

# Curriculum Vitae

Patrick Young  
School of Earth and Space Exploration  
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## Education

1999—2004: The University of Arizona, Ph.D. Astronomy

1995—1998: The University of Texas at Austin, B.A. Astronomy, B.S. Physics

## Employment

2007–Present: Assistant Professor, School of Earth and Space Exploration, Arizona State University

2005–2007: Director’s Postdoctoral Fellow, Los Alamos National Laboratory (with Q clearance); Adjunct Instructor & Visiting Scholar, Steward Observatory, University of Arizona

2004–2005: Postdoctoral Research Associate, Steward Observatory

## Service

Dissertation advisor to Carola Ellinger (ASU Physics), Michael Pagano (SESE)

Oral exam committee for the following students: Jeni McDermott, Natalie Hinkel, Lifang Xia, Brian Gleim, Vithal Tilvi, Michael Rutkowski, Michael Pagano.

Thesis Committee for Nahks Tr'Ehnl.

Dissertation Committee Nicholas Ouellette.

Space Grant mentor for undergraduate John Huppenthal

Graduate Student Oversight Committee from fall 2008

Graduate Student Oversight Committee Chair from fall 2009

Session organizer and chair for two Astrobiology Science Conference 2010 topical sessions

Referee for the Astrophysical Journal

November 2006–Present: Member, Large Synoptic Survey Telescope Supernova Working Group

January–March 2006: Visiting Faculty, Kavli Institute for Theoretical Physics

## Grants

### Pending

DOE Early Career Grant, 2010 (\$750K, submitted)

NSF CAREER Grant, 2010 (\$750K, submitted)

NASA Astrophysics Theory Program, 2010(\$350K, submitted)

NASA Origins of Solar Systems, 2010 as Co-I (\$150K, submitted PI Eric Mamajek)

### Active

Earthwatch SCAP Program (outreach) 2009 (\$16K), will be continued in 2010

NASA Astrobiology Institute as "Super-collaborator" (5% effort)

NSF Division of Astronomical Sciences, 2008 (\$342K, Frank Timmes Co-I)

## Fellowships and Awards

Director's Postdoctoral Fellowship, Los Alamos Natl. Lab. 2004

University of Arizona College of Sciences Fellowship 1999

Most Outstanding Physics Graduate, University of Texas, 1998

Most Outstanding Astronomy Graduate, University of Texas, 1998

McDonald Observatory Board of Visitor's Award, 1997

Texas Exes Scholarship, 1995

National Merit Scholar, 1995

## Professional References

Regents Professor David Arnett, University of Arizona, darnett@as.arizona.edu

Dr. Chris L. Fryer, Los Alamos National Laboratory, fryer@lanl.gov

Professor Frank Timmes, Arizona State University, francis.timmes@asu.edu

## Refereed Publications

"Abundance Variation of Dwarfs in the Solar Neighborhood", **Pagano, Michael (ASU student)**, Young, Patrick A., and Timmes, F. X. 2009 ApJ, in preparation

"Convection Theory and Sub-photospheric Stratification", Arnett, David, Meakin, Casey, & Young, Patrick A. 2009, ApJ, in press

"Solar System Shifts in Oxygen Isotopes Associated with Supernova Injection of  $^{26}\text{Al}$ ", **Ellinger, Carola I. (ASU Student)**, Young, Patrick A., & Desch, Steve 2009, ApJ, submitted

"Spectra and Lightcurves of Failed Supernovae", Fryer, Chris L.; Brown, Peter J.; Bufano, Filomena; Dahl, Jon A.; Fontes, Christopher J.; Frey, Lucille H.; Holland, Stephen T.; Hungerford, Aimee L.; Immler, Stefan; Mazzali, Paolo; Milne, Peter A.; Scannapieco, Evan; Weinberg, Nevin; Young, Patrick A., 2009, ApJ, submitted

"Binary Orbit, Physical Properties, and Evolutionary State of Capella ( $\alpha$  Aurigae)"  
Torres, Guillermo; Claret, Antonio; Young, Patrick A., 2009, ApJ, 700, 1349

