The members of the Astronomy and Astrophysics group are among the leaders of their chosen areas of research. We are one of the largest astrophysics groups within a physics department in the country. The research conducted in our group is interwoven and dynamic, with six complementary focus areas.

Supernovae. Supernovae are the explosions of dying stars. But in their death they give clues to the size and fate of the universe. Our group is among the top few in supernova research. Baron and Kilic are interested in the systematics of how supernovae explode and what kinds of stars lead to different supernovae. Baron studies the spectra of the expanding supernova atmosphere to determine physical conditions and chemical abundances in the ejecta. Kilic observes compact binary star systems that may lead to supernovae explosions. Some of these binary systems are among the strongest gravitational wave sources known. Dai studies the populations of gamma-ray bursts and their jet breaks. We have set up a "supernova spectrum repository" - a Web site at which any astronomer can view all of the supernova spectra that we gather from observers. This makes us the "headquarters" of supernova spectra.

Cosmology. The cosmological research in our group is anchored in observational data and aims at gaining a deep understanding of our universe. Wang's research focuses on using cosmic microwave background anisotropy, galaxy redshift surveys and supernovae to determine the cosmological parameters that describe our universe, to probe the physics of the very early universe, and to study the dark energy in the universe. Wang is a member of the Euclid Consortium, a Medium-class mission approved by the European Space Agency. Dai uses galaxy clusters to study the distribution of dark matter, the baryon fraction in clusters, and dark energy. Baron studies the use of supernovae as distance indicators to remote galaxies to determine the age, size and fate of the universe. Wang and Baron study the systematic uncertainties of using supernovae as cosmological probes.

Extragalactic Astronomy. Dai and Leighly study Active Galactic Nuclei. The ultimate power source for Active Galactic Nuclei is thought to be accretion onto a supermassive blackhole. Their extensive program involves observations in the X-ray, optical, and infrared, and also theoretical modeling. Leighly studies the fundamental properties (covering fractions and column densities) of quasar outflows. Dai uses gravitational lensing to map the quasar accretion disk structure. Henry studies the distribution of chemical elements in spiral galaxies like the Milky Way in order to study their origin and evolution.

Graduate student Sara Barber on an observing run at the Kitt Peak National Observatory 4m Telescope near Tucson, AZ

Extrasolar Planets and Circumstellar Disks. Wisniewski uses multi-wavelength observational techniques, using ground- and space-based facilities, to investigate the structure, evolution, and origin of circumstellar disks. He studies spatially resolved images of protoplanetary and debris disks to search for morphological indicators for the presence of young exoplanets in these systems. Kilic studies the chemical composition of Earth-like planets around evolved stars by observing the remnants of such planets, debris disks.

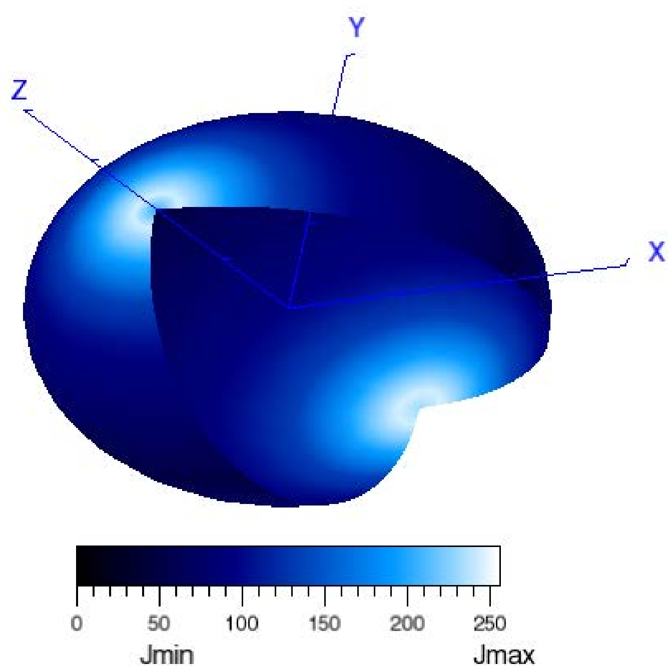
Nucleosynthesis. Henry studies the chemical abundances of a variety of emission line objects with the goal of understanding stellar production rates and subsequent cosmic accumulation of elements such as C, N, O, Ne, S, and Ar. Kilic uses white dwarf cosmochronology to measure the ages of the oldest stars in the Galactic disk and halo and to set limits on the age of the universe.

Computational physics studies on our 112 node Xserve cluster, at OU's OSCER super computer, at Argonne National Laboratory, at the National Energy Research Supercomputer Center (NERSC) in Berkeley are also ongoing in the areas of supernovae, cosmology, Galactic chemical evolution, active galactic nuclei, and nucleosynthesis.

Observational Astronomy. Our astronomers use ground- and space-based observatories to study supernovae, supernoave progenitors and remnants, Active Galactic Nuclei, galaxy clusters, gravitational wave sources, extrasolar planets, and debris disks. Our group has recently been awarded observing time on the ground-based MDM 2.4m, NASA IRTF 3m, APO 3.5m, KPNO 4m, Hale 5m, MMT 6.5m, Gemini 8m, Subaru 8.2m, Keck 10m, GTC 10.4m, LBT 12m telescopes and the space-based Hubble Space Telescope, Spitzer Space Telescope, XMM-Newton, and the Chandra X-ray Observatory. We use our 16-inch campus telescope for student training and weekly public star parties. Our graduate students host these star parties as well as a weekly journal club.

Astronomy continues to be an exciting field with new ideas and new facilities emerging in the coming decade. We welcome the chance to work with motivated and qualified graduate students.

For a recent list of my publications and preprints follow the links on my homepage http://nhn.ou.edu/~baron



A 3-D visualization of the surface brightness of an object with non-monotonic velocities. The flow is radial, but non-spherical in order to simulate a jet-like flow seen in many astrophysical objects.

