

## VITA

**NAME:** David J. Jeffery  
Vita Update: 2012 January 1  
Date and Place of Birth: 1958; Port Colborne, Ontario, Canada  
Citizenship: Canadian

### ADDRESS:

Department of Physics  
Koch Center for Engineering  
and Science, Rm 239  
University of Evansville  
1800 Lincoln Avenue  
Evansville, Indiana 47722, U.S.A.

Email: [jeffery@nhn.ou.edu](mailto:jeffery@nhn.ou.edu)  
Office Tel: 812-488-2420  
Departmental Tel: 812-479-2612  
Departmental FAX: 812-479-2621  
Homepage: <http://www.nhn.ou.edu/~jeffery/>

### RESEARCH INTERESTS:

Theoretical Astrophysics, Supernovae, Radiative Transfer

### PROFESSIONAL SOCIETY MEMBERSHIPS:

Canadian Astronomical Society / Société Canadienne d'Astronomie (CASCA)

### EDUCATION:

1988 Ph.D. Physics McMaster University, Hamilton, Ontario, Canada  
1984 M.Sc. Physics McMaster University, Hamilton, Ontario, Canada  
1981 B.Sc. Physics McMaster University, Hamilton, Ontario, Canada

### PROFESSIONAL EXPERIENCE:

2011aug–2012may Visiting Assistant Professor, Department of Physics, University of Evansville, 1800 Lincoln Avenue, Evansville, Indiana 47722, U.S.A.  
2010aug–2011may Instructor, Department of Physics & Astronomy, Northern Arizona University, NAU Box 6010, Flagstaff, Arizona 86011-6010, U.S.A.  
2008jul–2010jun Senior Instructor, Department of Physics, University of Idaho, PO Box 440903, Moscow, ID 83844-0903, U.S.A.  
2007aug–2008jun Temporary Lecturer, Department of Physics, University of Idaho, PO Box 440903, Moscow, ID 83844-0903, U.S.A.  
2005aug–2007jul Postdoctoral Research Associate, Homer L. Dodge Department of Physics & Astronomy, University of Oklahoma, Norman, Oklahoma 73019, U.S.A.  
2004aug–2005may Lecturer, Department of Physics & Astronomy, Washburn University, 1700 SW College Ave., Topeka, Kansas 66621, U.S.A.  
2003aug–2004may Visiting Assistant Professor, Department of Physics, University of Nevada, Las Vegas (UNLV), Las Vegas, Nevada, U.S.A.  
2001aug–2003may Visiting Assistant Professor, Physics Department, New Mexico Tech, Socorro, New Mexico, U.S.A.  
2000aug–2001may Visiting Assistant Professor, Department of Physics & Health Physics, Idaho State University (ISU), Pocatello, Idaho, U.S.A.  
1999aug–2000may Visiting Assistant Professor, Department of Physics & Astronomy, Middle Tennessee State University (MTSU), Murfreesboro, Tennessee, U.S.A.  
1998aug–1999jun Visiting Assistant Professor, Department of Physics, University of Nevada, Las Vegas (UNLV), Las Vegas, Nevada, U.S.A.

- 1996oct–1998jul Postdoctoral Research Associate, Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A.
- 1995aug–1996aug Visiting Assistant Professor of Astronomy, Department of Physics & Astronomy, Vanderbilt University, Nashville, Tennessee, U.S.A.
- 1994apr–1995jun Fellow (Becario) of the Spanish Ministerio de Educación y Ciencia, Dept. d'Astronomia i Meteorologia, Facultat de Física, Universitat de Barcelona, Barcelona, Spain
- 1993sep–1994apr Visiting Researcher, Department of Physics & Astronomy, McMaster University, Hamilton, Ontario, Canada
- 1993feb–1993jun Lecturer on Astronomy, Department of Astronomy, Harvard University, Cambridge, Massachusetts, U.S.A.
- 1991jun–1993aug Postdoctoral Research Associate, Harvard College Observatory (Harvard-Smithsonian Center for Astrophysics), Cambridge, Massachusetts, U.S.A.
- 1991jan–1991may Visiting Instructor, Department of Physics & Astronomy, University of Oklahoma, Norman, Oklahoma, U.S.A.
- 1990oct–1990dec Visiting Researcher, Department of Physics & Astronomy, University of Oklahoma, Norman, Oklahoma, U.S.A.
- 1988sep–1989jul Visiting Researcher, Institut für Astronomie und Astrophysik Der Universität München, Munich, Germany
- 1988jan–1990jun Postdoctoral Research Associate, Department of Physics & Astronomy, University of Oklahoma, Norman, Oklahoma, U.S.A.
- 1980may–1980aug NSERC Summer Student, Department of Physics, McMaster University, Hamilton, Ontario, Canada
- 1979sep–1987apr Teaching Assistant, Department of Physics, McMaster University, Hamilton, Ontario, Canada

### COURSES TAUGHT:

Classical Mechanics, graduate level

1. New Mexico Tech; 2001 fall; Text: H. Goldstein et al. *Classical Mechanics*, 3rd Edition

Colloquium in Physics/Astronomy, faculty and student colloquia, senior and graduate level

