our current understanding of the system's disk geometry. Using broad band analysis, I derive new information about the structure of the disk and the presence and location of a hot spot. These results place constraints on the geometrical distribution of material in beta Lyrae and can help quantify the amount of mass lost from massive interacting binary systems during phases of mass transfer and jet driven mass loss.



### **Full-Stokes Interferometric Imaging of Stars**

Nicholas M. Elias II (NRAO), Anders M. Jorgensen (NM Tech), David Mozurkewich (Seabrook Eng.), Carol E. Jones and Frances E. Mackay (Western Ontario), Henrique Schmitt (CPI), and Stanislav S. Edel (NM Tech).

Long-baseline optical interferometry and classical polarimetry have provided key insights in the fields of stellar atmospheres, stellar disks, and interacting binary stars. We present scientific justifications for "full-Stokes" polarization observations of these objects with optical interferometers. We also discuss: 1) instrument requirements; 2) a design for a simple and inexpensive polarizing beam combiner (including feed optics and detector) that can be integrated into existing instruments; 3) systems engineering simulations for coherent averaging, Stokes vector inversion, and instrumental polarization calibration; 4) full-Stokes images of Be stars created with the python-based radio interferometry software CASA; 5) a brief list of tasks to be completed; and 6) how the knowledge gained from full-Stokes interferometer design and observations can be used in other fields, such as exoplanet atmospheres.

### **Optical Observations with Milliarcsecond Resolution of Stars, their Environments, and Companions**

J. J. Sanborn (Lowell Observatory), and R. T. Zavala (USNO, Flagstaff Station)

Observations with milliarcsecond resolution using the Navy Prototype Optical Interferometer (NPOI) have been obtained for a number of stellar systems which include high-mass binaries, eclipsing binaries and radio stars. These observations also reveal the previously unseen companions in single-lined spectroscopic binaries via directly measured flux ratios. We will present examples of published and ongoing research efforts from the NPOI of these systems to illustrate how an optical interferometer contributes to our knowledge of stars, companions and their environments. These studies include successfully resolving the orbital motion of high-mass binaries such as Theta 1 Orionis C, the direct determination of orbital parameters in the wide and close orbits of Algol, and revealing the orbit of Beta Lyrae with spatially resolved images of the H-alpha emission.

## **Session VI. Extremes**

### **A Search for Exoplanets in Short-Period Binary Star Systems**

Ron Kaitchuck (Ball State University)

In recent years over 500 exoplanets have been discovered. So far only a few have been found in binary star systems. These have been cases where the exoplanet either orbits both stars at a very great distance (p-type) or the exoplanet orbits one star of a widely separated stellar pair (s-type). In either case the formation of the planet and its long-term orbital stability doesn't seem surprising. However, for the s-type situation, how close can the stars be before planetary

formation and stability are no longer possible? Can exoplanets be found in short period (<20 days) binaries? The existence of exoplanets would place constraints on both the theory of planetary and binary star formation. An on-going program to detect planetary transits in close binary star systems will be discussed. The stellar selection criteria, and the unique problems and advantages of searching for exoplanets in short-period binary stars will be presented.

### **Cepheids**

Scott Engle (Villanova University)

### **The Alpha Cen System**

Larry DeWarf (Villanova University)

### **Modeling Gamma-Ray Emission from High-Mass X-ray Binaries**

Stan Owocki (University of Delaware)

A handful of high-mass X-ray binaries have been found to be sources of gamma-rays at energies up to 10 TeV. This talk will summarize recent efforts to model this gamma-ray emission in terms of either wind accretion onto a compact companion, or interaction of the massive star's wind with the relativistic pair wind from a pulsar companion.