[Edward A. Baron]

professor

American Physical Society Fellow

George Lynn Cross Research Professor

B.A. 1980 Pennsylvania

Ph.D. 1985 SUNY Stony Brook

I am interested in the physics of supernova explosions, stellar evolution, and nucleosynthesis. I am also interested in using supernovae as galactic and cosmological probes. My main field of technical expertise is in numerical astrophysics, developing parallel algorithms and high performance scientific computing.

My research focuses on carrying out detailed theoretical models of the transport of radiation in the fast-moving supernova atmosphere. The tools of this research are detailed numerical calculations of both hydrodynamic and radiation transport. Primarily I am interested in understanding the detailed systematics of how a supernova works, what types of stars lead to what types of supernovae? What is the source of the variation in the energies of the explosion? What are the characteristics of the object that is left behind? Supernovae are fascinating systems to study, since all fields of physics are important to their understanding, and one is forever learning new things.

Recently I have begun work with my colleagues to calculate radiative transport in 3 spatial dimensions, a daunting computational task, that is proceeding apace. This work will allow us to analyze 3-D models of many objects: supernovae, the sun, variable stars, and even global climate models of extra-solar planets and the earth. The common thread is that almost all observed astrophysics depends on understanding the objects that are producing the observed spectrum and that can only be done by detailed modeling or quantitative spectroscopy.

[David R. Branch]

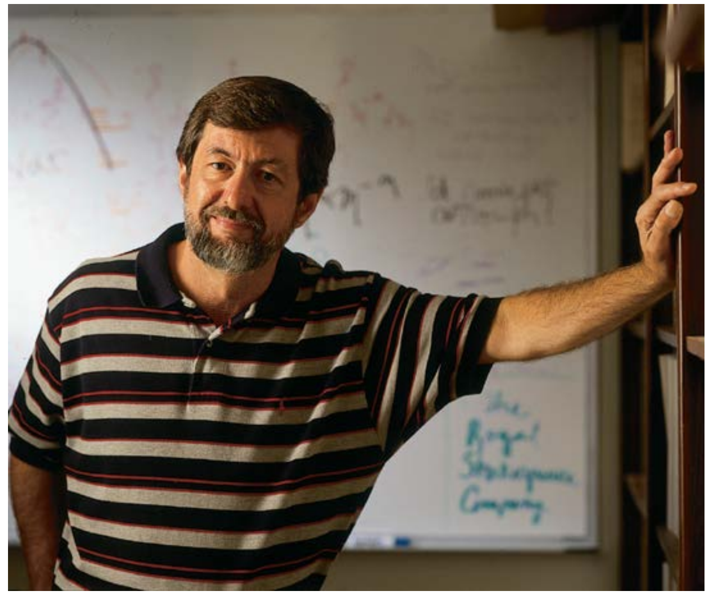
emeritus professor

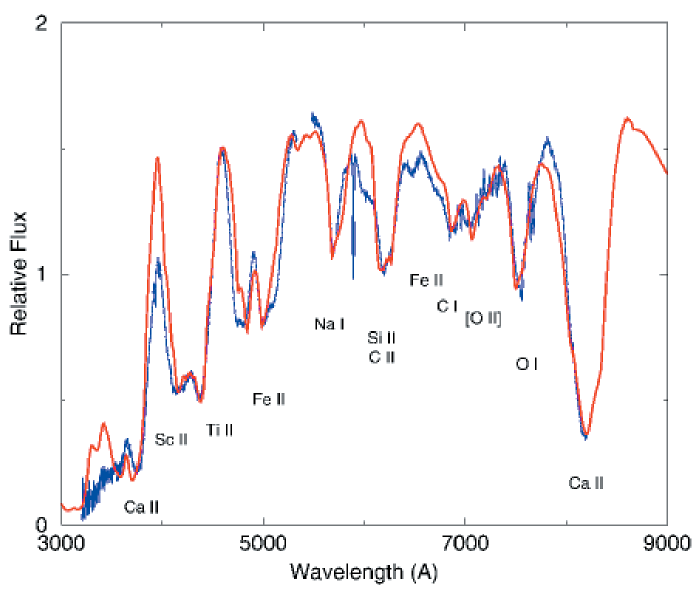
George Lynn Cross Research Professor

B.S. 1964 Rensselaer

Ph.D. 1969 University of Maryland

I am working on the interpretation of the spectroscopic, photometric and statistical properties of supernovae. One goal is to learn how to infer the physical conditions of the ejected matter – the temperature, density, velocity, chemical composition, and mass. By comparing this information with the predictions of theoretical explosion models, we try to find out which kinds of stars produce the various observed supernova types and how they explode. A related goal is to use supernovae as distance indicators, to measure the expansion history of the universe.





An observed spectrum (blue line) of the Type Ic supernova 1994I obtained by A. V. Filippenko at the Lick Observatory is compared to a theoretical spectrum (red line) calculated with our SYNOW supernova synthetic-spectrum code. Ions that are responsible for the most conspicuous supernova absorption features are indicated. The narrow absorption near 5900 Angstroms is produced not by the supernova but by interstellar sodium.

D. Branch, L. C. Dang, & E. Baron, "Comparative Direct Analysis of Type Ia Supernova Spectra. V. Insights from a Larger Sample and Quantitative Subclassification,, *Publications of the Astronomical Society of the Pacific*, **121**, 238 (2009).

D. Branch, D. J. Jeffery, J. Parrent, E. Baron, M. A. Troxel, V. Stanishev, M. Keithley, J. Harrison, & C. Bruner, "Comparative Direct Analysis of Type Ia Supernova Spectra. IV. Postmaximum," *PASP*, **120**, 135 (2008).

D. Branch, M. A. Troxel, D. J. Jeffery, K. Hatano, M. Musco, J. Parrent, E. Baron, L. C. Dang, D. Casebeer, N. Hall, & W. Ketchum. "Comparative Direct Analysis of Type Ia Supernova Spectra. III. Premaximum," *PASP*, **119**, 709 (2007).

D. Branch, L. C. Dang, N. Hall, W. Ketchum, M. Melakayil, J. Parrent, M. A. Troxel, D. Casebeer, D. J. Jeffery, & E. Baron, "Comparative Direct Analysis of Supernova Spectra. II. Maximum Light," *PASP*, **118**, 560 (2006).