"Accounting for the Iron in Cassiopeia A I: New Reddening Measurements", Eriksen, Kristoffer A., Arnett, David, McCarthy, Donald W., & Young, Patrick A. 2009, ApJ, 697, 29

- “Understanding Compact Object Formation and Natal Kicks: II. The case of XTE J1118+480”, Fragos, T., Willems, B., Kalogera, V., Ivanova, N., Rockefeller, G., Fryer, C. L., & Young, P. A. 2009, ApJ, 697, 1057
- “Finding Tracers for Supernova-Produced  $^{26}\text{Al}$ ”, Young, Patrick A., **Ellinger, Carola I. (ASU Student)**, Arnett, David, Fryer, Chris L., & Rockefeller, Gabriel R. 2009, ApJ, 699, 938
- “Turbulent Convection in Stellar Interiors. II. The Velocity Field”, Arnett, David, Meakin, Casey, & Young, Patrick A. 2009, ApJ, 690, 1715
- “Constraints on Type Ib/c Supernovae and Gamma-Ray Burst Progenitors”, Fryer, Chris L., Mazzali, Paolo A., Prochaska, Jason, Cappellaro, Enrico, Panaitescu, Alin, Berger, Edo, van Putten, Maurice, van den Heuvel, Ed P. J., Young, Patrick, Hungerford, Aimee, Rockefeller, Gabriel, Yoon, Sung-Chul, Podsiadlowski, Philipp, Nomoto, Ken’ichi, Chevalier, Roger, Schmidt, Brian, & Kulkarni, Shri, 2007, PASP, 119, 1211
- “The Local Environments of Long-Duration Gamma-Ray Bursts”, Young, Patrick A. & Fryer, Chris L., 2007, ApJ, 670, 584
- “Light-Curve Calculations of Supernovae from Fallback Gamma-Ray Bursts”, Fryer, Chris L., Hungerford, Aimee L., & Young, Patrick A. 2007, ApJ, 622L, 55
- “Uncertainties in Supernova Yields I: 1D Explosions”, Young, Patrick A. & Fryer, Chris L. 2007, ApJ, 644, 1033
- “Late Time Convection in the Collapse of a 23 Solar Mass Star”, Fryer, Chris L. & Young, Patrick A. 2007, ApJ, 659, 1438
- “Explosive Nucleosynthesis from GRB and Hypernova Progenitors: Direct Collapse versus Fallback”, Fryer, Christopher L., Young, Patrick A., & Hungerford, Aimee L. 2007, ApJ, 650, 1028
- “The Environments Around Long Duration Gamma-Ray Burst Progenitors”, Fryer, Chris L., Rockefeller, Gabriel, & Young, Patrick A. 2006, ApJ, 647, 1269
- “Constraints on the Progenitor of Cassiopeia A”, Young, Patrick A., Fryer, Chris L., Hungerford, Aimee, Arnett, David, Rockefeller, Gabriel, Timmes, F. X., Voit, Benedict, Meakin, Casey, & Eriksen, Kristoffer L. 2006, ApJ, 640
- “The Age and Progenitor Mass of Sirius B”, Liebert, James, Young, Patrick A., Arnett, David, Holberg, J. B., & Williams, Kurtis A. 2005, ApJL, 630, 69
- “The Impact of Hydrodynamics on Supernova Progenitors”, Young, Patrick A., Meakin, Casey, Arnett, David, & Fryer, Christopher L., 2005, ApJL, 629, 101
- “Observational Tests and Predictive Stellar Evolution II: Improvements from Hydrodynamic Simulations”, Young, Patrick A. & Arnett, David 2005, ApJ 618, 908