2. ISU; 2001 spring, one credit hour
1. Vanderbilt Univ.; 1995 fall, one credit hour

Conceptual Physics, non-science students

1. Univ. of Evansville; 2011 fall, Text: Paul G Hewitt, *Conceptual Physics*

Energy in Physics and Society, one of three course modules of the Physics of Everyday Life: the concept of the energy, energy and power units, thermodynamics, heat engines and refrigerators, world energy resources and consumption

1. Univ. of Idaho; 2009 fall, 2008 fall, 2007 fall; Texts: formerly Louis A. Bloomfield, *How Things Work*, my own online lectures at URL [http://www.nhn.ou.edu/~jeffery/course/c\\_energy/energy.html](http://www.nhn.ou.edu/~jeffery/course/c_energy/energy.html)  
Co-taught with Profs. Chris Berven and Ruprecht Machleidt of the Univ. of Idaho in 2007–2008, Profs. David McIlroy and Jason Barnes in 2009

History of Astronomy

1. Vanderbilt Univ.; 1995 fall, 1996 spring, summer; Texts: Michael Zeilik, *Astronomy*, John North, *The Norton History of Astronomy and Cosmology*

Independent Study/Research in Physics

1. Univ. of Evansville; 2012 spring, supervision of student Ryan Darwish in an independent study project

Introductory Astronomy for non-science students

7. Univ. of Evansville; 2011 fall (all astronomy), Text: my own online lectures at URL  
<http://www.nhn.ou.edu/~jeffery/astro/astlec/lecture.html>
6. Northern Arizona Univ.; 2010 fall (all astronomy), 2011 spring (all astronomy); Text: my own online lectures
5. Univ. of Idaho; 2009 fall (all astronomy); Text: my own online lectures
4. Washburn Univ.; 2004 fall, 2005 spring (2 sections on Stars and Galaxies; 1 section on the Solar System); Text: Neil F. Comins & William J. Kaufmann *Discovering the Universe* plus my own online lectures
3. UNLV; 2003 fall (2 sections on Solar System), 2004 spring (2 sections on Solar System); Text: Iain Nicolson, *Unfolding the Universe* plus my own online lectures
2. UNLV; 1998 fall (2 sections on Solar System), 1999 spring (2 sections on Solar System); Text: Michael Seeds *Foundations of Astronomy* for 1998–1999
1. Harvard; 1993 spring; taught jointly with William Press and Abraham Loeb

Introductory Physics I, algebra-based, mechanics, fluids, waves, thermodynamics (sometimes)

3. Univ. of Evansville: 2011 fall (1 lab section)
2. Univ. of Idaho: 2008 fall, 2007 fall; Text: John D. Cutnell & Kenneth W. Johnson, *Physics*
1. MTSU: 1999 fall (2 sections), 2000 spring (2 sections), 2000 summer; taught in laboratory mode (course developed by Victor Montemayor of MTSU); three credit hours

Introductory Physics II, algebra-based, electricity and magnetism optics, radiation (sometimes)

4. Univ. of Evansville: 2012 spring (1 lab section)
3. Northern Arizona Univ.: 2010 fall (1 lab section as instructor, 4 lab sections as supervisor, 2011 spring (several lab sections as supervisor); only a laboratory module
2. Univ. of Idaho: 2008 spring; Text: John D. Cutnell & Kenneth W. Johnson, *Physics*
1. MTSU: 2000 spring, 1999 fall (2 sections); one credit hour; only a laboratory course.

Introductory Physics I, calculus-based, mechanics, fluids (sometimes), waves (sometimes), thermodynamics (sometimes)

4. Univ. of Evansville: 2012 spring (2 sections and 2 lab sections) Text: Jearl Walker *Halliday & Resnick: Fundamentals of Physics*
3. Univ. of Idaho: 2010 spring (2 sections), 2009 fall, 2009 spring, 2008 fall, 2008 spring; Text: Raymond A. Serway & John W. Jewett, Jr. *Physics for Scientists and Engineers* plus my own online lectures (still in early development) at URL  
[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/intrc.html](http://www.nhn.ou.edu/~jeffery/course/c_intro/intrc.html)
2. New Mexico Tech: 2001 fall, 2002 fall; Text: Halliday, Resnick, & Walker, *Fundamentals of Physics*
1. ISU: 2001 spring; Text: Halliday, Resnick, & Walker, *Fundamentals of Physics*

Introductory Physics II, calculus-based: electricity, magnetism, optics, special relativity (sometimes)

5. Northern Arizona Univ.: 2010 fall, 2011 spring; one credit hour; only a laboratory course
4. Univ. of Idaho: 2009 summer (also lab), 2009 spring, 2008 summer; Text: Raymond A. Serway & John W. Jewett, Jr. *Physics for Scientists and Engineers*
3. New Mexico Tech: 2002 summer; Text: Halliday, Resnick, & Walker, *Fundamentals of Physics*

2. ISU: 2000 fall; Text: Halliday, Resnick, & Walker, *Fundamentals of Physics*
1. Univ. of Oklahoma; 1991 spring; Text: Richard Wolfson & Jay M. Pasachoff, *Physics*