D. Branch, E. Baron, N. Hall, M. Melakayil, & J. Parrent, "Comparative Direct Analysis of Type Ia Supernova Spectra: I. SN 1994D," *Publications of the Astronomical Society of the Pacific,* **117**, 545 (2005).

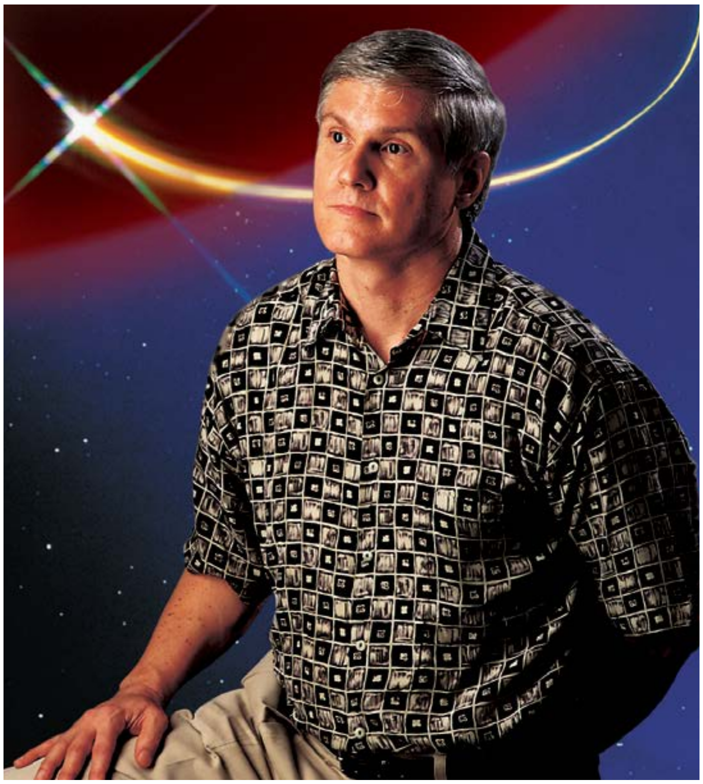
[John J. Cowan]

emeritus professor

David Ross Boyd Professor

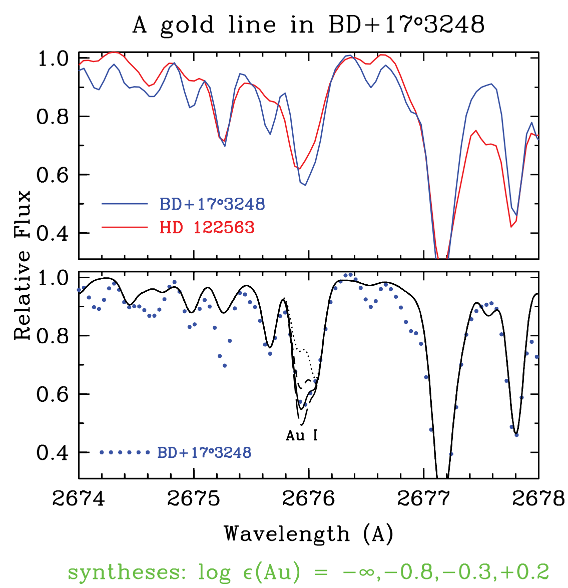
B.A. 1970 George Washington

Ph.D. 1976 University of Maryland



The primary emphasis of my research is observational and theoretical studies of elemental and isotopic abundances in stars. We are attempting to understand the formation of the neutron-capture elements by comparing theoretical, nucleosynthesis predictions with observed abundances in Galactic halo stars. We have employed both ground-based (Keck and HET) and space-based (HST) observations. Our studies have also incorporated the results of new experimental atomic physics determinations of the transition probabilities of the rare-earth elements. Utilizing the abundances of the heavy radioactive elements thorium and uranium in the oldest stars, we are determining the age of our Galaxy and, hence, setting lower limits on the age of the Universe.

I am also continuing my observational studies of external, nearby (face-on) galaxies. Employing the VLA, as well as Chandra, we have been searching for emission from young supernova remnants, and other (compact) point sources in these galaxies. In addition we have observed the central regions of several nearby galaxies leading to the probable detection of massive black holes in several cases.



Observed HST-STIS and synthetic (computed) spectra in the region surrounding the gold spectral line at a wavelength of 2675.94 Å. (Top) The observed spectrum of BD +17 3248, shown in blue, is compared to that of another old halo star in our Galaxy known as HD 122563, shown in red. The atomic gold spectral line is seen in BD +17 3248, but not in HD 122563. (Bottom) The observed BD +17 3248 spectrum, shown in blue dots, is compared to four synthetic spectra to determine the abundance of gold. The computed values, shown in order of increasing abundance of gold by dotted, short-dashed, solid, and long-dashed lines computed for these abundances are: log ϵ (Au) = -infinity, -0.80, -0.30, +0.2. The best fit is seen to be for log ϵ = -0.3, which indicates that gold in this star is less than a trillion times as abundant as hydrogen.

I. U. Roederer, K.-L. Kratz, A. Frebel, N. Christlieb, B. Pfeiffer, J. J. Cowan and C. Sneden, "The End of Nucleosynthesis: Production of Lead and Thorium in the Early Galaxy," *Astrophys. J.*, **698**, 1963 (2009).

C. Sneden, J. E. Lawler, J. J. Cowan, I. I. Ivans and E. A. Den Hartog, "New Rare Earth Element Abundance Distributions for the Sun and Five r-Process-Rich Very Metal-Poor Stars," *Astrophys. J. Supp.*, **182**, 80 (2009).

K. Farouqi, K.-L. Kratz, J. J. Cowan, L. I. Mashonkina, B. Pfeiffer, C. Sneden, F.-K. Thielemann and J. W. Truran, "Nucleosynthesis Modes in the High-Entropy-Wind of Type II Supernovae: Comparison of Calculations with Halo-Star Observations," *Astrophys. J. Letters*, **694**, L49 (2009).