- “A Model for the Formation of High Density Clumps in Proto-Planetary Nebulae”, Young, Patrick A., Highberger, J. L., Arnett, David, & Ziurys, L. M. 2003, ApJ, 597, L53
- “The Salty Scrambled Egg”, Highberger, J. L., Thomson, K. J., Young, P. A., Arnett, D., & Ziurys, L. M., 2003, ApJ, 593, 393
- “Stellar Hydrodynamics in Radiative Regions”, Young, Patrick A., Knierman, Karen A., Rigby, Jane R., & Arnett, David 2003, ApJ, 595, 1114
- “Observational Tests and Predictive Stellar Evolution”, Young, P. A., Mamajek, E. E., Arnett, David, & Liebert, James 2002, ApJ 556, 230
- “Observations of Ly $\alpha$ ; Absorption in a Triple Quasar System”, Young, P. A., Impey, C. D., & Foltz, C. B. 2001, ApJ, 549, 76
- “The Orbital Light Curve of Aquila X-1”, Welsh, William F., Robinson, Edward L., & Young, Patrick 2000, AJ, 120, 943
- “Giant, Repeating, Optical Bursts from the Soft X-Ray Transient Aquila X-1”, Robinson, Edward L. & Young, Patrick 1998, ApJL, 491, L89

## Education and Outreach

PI, “Southwestern Earth and Skies Through Time” Earthwatch Student Challenge Awards Program: 2 week research experience for high school students from around the country. Developed and oversaw program including proposal for competitive selection

“Forging the Elements”, Arizona Science Center International Year of Astronomy Public Talk

“Searching for Habitable Stars” Astrobiology Teaching Module

Mars Education Teacher Workshops 2008, 2009

AST 321 Intro to Stellar and Planetary Astrophysics, ASU

AST 522 Stars and Interstellar Medium II, ASU

AST 322 Introduction to Galactic and Extragalactic Astrophysics, ASU

Instructor, ASTR 535 Stellar Evolution for Astronomy Ph.D. program at University of Arizona, Spring 2006. Developed entirely new curriculum as well as teaching. The new curriculum will form the basis of an online text in association with the Apple Digital Campus

Steward Observatory Public Evening Lecture 10/10/2005 “Planets, People, and Other Products of Stellar Evolution”

Ph.D. Program Consultant, Sahuaro Girl Scout Council May 2004-Present

Press Release: “Astronomers at MMTO Capture Planetary Nebula in Glowing Detail”, featured image on space.com 01/19/04

JWST NIRCам E/PO program “Linking Girls with the Sky” 2003–present

University of Arizona Alumni Association Astronomy Camp counselor, 2000—present

Graduate Teaching Assistant, U of A graduate course in stellar evolution, 2002

Graduate Teaching Assistant, U of A introductory astronomy, 2000—2001

Public star parties and K-12 outreach through University of Texas Astronomy Students Association, 1995—1999, U of A 1999—2002