Mathematical Physics: various topics that can include vector analysis, curvilinear coordinates, tensors, infinite series, functions of complex variables, Sturm-Liouville theory, Legendre Polynomials and spherical harmonics, Fourier series, Fourier transforms

2. Northern Arizona Univ.; 2010 fall; Text: Hans J. Weber & George B. Arfken, *Essential Mathematical Methods for Physicists*
1. Univ. of Idaho; 2007 fall; Text: Hans J. Weber & George B. Arfken, *Essential Mathematical Methods for Physicists*

Modern Physics: some of quantum mechanics, quantum mechanics applications, special relativity

1. Univ. of Idaho; 2008 spring; Texts: Robert Eisberg & Robert Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*; Brian Greene, *The Fabric of the Cosmos*

Physical Science: introduction to physics, astronomy, chemistry, and geology for non-science students

2. Washburn Univ.; 2004 fall/2005 spring; Text: K.B. Krauskopf & A. Beiser, *The Physical Universe*; I taught physics and astronomy and co-instructor Sue Salem taught chemistry
1. MTSU; 2000 spring semester; Text: James T. Shipman et al., *An Introduction to Physical Science*; included an instructor-taught physics and chemistry laboratory

Quantum Mechanics I, graduate level

3. Northern Arizona Univ.; 2011 spring; Text: David J. Griffiths, *Introduction to Quantum Mechanics*; a graduate class, but essentially the same as undergraduate Quantum Mechanics II
2. New Mexico Tech: 2002 fall; Texts: Gordon Baym, *Lectures on Quantum Mechanics*, Walter A. Harrison, *Applied Quantum Mechanics*
1. ISU: 2000 fall; Text: Claude Cohen-Tannoudj et al. *Quantum Mechanics: Vol. I*

Quantum Mechanics II, graduate level

1. New Mexico Tech: 2003 spring; Texts: Gordon Baym, *Lectures on Quantum Mechanics*

Quantum Mechanics I, undergraduate level

3. Univ. of Idaho; 2009 spring; Text: David J. Griffiths, *Introduction to Quantum Mechanics*
2. New Mexico Tech: 2002 spring; Text: David J. Griffiths, *Introduction to Quantum Mechanics*
1. ISU: 2001 spring; Text: David J. Griffiths, *Introduction to Quantum Mechanics*

Quantum Mechanics II, undergraduate level

2. Univ. of Idaho; 2010 spring; Text: David J. Griffiths, *Introduction to Quantum Mechanics*; this was a special topics course that was 60 % Quantum Mechanics II and 40 % a follow-up course in classical mechanics
1. ISU: 2000 fall; Texts: M.A. Morrison, *Understanding Quantum Physics*, M.A. Morrison, T.L. Estle, and N.F. Lane, *Understanding More Quantum Physics*

Radiative Transfer

2. New Mexico Tech: 2002 spring; Text: Robert J. Rutten, *Radiative Transfer in Stellar Atmospheres* online at URL [http://www.phys.uu.nl/~rutten/Lecture\\_notes.html](http://www.phys.uu.nl/~rutten/Lecture_notes.html)

three credit hours; senior undergraduate level taught as a special topic course

1. Vanderbilt Univ.; 1996 spring, astrophysical radiative transfer; Text: D. Mihalas & B.W. Mihalas, *Foundations of Radiation Hydrodynamics*; three credit hours; graduate level taught as a special topic course

Survey of Science for Teachers, Physics module: introductory physics, algebra-based

1. New Mexico Tech: 2002 summer; Text: none; A short survey course of the sciences for K-1-12 teachers without a science background (2 credit hours); taught jointly with Christa Hockensmith (chemistry) and Robert Cormack (psychology)

### INVITED TALKS:

1. MARAC: 37th Annual Mid-American Regional Astrophysics Conference, 2007 April 13-14, University of Missouri, Kansas City, Kansas City, Missouri: *A Review of Supernova Atmosphere Modeling: Radiative Transfer and All That* ([http://www.nhn.ou.edu/~jeffery/aalib/052\\_marac/marac.html](http://www.nhn.ou.edu/~jeffery/aalib/052_marac/marac.html)), but the online version has never been completed.