C. Sneden, J. J. Cowan and R. Gallino, "Neutron-Capture Elements in the Early Galaxy," *Annual Reviews of Astronomy and Astrophysics*, **46**, 241 (2008).

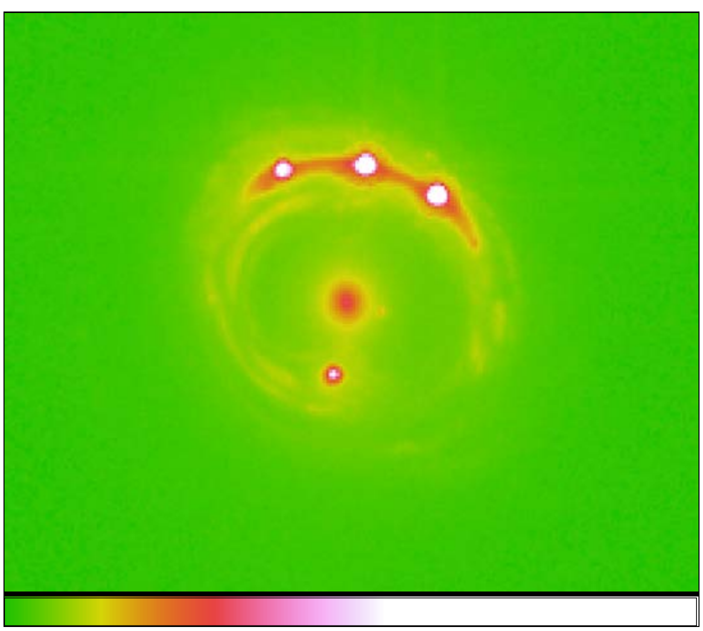
L. A. Maddox, J. J. Cowan, R. Kilgard, E. Schinner, and C. J. Stockdale, "A Study of Compact Radio Sources in Nearby Face-on Spiral Galaxies. II. Multiwavelength Analyses of Sources in M51," *Astron. J.*, **133**, 2559 (2007).

My research interests lie in understanding astronomical objects such as gravitational lenses, galaxy clusters, active galactic nuclei, and gamma-ray bursts. Since the discovery of the first cosmological gravitational lens in 1979, gravitational lensing has become an important tool in many astrophysical applications. In particular, quasar microlensing provides a novel method to map the quasar accretion disk structure. Utilizing the dependence of microlensing variability on the source size, we are able to resolve the disk structure that is several orders of magnitude smaller than the angular resolution of our current telescopes. Beside quasar microlensing, I am also interested in probing the interstellar medium of lens galaxies, and exploring the embedded lensing model.

Galaxy clusters are the largest gravitationally bound objects in the universe. They are ideal sites to constrain cosmological parameters and study structure formation. I am currently working on the Swift soft X-ray serendipitous cluster survey. The survey has the potential to find one of the largest X-ray selected cluster catalog to date. I also study the missing Baryon problem in the universe.

Active galactic nuclei (AGNs) are very energetic sources in the universe powered by supermassive black holes. I am interested in the feedback process of AGNs to their host galaxies, in particular, the kinetic feedback carried out by winds. I am working on measuring the intrinsic fractions of broad absorption line quasars of various species and the average absorption column densities of these objects. In addition, I also study the relationships between various AGN parameters such as the broadband spectral index, X-ray spectral index, luminosity, Eddington ratio, and variability with the aim to constrain AGN physics.

Gamma-ray bursts (GRBs) are the biggest explosions in the universe after the Big Bang. I am working on the population studies of GRBs, which include constraining the GRB jet structure from both observational and theoretical approaches.

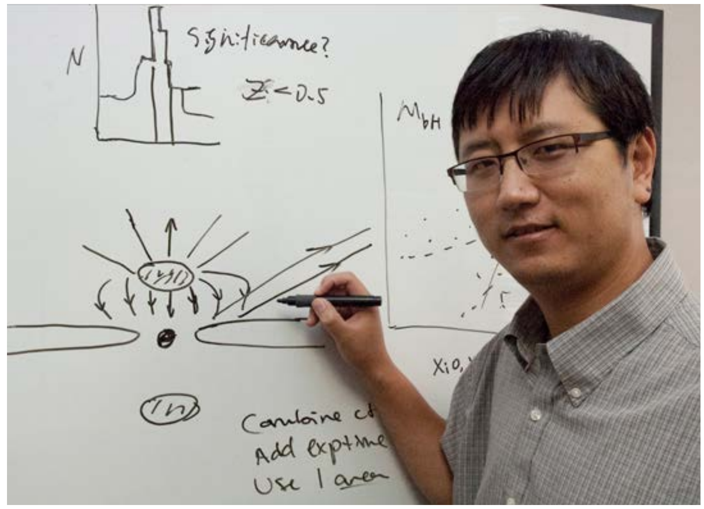


[Xinyu Dai]

assistant professor

B.S. 1998 Peking University

Ph.D. 2004 Pennsylvania State University



"On the Baryon Fractions in Clusters and Groups of Galaxies," X. Dai, J. N. Bregman, C. S. Kochanek, E. Rasia, *Astrophysical Journal* **719**, 119 (2010).

"The Sizes of the X-ray and Optical Emission Regions of RXJ1131-1231," X. Dai, C. S. Kochanek, G. Chartas, S. Kozlowski, C. W. Morgan, G. Garmire, E. Agol, *Astrophysical Journal* **709**, 278 (2010).

"2MASS Reveals a Large Intrinsic Fraction of BALQSOs," X. Dai, F. Shankar, & G. R. Sivakoff, *Astrophysical Journal* **672**, 108 (2008).

"Optical and X-ray Observations of GRB 060526: A Complex Afterglow Consistent with An Achromatic Jet Break," X. Dai, J. P. Halpern, N. D. Morgan, E. Armstrong, N. Mirabal, J. B. Haislip, D. E. Reichart, & K. Z. Stanek, *Astrophysical Journal* **658**, 509 (2007).