### **Are the Einstein Crossing Times of Galactic Microlensing Events Bimodal?**

Mitch Struble (University of Pennsylvania)

The OGLE data for Einstein ring crossing times,  $t_E$ , for microlensing events toward the galactic bulge are analyzed. The analysis shows that the crossing times are bimodal, indicating that two populations of lenses could be responsible for observed microlensing events. Given the possibility that microlensing in this direction can be due to both main-sequence stars and white dwarfs, we analyze and show that the observed bimodality of  $t_E$  can be derived from the accepted galactic density distributions of both populations. Our Kolmogorov-Smirnov (KS) one sample test shows that that a white dwarf population of about 25% of all stars in the galaxy agrees well with the observed bimodality with a KS significance level greater than 97%.

## **Session VII. Instrumentation**

### **Pierce-Blitzstein Dual Photometer – The PBPHOT**

Carol Ambruster (Villanova University), Tony Hull (University of New Mexico)

R. H. Koch (University of Pennsylvania), George Wolf (Missouri State University), Richard Mitchell (Gravic, Inc.), and R. E. Smith (University of Pennsylvania)

The origin of the Pierce-Blitzstein Pulse-Counting Photometer System is traced to the collaboration of Newton L. Pierce and William Blitzstein beginning in the mid-1940s. The

conception and architecture of the system was visionary for its time. Optimized for productive variable-star photometry in problematical skies, it was an automated, simultaneous 2-channel, pulse-counting photometer, a thought out system from the start. Both published work and unpublished paper and disk documentation exist to define the development of this instrument's hardware and software with almost no gaps in knowledge. Systematic limitations enforced by the instrument's design and its location in its dedicated observing room are described. The observational productivity of the system is traced together with an appreciation of observing errors.

### **Robert H. Koch's Work on Medium Aperture Mirrors**

Bruce D. Holenstein (Gravic, Inc.), and Richard J. Mitchell (Gravic, Inc.)

After a visit by Peter Waddell from the University of Strathclyde, Glasgow, UK in 1991, Robert H. Koch launched a program at the University of Pennsylvania to build pneumatic membrane mirrors, initially for balloon flight observations where weight is at a premium. Mirror cells were fabricated from sizes 7" to 70", and experiments conducted to characterize the mirror figure and stability. Most of the work stopped after Prof. Koch's retirement in 1996 until 2006 when the authors expressed an interest in building an array of medium-aperture portable telescopes. The program restarted in earnest at Gravic, Inc. in Malvern, PA in 2008 with the fabrication of a fully operational 42" membrane mirror telescope with an OTA mirror assembly weighing under 100 lbs. Residual wavefront aberrations remediation resulted in the investigation of membrane tensioning techniques with different cell designs, active secondary wavefront correction, photometric algorithms for aberrated images, and the use of additional lightweight mirror substrates from the Alt-Az Initiative Group such as foamed glass. A 1.6-m cast aluminum cell alt-az telescope was designed for prime focus use.

### **The Pennsylvania Polarimeters**

George Wolf (Missouri State University), Tony Hull (University of New Mexico), Nicholas M. Elias II (NRAO), Bruce D. Holenstein (Gravic, Inc.), and Rich J. Mitchell (Gravic, Inc.)

This report describes the inception, development and extensive use (over 30 years) of elliptical polarimeters at the University of Pennsylvania. The initial Mark I polarimeter design utilized oriented quarter wave plates and a calcite Foster-Clarke prism as the analyzer. The Mark I polarimeter was used on the Kitt Peak 0.9-m in 1969-70 to accomplish a survey of approximately 70 objects before the device was relocated to the 0.72-m reflector at the Flower and Cook Observatory. Successive generations of automation and improvements included the early-80's optical redesign to utilize a photoelastic modulated wave plate and an Ithaco lock-in amplifier – the PEMP. The final design in 2000 concluded with a fully remote operable device. The legacy of the Pennsylvania polarimeters includes studies of close binaries, pulsating hot stars, and luminous late-type variables.