### PUBLICATIONS:

58. X. Wang, L. Wang, A.V. Filippenko, G. Aldering, P. Antilogus, D. Arnett, D. Baade, E. Baron, B.J. Barris, S. Benetti, P. Bouchet, A.S. Burrows, R. Canal, E. Cappellaro, R. Carlberg, E. di Carlo, P. Challis, A. Crotts, J.I. Danziger, M. Della Valle, D. Jack, M. Fink, R. Foley, C. Fransson, A. Gal-Yam, P. Garnavich, C.I. Gerardy, G. Goldhaber, M. Hamuy, W. Hillebrandt, P.A. Hoefflich, S.T. Holland, D. Holz, J.P. Hughes, D.J. Jeffery, S.W. Jha, D. Kasen, A.M. Khokhlov, R.P. Kirshner, R. Knop, C. Kosma, K. Krisciunas, M. Kromer, B.C. Lee, B. Leibundgut, E. Lentz, D.C. Leonard, W.H.G. Lewin, W. Li, M. Livio, P. Lundqvist, D. Maoz, T. Matheson, P. Mazzali, P. Meikle, G. Miknaitis, P. Milne, S. Mochnacki, K. Nomoto, P.E. Nugent, E. Oran, N. Panagia, F. Patat, S. Perlmutter, M.M. Phillips, P. Pinto, D. Poznanski, C.J. Pritchett, M. Reinecke, A. Riess, P. Ruiz-Lapuente, R. Scalzo, E.M. Schlegel, B. Schmidt, J. Siegrist, A.M. Soderberg, J. Sollerman, G. Sonneborn, A. Spadafora, J. Spyromilio, R.A. Sramek, S.G. Starrfield, L.G. Strolger, N.B. Suntzeff, R. Thomas, J.L. Tonry, A. Tornambe, J.W. Truran, M. Turatto, M. Turner, S.D. van Dyk, K. Weiler, J.C. Wheeler, M. Wood-Vasey, S. Woosley, H. Yamaoka, & T. Zhang, "Ultraviolet Observations of Type Ia Supernovae with the Hubble Space Telescope," *Astrophysical Journal* (ApJ), 2012, in press, arXiv:1110.5809v2
57. D. Branch, D.J. Jeffery, J. Parrent, E. Baron, M.A. Troxel, V. Stanishev, M. Keithley, & C. Bruner, "Comparative Direct Analysis of Type Ia Supernova Spectra. IV. Postmaximum," *Publications of the Astronomical Society of the Pacific (PASP)*, 2008, 120, 135-149, arXiv:0712.2436v1
56. E. Baron, D.J. Jeffery, D. Branch, E. Bravo, D. García-Senz & P. H. Hauschildt, "Detailed Spectral Modeling of a 3-D Pulsating Reverse Detonation Model: Too Much Nickel," *Astrophysical Journal* (ApJ), 2008, 672, 1038-1042, arXiv:0709.4177v1
55. 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," *Publications of the Astronomical Society of the Pacific (PASP)*, 2007, 119, 709-721, arXiv:0706.0081
54. M. Parthasarathy, D. Branch, D.J. Jeffery, & E. Baron, "The Progenitors of Type Ia Supernovae: Binary Stars with White Dwarf Companions," *New*

- Astronomy Reviews*, 2007, 51, 524–538, arXiv:astro-ph/0703415
53. D. Branch, J. Parrent, M.A. Troxel, D. Casebeer, D.J. Jeffery, E. Baron, W. Ketchum, & N. Hall, “Probing the Nature of Type I Supernovae with SYNOW” in *The Multicoloured Landscape of Compact Objects and their Explosive Origins*, *AIP Conf. Pro. 924, Week One, Cefalù, Sicily, 2006 June 11–24*, ed. L. A. Antonelli, G. L. Israel, L. Piersanti, & A. Tornambè (Melville, New York: American Institute of Physics), 2007, 342–349
  52. J. Parrent, D. Branch, M.A. Troxel, D. Casebeer, D.J. Jeffery, W. Ketchum, E. Baron, F.J.D. Serduke, & A.V. Filippenko, “Direct Analysis of Spectra of the Unusual Type Ib Supernova 2005bf,” *Publications of the Astronomical Society of the Pacific (PASP)*, 2007, 119, 135–142, arXiv:astro-ph/0701198
  51. D.J. Jeffery & P.A. Mazzali, “Giant Steps in Cefalù” in *The Multicoloured Landscape of Compact Objects and their Explosive Origins*, *AIP Conf. Pro. 924, Week One, Cefalù, Sicily, 2006 June 11–24*, ed. L. A. Antonelli, G. L. Israel, L. Piersanti, & A. Tornambè (Melville, New York: American Institute of Physics), 2007, 401–406, arXiv:astro-ph/0611002
  50. D.J. Jeffery, D. Branch, & E. Baron, “On SN 2003fg: The Probable Super-Chandrasekhar-Mass SN Ia,” *Astrophysical Journal*, 2006, arXiv:astro-ph/0609804
  49. M. Parthasarathy, D. Branch, E. Baron, & D.J. Jeffery, “An Ultralow-Dispersion Spectrum of Sanduleak -69 202, the Progenitor of Supernova 1987A,” *Bulletin of the Astronomical Society of India*, 2006, 34, 385–391, arXiv:astro-ph/0611033
  48. D.J. Jeffery, W. Ketchum, D. Branch, E. Baron, A. Elmhamdi, & I.J. Danziger, “Goodness-of-Fit Tests DIFF1 and DIFF2 for Locally Normalized Supernova Spectra,” *Astrophysical Journal Supplement Series*, 2006, 171, 493–511, arXiv:astro-ph/0607084
  47. D. Branch, D.J. Jeffery, T.R. Young, & E. Baron, “Hydrogen in Type Ic Supernovae?,” *Publications of the Astronomical Society of the Pacific (PASP)*, 2006, 118, 791–796, arXiv:astro-ph/0604047
  46. D. Branch, L.C. Dang, N. Hall, W. Ketchum, M. Melakyil, J. Parrent, M.A. Troxel, D. Casebeer, D.J. Jeffery, & E. Baron, “Comparative Direct Analysis of Type Ia Supernova Spectra. II. Maximum Light,” *Publications of the Astronomical Society of the Pacific (PASP)*, 2006, 118, 560–571, arXiv:astro-ph/0601048
  45. E. Baron, D. Branch, D.J. Jeffery, P. Nugent, R.C. Thomas, S. Bongard, P. Hauschildt, D. Kasen, & D. Mihalas, “Quantitative Spectroscopy of Supernovae for Dark Energy Studies,” White paper submitted to the Dark Energy Task Force, 2005, unpublished, arXiv:astro-ph/0510166
  44. J. Deng, K.S. Kawabata, Y. Ohyama, K. Nomoto, M. Iye, P.A. Mazzali, L. Wang, D.J. Jeffery, H. Tomita, & Y. Yoshii, “Late-Time Spectroscopy of the Interacting Type Ia SN 2002ic: Evidence of a H-rich, Asymmetric CSM,” in *Annual Report of the National Astronomical Observatory of Japan, Vol. 6, Fiscal 2003*, ed. K. Tanikawa et al. (Tokyo: Astronomical Observatory of Japan), 2005, 16
  43. K.S. Kawabata, J. Deng, P.A. Mazzali, K. Nomoto, K. Maeda, N. Tominaga, H. Umeda, N. Kobayashi, L. Wang, M. Iye, G. Kosugi, Y. Ohyama, T. Sasaki, K. Aoki, N. Kashikawa, T. Takata, W. Aoki, Y. Komiyama, Y. Mizumoto, J. Noumaru, R. Ogasawara, K. Sekiguchi, Y. Shirasaki, J. Watanabe, T. Yamada, Höflich, P., J.C. Wheeler, D.J. Jeffery, N. Kawal, T. Sakamoto, Y. Urata, A. Yoshida, T. Tamagawa, K. Torii, & T. Totani, “Subaru/FOCAS spectropolarimetry of Type Ic hypernova SN 2003dh/GRB 030329” in *Annual*