Hubble image of the gravitational lens RXJ1131-1231. The background quasar is lensed by the foreground galaxy (the central object), and four quasar images are formed. We also see distorted images of the quasar host galaxy forming an Einstein ring.

[Richard C. Henry]

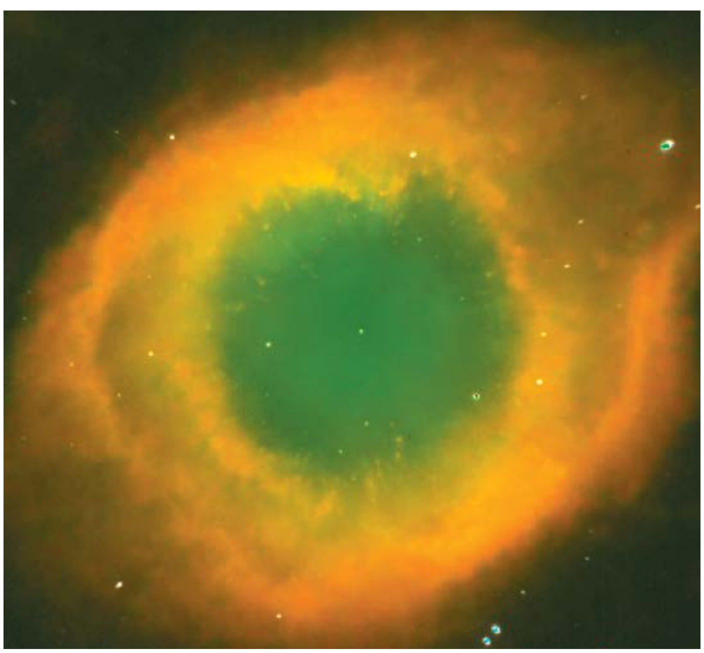
professor

David Ross Boyd Professor

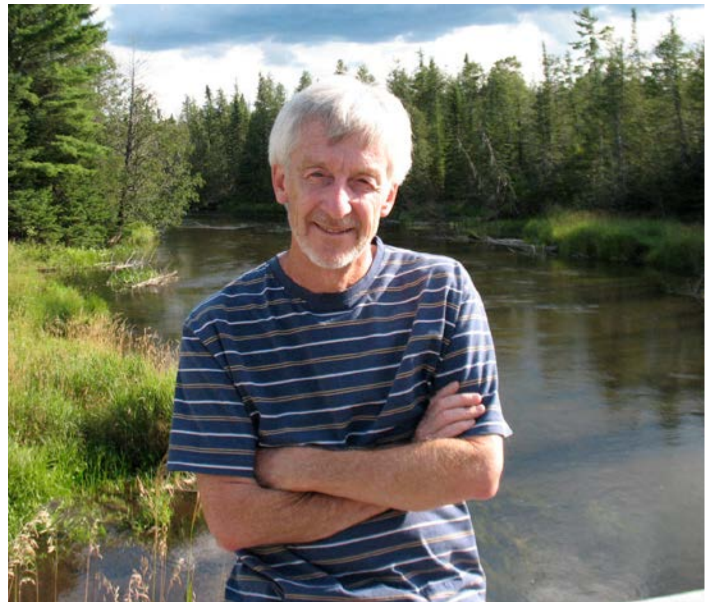
B.A. 1977 University of Kansas

Ph.D. 1983 University of Michigan

My research focuses on the cosmic chemical evolution of elements in the first three rows of the periodic table, e.g., C, N, O, Ne, S, Cl, and Ar, by studying the interstellar medium of galaxies over a broad redshift range. My long-term collaborators include Reggie Dufour (Rice), Karen Kwitter (Williams College), Bruce Balick (U. Washington), and Jackie Milingo (Gettysburg College). Together we measure the interstellar abundances of these elements spectroscopically by observing ISM abundance probes such as H II regions and planetary nebulae. These are regions associated with recent star formation and star death, respectively, in which hot stars heat the surrounding low density nebulae and cause the latter to radiate in discrete emission lines. In turn, these lines are converted into elemental abundances representative of the interstellar material out of which the objects formed. Once the abundance information becomes available, I then compute both detailed photoionization and chemical evolution models to interpret the results in a galactic context. Lately, our studies have focused on the disks of the Milky Way and M31 galaxies. Our data have recently been obtained during observing runs at McDonald, Gemini North, Kitt Peak, Cerro Tololo, Apache Point, Spitzer Space Telescope, and Hubble Space Telescope observatories.



When stars in the 1-8 solar mass range near the end of their lives, they shed outer portions of their atmospheres. The dying star left behind shrinks and gets hotter, and UV light from it causes the outer ring of gas to glow, forming a planetary nebula (left) and making it relatively easy to study the chemical makeup of the gas. This CCD image of NGC 7293, the Helix Nebula, was taken by Reginald Dufour of Rice University.



K.B. Kwitter, E.M.M. Lehman, B. Balick, & R.B.C. Henry, "Abundances of Planetary Nebulae in the Outer Disk of M31," *Astrophysical Journal*, **753**, 12 (2012).

R.B.C. Henry, A. Speck, A.I. Karakas, G.J. Ferland, & M. Maguire, "The Curious Conundrum Regarding Sulfur Abundances in Planetary Nebulae," *Astrophysical Journal*, **749**, 61 (2012).

R.B.C. Henry, K.B. Kwitter, A.E. Jaskot, B. Balick, M.A. Morrison, & J.B. Milingo, "Abundances of Galactic Anticenter Planetary Nebulae and the Oxygen Abundance Gradient in the Galactic Disk," *Astrophysical Journal,* **724**, 748 (2010).

J.B. Milingo, K.B. Kwitter, R.B.C. Henry, & S.P. Souza, "Alpha Element Abundances in a Large Sample of Galactic Planetary Nebulae," *Astrophysical Journal,* **711**, 619 (2010).

R.B.C. Henry, J.J. Cowan, & J. Sobeck, "Empirically Derived Integrated Stellar Yields of Fe-Peak Elements," *Astrophysical Journal* **709**, 715 (2010).