## Books and Conference Proceedings

- “Solar System Shifts in Oxygen Isotopes Associated with Supernova Injection of Aluminum 26”, Ellinger, Carola I., Young, Patrick A., & Desch, Steven J. 2009, 72nd Annual Meeting of the Meteoritical Society, held July 13-18, 2009 in Nancy, France. Published in Meteoritics and Planetary Science Supplement., p.5385
- “Comparisons of Spatially Resolved Nucleosynthesis in 3D Simulations and Cassiopeia A”, Patrick A. Young, Carola Ellinger, David Arnett, Chris Fryer, & Gabe Rockefeller 2008, Conference Proceedings for the ”10th Symposium on Nuclei in the Cosmos (NIC X)”, July 27 - August 1 2008, Mackinack Island, Michigan, USA
- “Complete nucleosynthesis calculations for low-mass stars from NuGrid”, Pignatari, Marco; Herwig, Falk; Bennett, Michael; Diehl, Steven; Fryer, Christopher L.; Hirschi, Raphael; Hungerford, Aimee; Magkotsios, Georgios; Rockefeller, Gabriel; Timmes, Francis X.; Young, Patrick, Conference Proceedings for the ”10th Symposium on Nuclei in the Cosmos (NIC X)”, July 27 - August 1 2008, Mackinack Island, Michigan, USA
- “NuGrid: s Process in Massive Stars”, Hirschi, Raphael; Frischknecht, Urs; Thielemann, F. -K.; Pignatari, Marco; Bennett, Michael; Diehl, Steven; Fryer, Christopher L.; Herwig, Falk; Hungerford, Aimee; Magkotsios, Georgios; Rockefeller, Gabriel; Timmes, Francis X.; Young, Patrick, Conference Proceedings for the ”10th Symposium on Nuclei in the Cosmos (NIC X)”, July 27 - August 1 2008, Mackinack Island, Michigan, USA
- “Nucleosynthesis simulations for a wide range of nuclear production sites from NuGrid”, Herwig, Falk; Bennett, Michael; Diehl, Steven; Fryer, Christopher L.; Hirschi, Raphael; Hungerford, Aimee; Magkotsios, Georgios; Pignatari, Marco; Rockefeller, Gabriel; Timmes, Francis X.; Young, Patrick, Conference Proceedings for the ”10th Symposium on Nuclei in the Cosmos (NIC X)”, July 27 - August 1 2008, Mackinack Island, Michigan, USA
- “<sup>44</sup>Ti and <sup>56</sup>Ni in core-collapse supernovae”, Magkotsios, Georgios; Timmes, Francis X.; Wiescher, Michael; Fryer, Christopher L.; Hungerford, Aimee; Young, Patrick; Bennett, Michael; Diehl, Steven; Herwig, Falk; Hirschi, Raphael; Pignatari, Marco; Rockefeller, Gabriel, Conference Proceedings for the ”10th Symposium on Nuclei in the Cosmos (NIC X)”, July 27 - August 1 2008, Mackinack Island, Michigan, USA
- “Nucleosynthetic Yields from ”Collapsars””, Rockefeller, Gabriel; Fryer, Christopher L.; Young, Patrick; Bennett, Michael; Diehl, Steven; Herwig, Falk; Hirschi, Raphael; Hungerford, Aimee; Pignatari, Marco; Magkotsios, Georgios; Timmes, Francis X., Conference Proceedings for the ”10th Symposium on Nuclei in the Cosmos (NIC X)”, July 27 - August 1 2008, Mackinack Island, Michigan, USA
- “Nucleosynthesis Calculations from Core-Collapse Supernovae”, Fryer, Christopher L.; Young, Patrick; Bennett, Michael; Diehl, Steven; Herwig, Falk; Hirschi, Raphael;

- Hungerford, Aimee; Pignatari, Marco; Magkotsios, Georgios; Rockefeller, Gabriel; Timmes, Francis X., Conference Proceedings for the "10th Symposium on Nuclei in the Cosmos (NIC X)", July 27 - August 1 2008, Mackinack Island, Michigan, USA
- "NuGrid: Toward High Precision Double-Degenerate Merger Simulations with SPH in 3D", Diehl, Steven; Fryer, Christopher L.; Hungerford, Aimee; Rockefeller, Gabriel; Bennett, Michael; Herwig, Falk; Hirschi, Raphael; Pignatari, Marco; Magkotsios, Georgios; Timmes, Francis X.; Young, Patrick; Clayton, Geoffrey C.; Motl, Patrick; Tohline, Joel E., Conference Proceedings for the "10th Symposium on Nuclei in the Cosmos (NIC X)", July 27 - August 1 2008, Mackinack Island, Michigan, USA
- "Difficulties in Probing Nuclear Physics: A Study of  $^{44}\text{Ti}$  and  $^{56}\text{Ni}$ ", Hungerford, Aimee; Fryer, Christopher L.; Timmes, Francis X.; Young, Patrick; Bennett, Michael; Diehl, Steven; Herwig, Falk; Hirschi, Raphael; Pignatari, Marco; Magkotsios, Georgios; Rockefeller, Gabriel, Conference Proceedings for the "10th Symposium on Nuclei in the Cosmos (NIC X)", July 27 - August 1 2008, Mackinack Island, Michigan, USA
- "Theory and Numerics: New Results on Convection in Stars", Arnett, David; Meakin, Casey; Starrfield, Sumner; Timmes, Frank; Young, Patrick, 2008, IXTH TORINO WORKSHOP ON EVOLUTION AND NUCLEOSYNTHESIS IN AGB STARS AND THE IIND PERUGIA WORKSHOP ON NUCLEAR ASTROPHYSICS. AIP Conference Proceedings, 1001, 287
- "A Splinter Session on the Thorny Problem of Stellar Ages", Mamajek, Eric et al. 2007, in ASP Conference Series v.363, *Cool Stars and Stellar Systems XIV*, ed. G van Belle, 2007
- "Stellar Convection with Nuclear Burning", Arnett, Meakin, & Young 2006, IAU Symposium 239 "Convection in Stars", ed. Krupa, Roxburgh, & Chan, 2007
- "The Lambert Problem", Arnett, D., Meakin, C., Young, P. A. 2005, in *Cosmic Abundances as Records of Stellar Evolution and Nucleosynthesis*, ASP Conference Series, Vol. 336
- "Improved Nucleosynthetic Yields", Arnett, David, Meakin, Casey, & Young, Patrick 2005, in *From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution*, IAU Symposium Proceedings of IAU 228, pp.151-156, Ed. Hill, Francois, & Primas, (Cambridge: Cambridge University Press)
- "Stellar Evolution with Hydrodynamic Ejection", Young, Patrick A. 2005, in *The Fate of the Most Massive Stars*, ASP Conference Series, Vol. 332
- "Simulations of a Supernova Impostor", Arnett, David, Meakin, Casey, & Young, Patrick A. 2005, in *The Fate of the Most Massive Stars*, ASP Conference Series, Vol. 332
- "Massive Star Evolution", Young, Patrick A. & Arnett, David 2004, in *Stellar Collapse*, p. 5, Ed. C. L. Fryer, (Dordrecht: Kluwer)