## **Posters**

### **Full-Stokes Interferometric Imaging of Stars**

Nicholas M. Elias II (NRAO)

### **Eclipse and Collapse of the Colliding Wind X-ray Emission from Eta Carinae**

Kenji Hamaguchi (NASA/GSFC & UMBC)

X-ray emission from the massive colliding wind binary system, Eta Carinae, plunges sharply around periastron passage. An X-ray observing campaign of Eta Carinae around periastron passage in 2003 presented two different scenarios for the mechanism producing the X-ray minimum --- (i) eclipse of X-ray emitting plasmas by the thick wind of the primary star and (ii) decay of the colliding wind activity by a change in the wind collision near periastron.

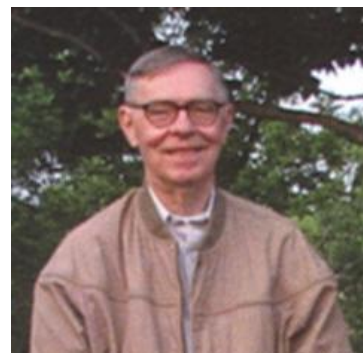
We launched another focused observing campaign for Eta Carinae around the next periastron passage in early 2009 with the RXTE, Chandra, XMM-Newton, Suzaku and Swift observatories. Soft X-ray emission from Eta Carinae below 10 keV declined as in the previous minimum, though it recovered a month earlier. Hard X-ray emission between 15-25 keV, monitored for the first time with the Suzaku HXD/PIN, decreased similarly, but it reached its minimum after the soft X-ray emission already began to recover. This indicates that the X-ray minimum is produced by two composite mechanisms: the thick primary wind first obscures soft X-ray emission from the plasma, and then the activity decays with a phase transition. We discuss possible mechanisms of cooling the X-ray emitting plasma around periastron passage.

## AAS Obituary

Robert H. Koch

1929 - 2010

Robert H. Koch, emeritus professor of astronomy and astrophysics at the University of Pennsylvania, passed away at his home in Ardmore, Pennsylvania on 11 October 2010 after a brief illness. Bob was 80 years old and remained sharp and intellectually engaged with the astronomical community up until the onset of complications from a brain tumor.



Bob was born in York, Pennsylvania on 19 December 1929, and graduated from York Catholic High School in 1947. He attended the University of Pennsylvania on a senatorial scholarship, graduating in 1951. After two years in the United States Army, he enrolled in graduate school at the University of Pennsylvania, doing his doctoral research on the photoelectric photometry of R CMa, AO Cas, AS Eri, and XY Leo at the Steward Observatory, University of Arizona in Tucson. Bob would continue this exploration of close binary stars, their atmospheres and interactions, for the rest of his career. Bob met his future spouse, Joanne C. Underwood, while in graduate school in 1957 and they were married in 1959. Bob received his PhD in astronomy in 1959 and moved to Amherst, Massachusetts where he taught as a member of the Four College Astronomy Department until 1966.

Following a year at the University of New Mexico in Albuquerque, Bob joined the Astronomy Department at Penn, teaching and doing research there until his retirement in 1996. Bob's main interests were the study of close and eclipsing binary stars, stellar envelopes and winds, intrinsic variables, transits and occultations, and the Milky Way Galaxy, producing well over 100 refereed publications. Bob was partial to photoelectric photometry and polarimetry, conducting most of his observational research at the University of Pennsylvania Flower and Cook Observatory, and at other ground- and space-based observatories. As an international figure in the area of binary stars, Bob had widespread collaborations with scientists at other institutions, in the US and throughout the world, and made significant contributions to the understanding of the process of mass transfer and accretion in close binary star systems and in developing stellar polarization standards. A number of astronomers were the recipients of his inspiration and mentorship as doctoral students at Penn.