[Mukremin Kilic]

assistant professor

B.S. 1999 Bogazici University

Ph.D. 2006 University of Texas

I am interested in identifying the progenitors of Type Ia supernovae explosions. These supernovae are used as cosmological distance indicators to measure the expansion history of the universe. To use supernovae as cosmological probes requires an understanding of the initial conditions. This is only possible by identifying the types of stars that may lead to an explosion. I use several different telescopes in Arizona and Texas to search for short period binary systems that may merge relatively quickly. We have recently identified binary white dwarf systems with orbital periods as short as 12 minutes. These systems will merge in a few million years and possibly form faint supernovae.

I am also interested in the formation and the fate of planetary systems around Sun-like stars. The short main-sequence lifetimes of intermediate-mass stars and the small radii of remnant white dwarfs impy that the planetary systems around massive stars can be effectively studied after the hosts have been transformed into white dwarfs. Along with pulsars, white dwarfs also provide a unique opportunity to study the effects of the late stages of stellar evolution on planetary systems. I use ground-based telescopes in Chile and Hawaii and the Spitzer Space Telescope to search for planetary companions and debris disks around white dwarfs. I study the elemental abundances of these debris disks, which indicate that the disks contain mostly metals and they are the remains of tidally disrupted asteroids and small planets.

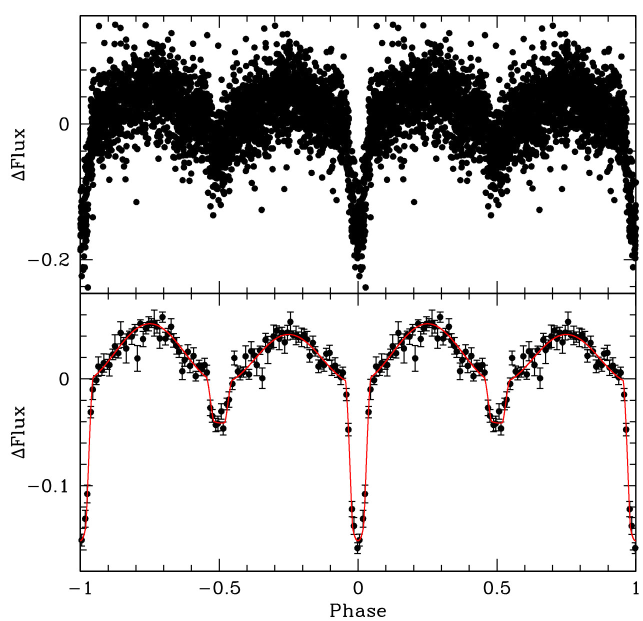
M. Kilic *et al.,* "The shortest period detached binary white dwarf system," *MNRAS,* **413**, L101 (2011).

M. Kilic, W. R. Brown, C. Allende Prieto, S. J. Kenyon, and J. A. Panei, "The Discovery of Binary White Dwarfs that will Merge Within 500 Myr," *Astrophysical Journal* **716**, 122 (2010).

M. Kilic *et al.,* "Visitors from the Halo: 11 Gyr Old White Dwarfs in the Solar Neighborhood," *Astrophysical Journal* **715**, 21 (2010).

M. Kilic, A. Gould, and D. Koester, "Limits on Unresolved Planetary Companions to White Dwarf Remnants of 14 Intermediate-Mass Stars," *Astrophysical Journal* **705**, 1219 (2009).

M. Kilic, T. von Hippel, S. K. Leggett, and D. E. Winget, "Debris Disks around White Dwarfs: The DAZ Connection," *Astrophysical Journal* **646**, 474 (2006).

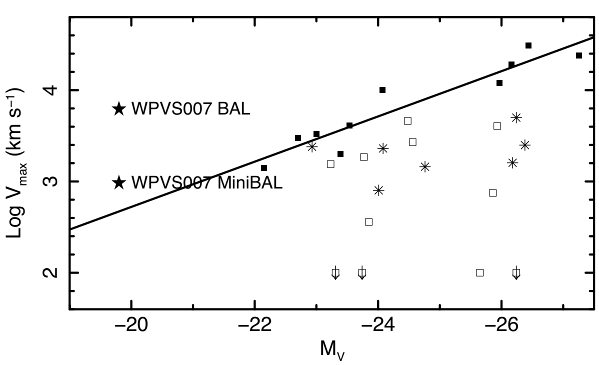


The light curve of the 12 minute orbital period binary white dwarf system J0651. This binary is oriented such that the two stars eclipse each other every 6 minutes (at phase 0 and 0.5). The upper panel plots the observed photometry versus orbital phase, while the lower panel compares the binned data to the best-fit model. In addition to the eclipses, the data reveal a sinusoidal pattern due to ellipsoidal variations from the tidally distorted white dwarf and also a relativistic beaming effect.

Active Galactic Nuclei (AGN) are the most luminous, persistently emitting individual objects in the Universe. My overall research goal is to understand how the primary physical parameters for black hole accretion, the black hole mass and accretion rate, manifest themselves in the broad band continuum and line emission from AGN.

My research uses the observations of the optical through X-ray emission, coupled with modeling, to understand how the black hole mass and accretion rate influence the observable properties of AGN. The X-ray emission emerges from the AGN central engine, just before the accreting gas falls into the black hole. The X-ray spectrum and variability properties reflect the geometry and physical conditions in this region. The shape of the broad-band continuum emerging from the central engine is expected to be a function of the black hole mass and accretion rate. The optical and UV line emission, a hallmark feature of AGN, is powered by photoionization by this continuum, and thus the signature of the continuum shape should be detectable in the line emission properties. Recently, we have discovered links between the continuum shape and line properties. We found that the continnum shape can influence the kinetics of the gas emitting high-ionization lines, and it can influence the line emission through variations in relative photon density as a function of energy, and through variations in gas cooling.