- “Scientific Results from the MMT Natural Guide Star Adaptive Optics System”, Kenworthy et al. 2005, Proc. SPIE, 5490, 351, *Advancements in Adaptive Optics*
- “Boundary Conditions for Stellar Convection (invited review)”, Arnett, D., Young, P. A., Knierman, K. A., & Rigby, J. R. 2003, in *CNO in the Universe*, ASP Conference Series, Vol. 304
- “Boundary Conditions on Stellar Convection”, Young, Patrick A., Knierman, Karen A., Rigby, Jane R., & Arnett, David 2003, in *3D Stellar Evolution* eds. S. Turcotte et al. (San Francisco: PASP), 157
- “Dynamically refocused Rayleigh laser beacons for atmospheric tomography”, Lloyd-Hart, Michael, Georges, James A., Angel, James Roger P., Brusa, Guido, & Young, Patrick 2002, Proc. SPIE, 4494, 259, *Adaptive Optics Systems and Technology II*
- “The Orbital Light Curve of Aquila X-1”, Robinson, E. L., Welsh, W. F., & Young, P. 2001, AIP conference proceedings, 599, 902

## Invited Talks

- “New Frontiers in the Synthesis of the Elements”, NRAO Colloquium, Socorro, NM, February 2007
- “Uncertainties in Stellar Evolution Calculations and Theoretical Ages”, Cool Stars XIV, Pasadena, CA, November 2006
- “New Constraints on GRB Progenitors”, Black Holes: Power Behind the Scenes, Kathmandu, Nepal, October 2006
- “Constraints on the Progenitor of Cassiopeia A”, Supernovae and  $\gamma$ -ray Bursts, Kavli Institute for Theoretical Physics, Sanata Barbara, CA, February 2006
- “New Physics and Old Uncertainties in Stellar Evolution”, Observatoire de Genève Seminar, Geneva, Switzerland, September 2005
- “The Dramatic Impact of Hydrodynamic Mixing on Supernova Progenitors”, HEAD Colloquium, Center for Astrophysics, Cambridge, MA, August 2005
- “The Dramatic Impact of Hydrodynamics on Supernova Progenitors”, IPAM Supernova Workshop, UCLA, Los Angeles, CA, May 2005
- “Stellar Evolution with Hydrodynamic Ejection”, Fates of the Most Massive Stars, Jackson Hole, WY, May 2004
- “Mass Loss in SNIb/c Progenitors”, 201st AAS, Seattle, WA, Jan. 2003