Bob was a polymath who was able to expound eloquently on the intricacies of observational polarization measures or the various dealings of notable figures of the High Middle Ages with no advance notice. Along with his friend, biochemist Dr. Robert E. Davies, Bob helped establish at Penn one of the first courses to examine the astrophysical and biological implications for life beyond earth, long before NASA's own focus on the subject took shape. Bob was active in the astronomical community and served as president of IAU Commission 42 (close binaries).

A life-long love of astronomy led Bob to continue pursuing many areas of astronomical research during retirement. As an emeritus professor, he made important contributions to the detection of exoplanets by

the eclipse-timing method, and explored the development of large, lightweight telescope mirrors for ground- and space-based observatories.

In his retirement, Bob also researched and wrote a history of observational astronomy at the University of Pennsylvania. He also was an active gardener and a talented musician, and learned to play the mandolin when he was 77. In addition, Bob and Joanne both loved traveling and bird watching, visiting nearly 30 countries during his retirement years. Besides Joanne, Bob's survivors include sons Thomas and James (Dana), daughters Elizabeth (Murray) and Patricia Budlong (Steven), seven grandchildren, a brother and a sister. Bob once wrote that he long ago decided "to control my career so as to have as much fun as grief"; in this he was successful beyond his dreams.

Joanne Koch  
Michael Corcoran  
Bruce Holenstein  
Edward Sion

For more information:

<http://www.legacy.com/obituaries/mainlinemedianews/obituary.aspx?n=robert-h-koch&pid=146110910>

<http://www.upenn.edu/almanac/volumes/v57/n08/obit.html#koch>

Robert H. Koch's *Facebook* page: <http://www.facebook.com/pages/Robert-H-Koch-Astronomer/166544633365581>