Recently I have begun to focus on understanding the low-ionization line emitting gas in quasars. Understanding the low-ionization line-emitting gas is important because it emits the higydrogen, iron and magnesium lines whose ratios are used for metallicity estimates, and whose velocity widths are used for black-hole mass estimates. My research leverages large uniformly-selected samples from the Sloan Digital Sky Survey, carefully-targeted new observations, new perspectives combined with large-scale photoionization modeling, and a state-of-the-art spectral synthesis model. Altogether, valuable constraints on the physical conditions including density, ionization, illuminating spectral energy distribution, column density, and metallicity will be obtained by this research, leading to a better understanding of quasar broad-line region emission, and of quasars in general.



The absorption line properties of WPVS 007 in comparison with those of low-redshift quasars (taken from Laor & Brandt 2002). They discovered an upper limit on the maximum outflow velocity that appeared to be function of the luminosity (M_V). They interpreted this as evidence for acceleration of the outflow by the radiation field of the quasar. The mini broad-absorption line (mini-BAL; the low-velocity absorbing component) present in both the 1996 HST and 2003 FUSE spectra is consistent with their trend. However, the broad absorption line that first appeared in the FUSE spectrum has a much higher maximum velocity, possibly indicating a different or additional acceleration mechanism (Leighly et al. 2009).

[Karen Leighly]

associate professor

B.S. 1983 NMIMT

Ph.D. 1991 Montana State University

K. M. Leighly, F. Hamann, D. A. Casebeer, & D. Grupe, "Emergence of a Broad Absorption Line Outflow in the Narrow-line Seyfert 1 Galaxy WPVS 007," *The Astrophysical Journal* **701**, 176 (2009).

K. M. Leighly, J. P. Halpern, E. B. Jenkins, D. Grupe, J. Choi, & K. B. Prescott, "The Intrinsically X-Ray Weak Quasar PHL 1811. I. X-Ray Observations and Spectral Energy Distribution," *The Astrophysical Journal* **663**, 103 (2007).

K. M. Leighly, J. P. Halpern, E. B. Jenkins, & D. Casebeer, "The Intrinsically X-Ray-weak Quasar PHL 1811. II. Optical and UV Spectra and Analysis," *The Astrophysical Journal Supplement Series* **173**, 1 (2007).

K. M. Leighly, & J. R. Moore, "Fe II and Mg II in Luminous, Intermediate-Redshift, Narrow-Line Seyfert 1 Galaxies from the Sloan Digital Sky Survey," *The Astrophysical Journal* **644**, 748 (2006).

D. A. Casebeer, K. M. Leighly, & E. Baron, "FUSE Observation of the Narrow-Line Seyfert 1 Galaxy RE 1034+39: Dependence of Broad Emission Line Strengths on the Shape of the Photoionizing Spectrum," *The Astrophysical Journal* **637**, 157 (2006).

[William Romanishin]

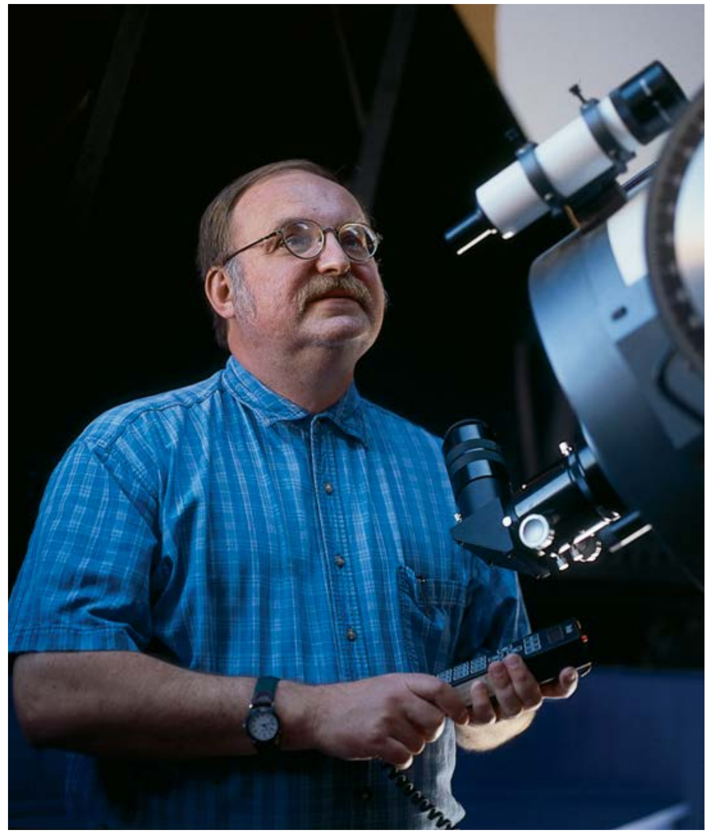
emeritus professor

B.S. 1974 Harvard

Ph.D. 1980 University of Arizona

My research involves the application of optical CCD imaging of astronomical objects using various large and small telescopes, along with associated image processing techniques, to a variety of astronomical topics.

Currently, my main topic of interest is the colors and other photometric properties of minor bodies in the outer solar system, including Kuiper Belt Objects and irregular satellites of the Jovian planets. A common theme of these projects is to obtain accurate measurements of the observed brightness and colors of various astronomical objects, frequently in the presence of contaminating background or foreground light sources. The scientific goal of these studies is to trace how and where the diverse population of minor outer solar system bodies we now observe originated and how these objects fit into the story of the formation of our solar system. By measuring colors for a large sample of minor outer solar system objects and finding patterns in their colors and orbital properties, my colleagues and I have already found interesting clues to the places of origin of certain classes of these objects.



The twin 10 meter telescopes of the Keck Observatory, Mauna Kea, Hawaii, prepare to start another night of observing. Astronomers at OU have been granted observing time on these giant telescopes to study faint objects at the edge of the solar system, as well as the elemental abundances in old stars in our galaxy.

W. Romanishin and S. C. Tegler, "Statistics of Optical Colors of KBOs and Centaurs," in *Statistical Challenges in Modern Astronomy,* ASP Conference Series, San Francisco, 2007.

W. Romanishin and S. C. Tegler , "Accurate Absolute Magnitudes for Kuiper belt objects," *Icarus*, **179**, 523, 2005.

S. C. Tegler and W. Romanishin, "Extremely red Kuiper belt objects in near-circular orbits beyond 40AU," *Nature*, **407**, 979, 2000.