## Contributed Talks and Posters

- “Modeling Supernova Remnant Interactions With Dense Molecular Clouds Using The Smooth Particle Hydrodynamics Codes TYCHO And SNSPH”, Rutkowski, Michael J.; Young, P. A. 2009 American Astronomical Society Meeting #213, #488.02
- “New Observational and Theoretical Insights on Cassiopeia A”, Eriksen, Kristoffer A.; Arnett, D.; Raymond, J. C.; Young, P. A., 2009, American Astronomical Society Meeting #213, #359.06
- “Turbulent Convection in Stellar Interiors and Stellar Ages”, Patrick A. Young, David Arnett, & Casey Meakin 2008, *The Ages of Stars*
- “Comparisons of Spatially Resolved Nucleosynthesis in 3D Simulations and Cassiopeia A”, Patrick A. Young, Carola Ellinger, David Arnett, Chris Fryer, & Gabe Rockefeller 2008, *Nuclei in the Cosmos X*
- “The Birthplaces of Gamma-ray Bursts”, Patrick A. Young & Chris Fryer 2008, *Gamma-Ray Bursts 2007*
- “Collaboration for Education with the Apple Learning Interchange”, Patrick A. Young, Terry Zimmerman, & Karen A. Knierman 2007, AAS/AAPT Joint Meeting, #094.01
- “Uncertainties in Supernova Yields”, Patrick A. Young & Chris L. Fryer 2007, AAS/AAPT Joint Meeting, #150.04
- “New Outreach Activities for Stellar Astronomy”, Patrick A. Young, Abigail S. Hedden, & Karen A. Knierman 2005, *Building Community: The Emerging EPO Profession (Tucson)*
- “High Energy Density Laboratory Astrophysics, Observational Tests, and Stellar Evolution”, Young, Patrick A. & Arnett, David, 2004, 5th High Energy Density Laboratory Astrophysics Conference (Tucson)
- “NIRCam/JWST Outreach: Girl Scout Leaders at Astronomy Camp”, Knierman, Karen A., Young, Patrick A., McCarthy, Donald W., & Reike, Marcia 2004, in *Women in Astronomy II: Ten Years After*
- “Mass Loss From SN Ib/c Progenitors”, Young, Patrick A. & Arnett, David 2003, American Astronomical Society Meeting 201, #22.09
- “A Strictly Hydrodynamic Treatment of Convective Overshooting in Stars”, Young, Patrick A. & Arnett, David 2002, American Astronomical Society Meeting 200, #07.15
- “Observational Tests and Predictive Stellar Evolution”, Young, P., Mamajek, E., Arnett, D., & Liebert, J. 2000, American Astronomical Society Meeting 197, #114.01
- “Ellipsoidal Variations in the Soft X-Ray Transient AQL X-1”, Young, P., Welsh, W. F., & Robinson, E. L. 1997 American Astronomical Society, 193rd AAS Meeting, #43.08

## Teaching and Education

I have had two semesters of teaching relief as a part of my startup package, and have taught three courses in SESE (AST 321, 322, and 522). I have developed a new curriculum for all three courses. One of the students from AST 321 is now working for me as a Space Grant undergraduate intern, and a student from 322 previously worked for me as an undergraduate research assistant. AST 522 (Stellar Evolution) used a research-directed approach. In parallel to lectures the students use my research stellar evolution code for projects that are written up and presented in the format of published papers and conference talks. I hope to develop a version of this course suitable for AST 421, one of two undergraduate astrophysics courses required for the SESE astrophysics concentration. In Spring 2010 I will be teaching AST 112. I will be employing lecture tutorials to enrich the large 100 level class format with interactive problem solving elements. In the future I plan to expand my use of online materials to transition to a hybrid course model capable of serving more students. I have been asked to develop astronomy content for Ariel Anbar's forthcoming Habitable Worlds course.

I am working with the Mars Education Program to develop new informal education material. I have created a teacher workshop on stars and nucleosynthesis to augment existing Starlab planetarium training and have presented at one teacher workshop with favorable reviews and will have another in December 2009. I am developing a research-based online/classroom activity for the NASA Astrobiology Institute Follow the Elements program that teaches about the stellar contribution to habitability. I tested this activity in a teacher workshop in Spring 2009. My current grant proposals include funding requests for establishing a central point of contact and repository for astrophysics education resources.