- Report of the National Astronomical Observatory of Japan, Vol. 6, Fiscal 2003*, ed. K. Tanikawa et al. (Tokyo: Astronomical Observatory of Japan), 2005, 15
42. K.S. Kawabata, D.J. Jeffery, M. Iye, N. Kashikawa, Y. Saito, T. Misawa, T. Yamada, I. Tanaka, Y. Ohyama, G. Kosugi, T. Sasaki, K. Sekiguchi, K. Aoki, T. Takata, N. Ebizuka, K. Nomoto, P.A. Mazzali, J. Deng, K. Maeda, H. Umeda, K. Ota, M. Yoshida, M. Inata, K. Okita, Y. Shimizu, R. Asai, T. Ozawa, Y. Yadoumaru, H. Taguchi, F. Nakata, & T. Kodama, “Optical Spectropolarimetry of SN 2002ap with Subaru Telescope,” in *Annual Report of the National Astronomical Observatory of Japan, Vol 5, Fiscal 2002*, ed. K. Tanikawa et al. (Tokyo: Astronomical Observatory of Japan), 2004, 22
41. D.J. Jeffery, “A Simple Bipolar Jet Model for the Polarization of Core-Collapse Supernovae,” 2004, unpublished, arXiv:astro-ph/0406440
40. J. Deng, K.S. Kawabata, Y. Ohyama, K. Nomoto, P.A. Mazzali, L. Wang, D.J. Jeffery, M. Iye, H. Tomita, & Y. Yoshii, “Subaru Spectroscopy of the Interacting Type Ia Supernova SN 2002ic: Evidence of a Hydrogen-rich, Asymmetric Circumstellar Medium,” *Astrophysical Journal (Letters)*, 2004, 605, L37–40, arXiv:astro-ph/0311590
39. K.S. Kawabata, J. Deng, L. Wang, P.A. Mazzali, K. Nomoto, K. Maeda, N. Tominaga, H. Umeda, M. Iye, G. Kosugi, Y. Ohyama, T. Sasaki, P. Höflich, J.C. Wheeler, D.J. Jeffery, K. Aoki, N. Kashikawa, T. Takata, N. Kawai, T. Sakamoto, Y. Urata, A. Yoshida, T. Tamagawa, K. Torii, W. Aoki, N. Kobayashi, Y. Komiyama, Y. Mizumoto, J. Noumaru, R. Ogasawara, K. Sekiguchi, Y. Shirasaki, T. Totani, J. Watanabe, & T. Yamada, “On the Spectrum and Spectropolarimetry of Type Ic Hypernova SN 2003dh/GRB 030329,” *Astrophysical Journal Letters*, 2003, 593, L19–22, arXiv:astro-ph/0306155
38. D. Branch, E. Baron, & D.J. Jeffery, “Optical Spectra of Supernovae” in *Supernovae and Gamma-Ray Bursters*, ed. K.W. Weiler (Berlin: Springer-Verlag), 2003, 47–76, arXiv:astro-ph/0111573
37. K.S. Kawabata, D.J. Jeffery, M. Iye, Y. Ohyama, G. Kosugi, K. Kashikawa, N. Ebizuka, T. Sasaki, K. Sekiguchi, K. Nomoto, P.A. Mazzali, J. Deng, K. Maeda, K. Aoki, Y. Saito, T. Tanaka, M. Yoshida, R. Asai, M. Inata, K. Okita, K. Ota, T. Ozawa, Y. Shimizu, H. Taguchi, Y. Yadoumaru, T. Misawa, F. Nakata, T. Yamada, I. Tanaka, & T. Kodama, “Optical Spectropolarimetry of SN 2002ap: A High Velocity Asymmetric Explosion” in *The Proceedings of the IAU 8th Asian-Pacific Regional Meeting, Volume II*, ed. S. Ikeuchi, J. Hearnshaw, & T. Hanawa (Japan: Astronomical Society of Japan), 2002, 333–334
36. K.S. Kawabata, D.J. Jeffery, M. Iye, Y. Ohyama, G. Kosugi, K. Kashikawa, N. Ebizuka, T. Sasaki, K. Sekiguchi, K. Nomoto, P.A. Mazzali, J. Deng, K. Maeda, H. Umeda, K. Aoki, Y. Saito, T. Tanaka, M. Yoshida, R. Asai, M. Inata, K. Okita, K. Ota, T. Ozawa, Y. Shimizu, H. Taguchi, Y. Yadoumaru, T. Misawa, F. Nakata, T. Yamada, I. Tanaka, & T. Kodama, “Optical Spectropolarimetry of SN 2002ap: A High Velocity Asymmetric Explosion,” *Astrophysical Journal (Letters)*, 2002, 580, L39–42, arXiv:astro-ph/0205414
35. D. Branch, S. Benetti, D. Kasen, E. Baron, D.J. Jeffery, K. Hatano, R.A. Stathakis, A.V. Filippenko, T. Matheson, A. Pastorello, G. Altavilla, E. Cappellaro, L. Rizzi, M. Turatto, Weidong Li, D.C. Leonard, & J.C. Shields, “Direct Analysis of Spectra of Type Ib Supernovae,” *Astrophysical Journal*, 2002, 566, 1005–1017, arXiv:astro-ph/0106367