- 1 ALUMNI HALL** • (1849)  
Residence hall, Custodial Services, gymnasium for intramural athletics
- 2 ALUMNI HOUSE** (1964)  
Alumni Affairs, University Communication: Constituent Publications and Media Relations
- 3 AUSTIN HALL** • (1924)  
Office of University Admission, Residence hall
- 4 BARTLEY HALL** • (1958)  
Villanova School of Business, Dean's Office, administrative offices, faculty offices, Applied Finance Laboratory, classrooms, dining facilities, Graduate Business Programs, Print Center, ATM
- 5 BURNS HALL** • (1978)  
Augustinian residence
- 6 BUTLER ANNEX** (1968)  
Athletic facility
- 7 CAUGHLIN HALL** • (1989)  
Residence hall
- 8 CEER: CENTER FOR ENGINEERING EDUCATION AND RESEARCH** • (1997) *College of Engineering*, Dean's Office, administrative offices, laboratories, conference rooms, auditorium, dining facility
- 9 CHEMICAL ENGINEERING BUILDING** (1947) Classrooms, laboratories, Chemical Engineering offices
- 10 CONNELLY CENTER** • (1980)  
Auxiliary Services, University Center, Presidents' Lounge, lounges, cinema, meeting rooms, information desk, cyber lounge, dining facilities, ATM, convenience/video store, International Student Advisor, Office of Human Services (students with disabilities), Art Gallery
- 11 CORR HALL** • (1914)  
Residence hall, Career Services office, Greek Affairs, chapel
- 12 DAVIS CENTER** • (2007)  
Men's and women's basketball offices, men's and women's basketball practice facilities, Intramural/Recreation department offices, fitness center
- 13 DELUREY HALL** • (1943)  
Residence hall
- 14 DONAHUE HALL** • (1985)  
Dining facilities, ATM
- 15 DOUGHERTY HALL** • (1955)  
Office of the Vice President for Student Life, Center for Multicultural Affairs, Dean of Students office, Offices of Dining Services, Student Government office, dining facilities, student organization offices, lounges, barber shop, bank, ATMs, Wildcard office
- 16 DRISCOLL HALL** • (2008)  
*College of Nursing*, Dean's Office, administrative offices, Center for Nursing Research, Center for Study of Global Health, auditorium, lecture hall, seminar rooms, classrooms, Clinical Simulation Laboratories, chapel, reading room, dining facility
- 17 FACILITIES MANAGEMENT BUILDING** • (1965) Headquarters for Facilities Management staff, shops
- 18 FALVEY MEMORIAL LIBRARY** • (1949)  
Library, University Communication: Creative Services and Marketing, Writing Center, Mathematics Center, Augustinian Institute, Augustinian Historical Institute, dining facility
- 19 FARLEY HALL** • (2000)  
Residence hall, fitness center
- 20 FARRELL HALL** • (1960)  
Office of Public Safety, parking office
- 21 FEDIGAN HALL** • (1930)  
Residence hall
- 22 GALBERRY HALL** (1940)  
University Graphic Services, Conference Services
- 23 GALLEN HALL** • (2000)  
Residence hall
- 24 GAREY HALL** • (1958)  
Administrative offices, classrooms, lounges, dining facility, ATM
- 25 GERAGHTY HALL** (1958)  
Campus Ministry offices, Dean of Enrollment Management
- 26 GOOD COUNSEL HALL** • (1969)  
Residence hall
- 27 HEALTH SERVICES BUILDING** • (2002)  
Counseling Center, Center for Health & Wellness Education, Health Center, VEMS: Villanova Emergency Medical Service
- 28 HEATING PLANT** (1950)
- 29 JACKSON HALL** • (2000)  
Residence hall
- 30 JAKE NEVIN FIELD HOUSE** • (1932)  
Athletic Department offices, basketball court, other athletic facilities, V Club
- 31 JOHN BARRY HALL** • (1947)  
Naval R.O.T.C. headquarters, classrooms
- 32 KATHARINE HALL** • (1986)  
Residence hall
- 33 KENNEDY HALL** • (1968)  
University Shop, Office of Financial Assistance, Office of Residence Life, Bursar's Office, Mail Services, Graduate School of Liberal Arts & Sciences, Dean's Office, Learning Support Services
- 34 KLEKOTKA HALL** • (1994)  
Residence hall
- 35 MCGUIRE HALL** • (1989)  
Residence hall
- 36 MENDEL SCIENCE CENTER** • (1961)  
Science Center, classrooms, lecture halls, laboratories, administrative offices, UNIT data center, student public computing labs, observatory, greenhouse
- 37 MIDDLETON HALL** (1943)  
International Studies, Office of Research and Sponsored Projects
- 38 MILITARY SCIENCES BUILDING** • (1949)  
Army R.O.T.C. headquarters, classrooms
- 39 MORIARTY HALL** • (1963)  
Residence hall
- 40 MOULDEN HALL** • (1994)  
Residence hall
- 41 O'DWYER HALL** • (1941)  
Residence hall
- 42 PAVILION** • (1985)  
Indoor sports complex, athletic offices, locker rooms, swimming pool, 200-meter indoor track, ATM
- 43 PICOTTE HALL AT DUNDALE** • (1974)  
Office of University Advancement
- 44 RUDOLPH HALL** • (1994)  
Residence hall
- 45 ST. AUGUSTINE CENTER FOR THE LIBERAL ARTS** • (1992) *College of Liberal Arts & Sciences*, Dean's Office, administrative offices, Honors Program, faculty offices, seminar rooms, dining facility
- 46 ST. CLARE HALL** • (2000)  
Residence hall
- 47 ST. MARY HALL** • (1964)  
Human Resources, HRD: HR Development Graduate Program, Procurement, Payroll, Financial Affairs, Budget, OPIR: Office of Planning and Institutional Research, administrative offices, residence hall, dining facility, University Senate office, chapel, pool, gymnasium, Music Activities, Art Conservatory, student mail services, ATM
- 48 ST. MONICA HALL** • (1986)  
Residence hall
- 49 ST. RITA HALL** • (1913)  
Residence hall, Campus Ministry offices
- 50 ST. THOMAS OF VILLANOVA CHURCH** • (1887) Parish church for local community & Villanova University students
- 51 ST. THOMAS OF VILLANOVA MONASTERY** • (1901 & 1934) Augustinian residence and care center, Augustinian Heritage Room, Augustinian Way of Life Center
- 52 SCHOOL OF LAW** • (2009)  
Dean's Office, administrative offices, classrooms, lounges, Law Library, Moot Court, dining facility, ATM
- 53 SHEEHAN HALL** • (1957)  
Residence hall
- 54 SIMPSON HALL** • (1948)  
Residence hall
- 55 STANFORD HALL** • (1971)  
Residence hall, fitness center, Office of Continuing Studies
- 56 STONE HALL** (1957)  
Office of Environmental Health and Safety
- 57 STRUCTURAL ENGINEERING TEACHING AND RESEARCH LABORATORY** • (2005)  
Structural member and load testing facility, 25-ton overhead crane, environmental room, wet room, material testing room
- 58 SULLIVAN HALL** • (1953)  
Residence hall, Center for Peace & Justice Education
- 59 TECHNOLOGY SERVICES BUILDING** • (1993) General computing and technology information; UNIT administrative offices, CIT: Center for Instructional Technologies main office, Network and Communications, University Information Systems, faculty/staff training facility
- 60 TOLENTINE HALL** • (1929)  
Office of the University President, Offices of the Vice President for Academic Affairs, Vice President for Administration and Finance, Vice President for University Communication, Vice President and General Counsel; College of Engineering offices, Registrar's Office, other administrative offices, classrooms, Department of Psychology (labs, offices); CIT: Center for Instructional Technologies, video/teleconference facility
- 61 VASEY HALL** • (1931)  
Office for Mission and Ministry, Vice President for Mission and Ministry, VITAL: Villanova Institute for Teaching and Learning, Office of Part-time Studies, Summer Sessions program, Theatre Department, theatre, offices, classrooms; TechZone Computer Support Center
- 62 VILLANOVA CONFERENCE CENTER** • (1998) Hotel accommodations, meeting space, dining facility, special events catering, Office of Executive Programs, Executive M.B.A. Program, Executive Education
- 63 VILLANOVA STADIUM** • (1927)  
Stadium, track, athletic weight room, Grounds Department
- 64 WELSH HALL** • (1994)  
Residence hall
- 65 WHITE HALL** • (1974)  
Classrooms, laboratories, Chemical Engineering offices