W. Romanishin and S. C. Tegler "Rotation Rates of Kuiper-belt Objects from Their Light Curves," *Nature*, **398**, 129 (1999).

S. C. Tegler and W. Romanishin, "Two Distinct Populations of Kuiper Belt Objects," *Nature,* **392**, 49 (1998).

[Yun Wang]

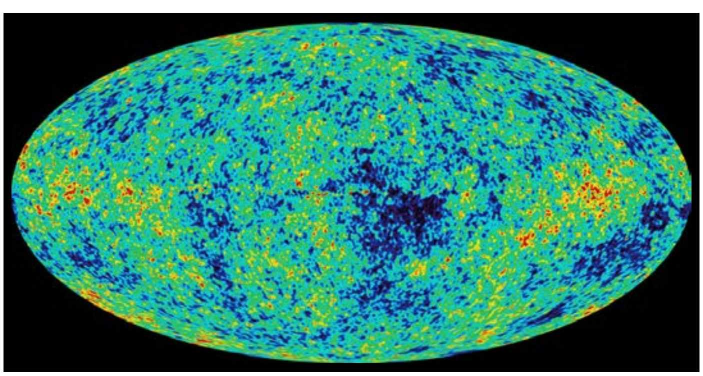
associate professor

Regents Award for Superior Research (2006)
B.S. 1985 Tsinghua Univ., P.R. China
Ph.D. 1991 Carnegie-Mellon

My research has focused on extracting fundamental physics from cosmological data, in particular, probing dark energy and early universe physics using supernovae (SNe), cosmic microwave background anisotropy (CMB), and cosmic large scale structure data.

Our Universe has been observed to be undergoing accelerated expansion today. The unknown reason for this cosmic acceleration is referred to as "dark energy". At present, we do not know whether it is a new energy component of the Universe with negative pressure, or a modification of Einstein's theory of gravity (*i.e.*, general relativity). Solving the mystery of the nature of dark energy is the most important problem in cosmology today. Dark energy can be probed using various techniques, most notably, using Type Ia supernovae (SNe Ia) as cosmological standard candles. I have done fundamental work in the use of supernovae to probe dark energy. My work has ranged from survey strategy, optimal data analysis, to the modeling of weak lensing effects. In the last several years, I have focused on using galaxy redshift surveys to probe dark energy and test gravity theories.

I am involved with observational projects to probe dark energy from both space and ground. I am a member of the Wide-Field Infrared Survey Telescope (WFIRST) Science Definition Team, and a member of the LSST Supernova Science Collaboration. I served as the U.S. Representative on the Science Advisory Team for Euclid-NIS, and am now a member of the Euclid Consortium.



The imprint of the primordial seeds in the cosmic microwave background, as seen by the Wilkinson Microwave Anisotropy Probe (WMAP) satellite. (credit: the WMAP team, http://map.gsfc.nasa.gov)

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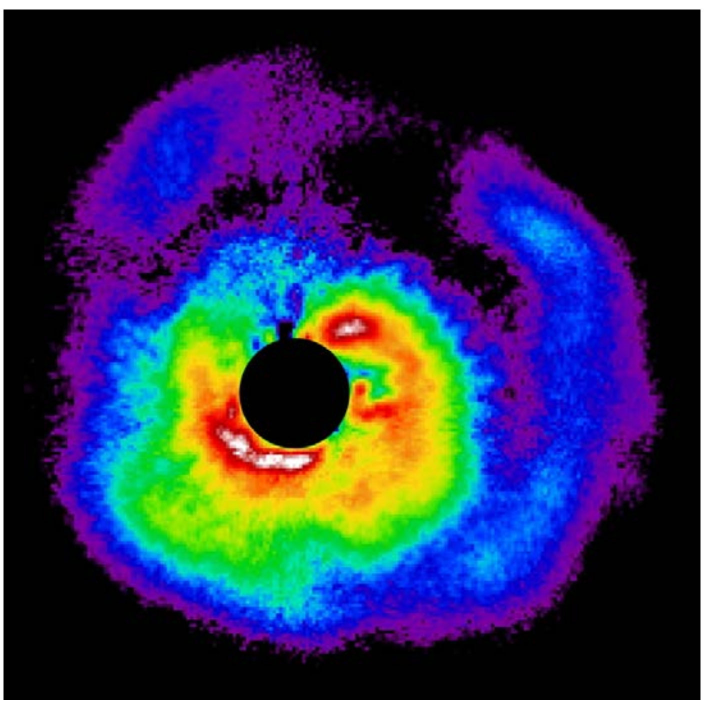
[John Wisniewski]

assistant professor

I am interested in studying circumstellar disks. Circumstellar disks are ubiquitous throughout all stages of stellar evolution for all masses of stars: they guide the accretion of matter in star formation, serve as the birthplace of planets and may influence the subsequent migration of these bodies, and shape stellar outflows in later stages of stellar evolution. I use multi-wavelength observational techniques, using ground- and space-based facilities, to investigate the structure, evolution, and origin of circumstellar disks.

Recently, my research has focused on analyzing high contrast imagery of nearby disks using the HiCIAO coronagraph at the Subaru 8.2m telescope on Mauna Kea, as part of the Strategic Exploration of Exoplanets and Disks with Subaru (SEEDS) project. Although we know that dust grains in young protoplanetary disks serve as the seed material for the production of young exoplanets, we do not know how grain properties differ/evolve as a function of age or radiation field. To address this fundamental question, my colleagues and I are imaging roughly 200 nearby, young disks via the SEEDS survey. With this exquisite imagery, we can also search for morphological signatures of young planets that are forming or have recently formed in these disks, such as disk gaps, spiral arms, and geometrical offsets.



The protoplanetary disk surrounding the young Herbig Ae star AB Aur is revealed in this near-infrared coronagraphic image taken at the 8.2m Subaru telescope, as part of the SEEDS program. The complex morphology observed, including the ring gap, could be caused by gravitational interactions between a young planet and the disk material in which it is embedded (Hashimoto et al. 2011).

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