I was PI for an Earthwatch Institute Student Challenge Awards Program in summer 2009. This program brings eight high school students for two weeks during which they do research projects with THEMIS and LROC data (as in the Mars Student Imaging Project) and travel to geological sites that provide interesting planetary analogues (i.e. Meteor Crater, S. P. Crater) to carry out mapping of geological features. Students were mentored by several SESE faculty/staff, including Wendy Taylor, Frank Timmes, Amanda Clarke, and Ramon Arrowsmith. This will receive continued funding to become an annual program. Earthwatch and I are interested in expanding the program if sufficient staff support can be found.

I am the Dissertation Advisor for Carola Ellinger (ASU Physics) and Michael Pagano (ASU SESE), and co-advisor for Nahks TrEhnl (ASU SESE Masters).

## Research

My research has coalesced around a central theme of creation and distribution of the chemical elements on scales from galactic chemical evolution to the enrichment of individual stellar and planetary systems. My research topics are of course strongly interrelated, but I will present three main thrusts under this theme.

My first focus is building a library of stellar evolution histories with yields of luminosity, kinetic energy, and chemical elements. This involves continued development of stellar interior physics from multi-D simulations and implementation in a stellar evolution code. It also requires 3D calculations of supernova explosions and nucleosynthesis post-processing. This

work has made ample use of the Saguaro HPC facility at ASU and computational facilities at Los Alamos National Laboratory (LANL). This work is currently being funded by the NSF Division of Astronomical Sciences. The models will be the basis for a library of theoretical supernova lightcurves and spectra that will be used by the Large Synoptic Survey Telescope and SWIFT for identifying the progenitors of the large number of supernovae they have or will discover, as well as being available to the community. Much of the stellar evolution work requires rigorous observational testing, which I am working on with collaborators at the University of Arizona (U of A), the University of Rochester (UR), and the Harvard-Smithsonian Center for Astrophysics. A substantial fraction of Nahks Tr'Ehnl's Master's thesis will consist of this work. My primary ASU collaborator is Frank Timmes.

My second focus is the detailed production of isotopes in supernovae and their incorporation into the interstellar medium and forming stellar and planetary systems. A detailed comparison of models with the nearby, young supernova remnant Cassiopeia A is one component. This is an important test of the theoretical framework that underlies the larger project. It is also a laboratory for interactions of supernovae with the ISM. Grant proposals are pending at NASA, the NSF, and DOE on this topic. I am also exploring the injection of short-lived radioisotopes and bioessential elements into developing planetary systems and the tracers which will allow us to identify systems enriched in them. The first and second focuses will provide the bulk of Carola Ellinger's dissertation. I have collaborated with Steve Desch at ASU and researchers at U of A, LANL, Princeton, and Rutgers.

Understanding the extent of elemental variations in stars and their impact is my third focus. A paper on the intrinsic variation of abundance ratios in stars in the solar neighborhood is on the verge of submission. With collaborators at UR I am developing a project to measure and model the abundance variations and supernova enrichment of stars in the closest OB association to Earth, which has a history of triggered star formation allowing ample opportunity for such enrichment. AN NSF proposal on this topic is pending. This will constitute the bulk of Michael Pagano's dissertation.

Much of this work supports the NASA Astrobiology Institute (NAI) "Follow the Elements" program at ASU. I am currently lead on two of the astrophysics tasks from the proposal and increasingly find my choice of research topics influenced by astrobiology questions. I am exploring ideas that I hope will lead to collaborations with Mini Wadhwa on isotopic signatures of supernova enrichment of the early solar system and Rick Hervig on his laboratory analysis of abundances in the Genesis solar wind samples.

## Service

I am Chair of the SESE Graduate Student Oversight Committee, after one year as a member. As such I had substantial input on the graduate student policy guidelines distributed this year. I also worked with the astrophysics faculty to develop the SESE Astrophysics Concentration degree program. I am working with AD for graduate studies Matt Fouch and SESE students to establish formal and regular communication with representatives for the grad community through a grad student council. I plan to use my remaining period as chair to increase the sense of SESE community and transdisciplinarity among the students by re-instituting the grad research seminar and helping streamline the process of finding and completing a secondary project well outside of the student's primary area of expertise.