- 62** University Building Number
- A** Commuter Rail Stations
- P** Parking
- Handicap Accessible Parking Areas
- Call Box indicator: Phones located at buildings with direct-dial to Public Safety are indicated on key; free-standing Call Boxes to Public Safety are indicated on map









# NOTES

## Train Travel Directions

Compiled July 28, 2011

Philadelphia International Airport → The Radnor Hotel via SEPTA trains

- From the Bag Claim follow signs for “Trains to Philadelphia”
- Exit the Bag Claim, cross the street and walk up the stairs to the platform. Trains leave at :13 and :43 after the hour.
- Take the train to the 30<sup>th</sup> St. Pennsylvania Station. The ride will take about 15 minutes. There are two stops before 30<sup>th</sup> St. Station.
- At 30<sup>th</sup> Street Station you will arrive on the platform 6. Go down the stairs to the concourse.
- Go up the stairs to platforms 3 and 4. You are looking for the train to Malvern which will be on platform 4.
- Radnor is the 10<sup>th</sup> stop. The train ride takes approximately 30 minutes.
- At Radnor Train Station, descend to the platform and take the stairs down to the tunnel. You will cross below the tracks and on the other side of the tunnel take a right. You will see King of Prussia Rd. in front of you. Walk to it and follow the sidewalk to the left.
- You will come to the intersection of King of Prussia Rd. and N. Radnor Chester Rd. Cross the road and follow the sidewalk along side of N. Radnor Chester Rd.
- You will pass the Penn Medicine at Radnor Center. At Radnor High School cross the street. You will pass a TD Bank.
- Keep going straight and you will see a sign for The Radnor Hotel. Keep following the sidewalk until you hit the Rt. 30 intersection. Turn right, and you will see the entrance to The Radnor Hotel.