34. D. Kasen, D. Branch, E. Baron, & D.J. Jeffery, “A Complete Analytic Inversion of Supernova Lines in the Sobolev Approximation,” *Astrophysical Journal*, 2002, 565, 380–384, arXiv:astro-ph/0108403
33. D. Branch, D.J. Jeffery, M. Blaylock, & K. Hatano, “Supernova Resonance-Scattering Profiles in the Presence of External Illumination,” *Publications of the Astronomical Society of the Pacific (PASP)*, 2000, 112, 217–223, arXiv:astro-ph/9911099
32. D.J. Jeffery, “Radioactive Decay Energy Deposition in Supernovae and the Exponential/Quasi-Exponential Behavior of Late-Time Supernova Light Curves,” 1999, unpublished, arXiv:astro-ph/9907015
31. D.J. Jeffery, P.S. Krstić, W. Liu, D.R. Schultz, & P.C. Stancil, “Atomic and Molecular Physics and Data Activities for Astrophysics at Oak Ridge National Laboratory” in *Proceedings of the NASA Laboratory Space Science Workshop*, Harvard-Smithsonian Center for Astrophysics, 1998 April 1–3, Local Organizing Committee: W. H. Parkinson, Kate Kirby, & Peter L. Smith, 1998, p. 101
30. D.J. Jeffery, “A Grey Radiative Transfer Procedure for  $\gamma$ -ray Transfer in Supernovae,” 1998, unpublished, arXiv:astro-ph/9811356
29. D.J. Jeffery, “A Grey  $\gamma$ -ray Transfer Procedure for Supernovae” in *Stellar Evolution, Stellar Explosions, and Galactic Chemical Evolution: Proceedings of the 2nd Oak Ridge Symposium on Atomic & Nuclear Astrophysics*, ed. A. Mezzacappa (Bristol: Institute of Physics Publishing), 1998, p. 687–691, arXiv:astro-ph/9802229
28. D.R. Schultz, P.S. Krstić, F.M. Ownby, F.W. Meyer, C.C. Havener, M.E. Bannister, W. Liu, D.J. Jeffery, & P.C. Stancil, “The ORNL Controlled Fusion Atomic Data Center” in *NIST Special Publication 926, Poster Papers, International Conference on Atomic and Molecular Data and their Applications*, ed. W. L. Wiese & P. J. Mohr, (Washington, DC: GPO) 1998, p. 65, online: <http://physics.nist.gov/Divisions/Div842/Icamdata/index.html>
27. W. Liu, D.J. Jeffery, & D.R. Schultz, “Ionization of Type Ia Supernovae: Electron Impact, Photon Impact, or Charge Transfer?,” *Astrophysical Journal*, 1998, 494, 812–815
26. W. Liu, D.J. Jeffery, D.R. Schultz, P. Quinet, J. Shaw, & M.S. Pindzola, “Emission from Cobalt in Type Ia Supernovae,” *Astrophysical Journal (Letters)*, 1997, 489, L141–L143
25. W. Liu, D.J. Jeffery, & D.R. Schultz, “Nebular Spectra of the Unusual Type Ia Supernova 1991T,” *Astrophysical Journal (Letters)*, 1997, 486, L35–L38
24. W. Liu, D.J. Jeffery, & D.R. Schultz, “Nebular Spectra of Type Ia Supernovae,” *Astrophysical Journal (Letters)*, 1997, 483, L107–L110
23. D.J. Jeffery, “An Expansion Opacity Formalism for the Sobolev Method,” *Astronomy and Astrophysics*, 1995, 299, 770–790
22. D.J. Jeffery, “The Sobolev Optical Depth for Time-Dependent Relativistic Systems,” *Astrophysical Journal*, 1995, 440, 810–814
21. D.J. Jeffery, R.P. Kirshner, P.M. Challis, C.S.J. Pun, A.V. Filippenko, T. Matheson, D. Branch, R.A. Chevalier, C. Fransson, N. Panagia, R.V. Wagoner, J.C. Wheeler, & A. Clocchiatti, “An *HST* Ultraviolet Spectrum of SN 1993J,” *Astrophysical Journal (Letters)*, 1994, 421, L27–L30

20. P. Ruiz-Lapuente, D.J. Jeffery, P.M. Challis, A.V. Filippenko, R.P. Kirshner, L.C. Ho, B.P. Schmidt, F. Sánchez, & R. Canal, “A Possible Low-Mass Type Ia Supernova,” *Nature*, 1993, 365, 728–730
19. P. Ruiz-Lapuente, D.J. Jeffery, P.M. Challis, & R. Canal, “Subluminous SNIa: Scenarios and Models” in *Proceedings of the 7th Workshop on Nuclear Astrophysics (Ringberg Castle, Tegernsee, Germany)*, ed. W. Hillebrandt & E. Müller (Garching: Max-Planck-Institut für Astrophysik), 1993, p. 12–17
18. D.J. Jeffery, “The Relativistic Sobolev Method Applied to Homologously Expanding Atmospheres,” *Astrophysical Journal*, 1993, 415, 734–749
17. R.P. Kirshner, D.J. Jeffery, B. Leibundgut, P.M. Challis, G. Sonneborn, M.M. Phillips, N.B. Suntzeff, R.C. Smith, P.F. Winkler, C. Winge, M. Hamuy, D.A. Hunter, K.C. Roth, J.C. Blades, D. Branch, R.A. Chevalier, C. Fransson, N. Panagia, R.V. Wagoner, J.C. Wheeler, & R.P. Harkness, “SN 1992A: Ultraviolet and Optical Studies Based on *HST*, *IUE*, and CTIO Observations,” *Astrophysical Journal*, 1993, 415, 589–615
16. B.P. Schmidt, R.P. Kirshner, R. Schild, B. Leibundgut, D.J. Jeffery, S. Willner, R. Peletier, A.I. Zabludoff, M.M. Phillips, N.B. Suntzeff, M. Hamuy, L.A. Wells, R.C. Smith, J.A. Baldwin, W.G. Weller, M. Navarette, L. Gonzalez, A.V. Filippenko, J.C. Shields, C.C. Steidel, S. Perlmutter, C. Pennypacker, C.K. Smith, A.C. Porter, T.A. Boroson, R. Stathakis, R. Cannon, J. Peters, E. Horine, K.C. Freeman, D.S. Womble, R.P.S. Stone, L.A. Marschall, A.C. Phillips, A. Saha, & H.E. Bond, “Photometric and Spectroscopic Observations of SN 1990E in NGC 1035: Observational Constraints for Models of Type II Supernovae,” *Astronomical Journal*, 1993, 105, 2236–2250
15. D.J. Jeffery, B. Leibundgut, R.P. Kirshner, S. Benetti, D. Branch, & G. Sonneborn, “Analysis of the Photospheric Epoch Spectra of Type Ia Supernovae SN 1990N and SN 1991T,” *Astrophysical Journal*, 1992, 397, 304–328
14. D.J. Jeffery, “Catalog of SN 1987A Polarimetry Corrected for Interstellar Polarization,” *Astrophysical Journal Supplement Series*, 1991, 77, 405–415
13. D.J. Jeffery, D. Branch, A.V. Filippenko, & K. Nomoto, “The Near Maximum-Light Spectrum of the Type Ic Supernova 1987M,” *Astrophysical Journal (Letters)*, 1991, 377, L89–L92
12. D.J. Jeffery, “Analysis of SN 1987A Polarimetry,” *Astrophysical Journal*, 1991, 375, 264–287
11. D.J. Jeffery, “Analysis of SN 1987A Polarimetry” in *ESO/EIPC Workshop: SN 1987A and other Supernovae*, ed. I. J. Danziger & K. Kjær (Garching: European Southern Observatory), 1991, p. 257–263
10. D. Branch, A.W.A. Pauldrach, J. Puls, D.J. Jeffery, & R.P. Kudritzki, “NLTE Modeling of a Type Ia Supernova at Maximum Light” in *ESO/EIPC Workshop: SN 1987A and other Supernovae*, ed. I. J. Danziger & K. Kjær (Garching: European Southern Observatory), 1991, p. 437–445
9. D.J. Jeffery, & D. Branch, “Analysis of Supernova Spectra” in *Jerusalem Winter School for Theoretical Physics*, Vol. 6, *Supernovae*, ed. J.C. Wheeler, T. Piran, & S. Weinberg (Singapore: World Scientific), 1990, p. 149–247
8. D.J. Jeffery, “The Sobolev-P Method. III. The Sobolev-P Method Generalized for Three-Dimensional Systems,” *Astrophysical Journal*, 1990, 352, 267–278
7. D.J. Jeffery, “The Sobolev-P Method: A Generalization of the Sobolev Method for