## **Some Points of Interest in the Philadelphia Area August 8<sup>th</sup> - 14<sup>th</sup> 2011**

### **Sports**

**Baseball** August 12<sup>th</sup> – 14<sup>th</sup> at Citizens Bank Park, the Philadelphia Phillies will be playing the Washington Nationals. The games on the 12<sup>th</sup> and the 13<sup>th</sup> start at 7:05 pm. The game on the 14<sup>th</sup> starts at 1:35 pm. [www.phillies.com](http://www.phillies.com)

**Football** August 11<sup>th</sup> at 7:30 pm there will be an NFL Preseason Game. Philadelphia Eagles vs. Baltimore Ravens. [www.philadelphiaeagles.com](http://www.philadelphiaeagles.com)

**Soccer** August 13<sup>th</sup> at 8:00 pm, the Philadelphia Union vs. FC Dallas at PPL Park. [www.philadelphiaunion.com](http://www.philadelphiaunion.com)

### **Historical Attractions**

**Independence Hall & The Liberty Bell-** <http://www.independencevisitorcenter.com/>

**Valley Forge National Historical Park-** <http://www.valleyforge.org/nationalpark/>

**Brandywine Battlefield-** <http://www.ushistory.org/Brandywine/>

### **Points of Interest**

**The Philadelphia Museum of Art-** <http://www.philamuseum.org/>

**The Franklin Institute & Fels Planetarium-** <http://www2.fi.edu/>

**Longwood Gardens-** Once owned by Pierre du Pont as a summer home, Longwood Gardens is now a large estate dedicated to inspiring people through excellence in garden design, and horticulture. With more than one thousand acres to explore, the gardens are sure to delight anyone who loves exquisite flowers, majestic trees, and opulent architecture. <http://www.longwoodgardens.org/>

**Philadelphia Zoo-** <http://www.philadelphiazoo.org/>

**Camden Aquarium-** <http://www.adventureaquarium.com/>



## **Contact Information**

### **Emergency – Dial 911**

**Directory Assistance** – Dial 411

**Villanova University Main Number** +1.610.519.4500

**Dept. of Astronomy & Astrophysics**, Villanova University, Mendel Hall, 800 Lancaster Avenue, Villanova, PA 19085 +1.610.519.4820

<http://www1.villanova.edu/villanova/artsci/astronomy.html>

**LOC Chair** – Bruce Holenstein Cell +1.610.405.7552

### **Cab Services near Villanova**

#### **On Time Car Services**

Conestoga Rd, Wayne +1.610.647.1354

#### **Main Line Taxi Co**

<http://www.mainlinetaxi.com>- 908 Dekalb Street, Bridgeport +1.610.664.0444

#### **Rosemont Taxi**

<http://www.rosemonttaxi.com>- 829 Conestoga Road, Bryn Mawr +1.610.525.1777

### **Septa Schedule**

R5 Line, Villanova Stop <http://www.septa.org/schedules/rail/index.html>

### **Amtrak Schedule**

PDFs of the Amtrak Schedule can be found here:

<http://www.amtrak.com/servlet/Satellite/Page/1237405732505/1237405732505>

### **Hotels**

The Radnor Hotel +1.610.937.6800

Villanova Conference Center +1.610.523.1776

The Wayne Hotel +1.610.687.5000

Marriott Courtyard Valley Forge/Collegeville +1.610.687.6700

### **Conference Website**

[www.gravic.com/RHKochConference](http://www.gravic.com/RHKochConference)

### **Conference Email**

[rhkochconference@gravic.com](mailto:rhkochconference@gravic.com)