- the Treatment of the Polarization State of Radiation and the Polarizing Effect of Resonance Line Scattering,” *Astrophysical Journal Supplement Series*, 1989, 71, 951–981
6. D.J. Jeffery, “Astronomer’s Sonnet,” *Irish Astronomical Journal*, 1989, 19, 88
  5. D. Branch, W. Drucker, & D.J. Jeffery, “Differences Among Expansion Velocities of Type I Supernovae,” *Astrophysical Journal (Letters)*, 1988, 330, L117–L118
  4. D.J. Jeffery, “Supernova Polarization Spectra Calculated Using the Sobolev-H Method,” Ph.D. Thesis, McMaster University, 1988
  3. D.J. Jeffery, “The Polarization Spectrum of Supernova 1987a Interpreted in Terms of Shape Asymmetry,” *Nature* 1987, 329, 419–421
  2. D.J. Jeffery, & P.G. Sutherland, “Deflagration of White Dwarfs as a Model for Type I Supernovae” *Astrophysics and Space Science*, 1985, 109, 277–285
  1. D.J. Jeffery, “Deflagrating White Dwarf Models for Type I Supernovae,” M.Sc. Thesis, McMaster University, 1983

## **CURRENT RESEARCH INTERESTS AND PROGRAM AND RESEARCH PROJECTS FOR THE FUTURE AND FOR STUDENTS:**

The following subsections introduce my main research areas (§ 1), give my current research interests and program (§ 2), discuss projects for future research and for students (§ 3), and give a last word (§ 4).

### *1. Introduction*

My primary research interests are in the theoretical study of supernovae, particularly through radiative transfer analysis work, and in the development of radiative transfer techniques mainly to support the aforesaid analysis work. Since almost all that we know about supernovae (and all other extra-solar-system objects) must be determined from the electromagnetic radiation they emit, the importance of radiative transfer analysis and radiative transfer techniques is manifest.

A brief introduction to supernovae is that they are the powerful explosions of stars and are of considerable astrophysical importance. They are among the brightest astrophysical objects and, unlike most observable astrophysical objects, they evolve rapidly in time. The brightest type of supernovae, Type Ia (SNe Ia), are currently of great importance in the determination of the cosmological parameters. All types of supernovae eject into the interstellar medium heavy elements (carbon and above) synthesized in the explosion or from pre-explosion evolution. This element yield from supernovae drives most of the heavy element evolution of the universe. Rocky planets, like Earth, and life as we know it would probably not be possible without the heavy elements from supernovae. The impact of supernova ejecta, especially Type II supernova (SN II) ejecta, on the interstellar medium is also important in the creation and dispersal of star-forming regions. The physics of the explosions of all supernova types is of intrinsic interest and is also of interest in

understanding material properties under extreme conditions.

Since 2007, my research activity has been low due to heavy teaching loads and employment changes. This has caused more of my creative efforts to be expended on development of course materials. These efforts are detailed in my section **TEACHING EXPERIENCE AND INTERESTS**. However, I will comment here that I have devoted considerable time to developing online lectures (which are the equivalent of textbooks) for introductory astronomy,

<http://www.nhn.ou.edu/~jeffery/astro/astlec/lecture.html> ,

calculus-based introductory physics,

[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/introl/000.html](http://www.nhn.ou.edu/~jeffery/course/c_intro/introl/000.html) ,

and introductory quantum mechanics,

[http://www.nhn.ou.edu/~jeffery/course/c\\_quantum/qml/000.html](http://www.nhn.ou.edu/~jeffery/course/c_quantum/qml/000.html) .

The development of these lectures and perhaps others will continue. In these developments, projects for undergraduate students will arise.

## *2. Current Research Interests and Program*

A primary interest of mine is in the development of Monte Carlo radiative transfer methods. I have an idea for a novel method that I am calling cell Monte Carlo radiative transfer (CMC). My thinking and work on CMC is still very preliminary and has largely been in abeyance since 2007. So I can only give a sketch of CMC. I believe that CMC will have a speed-up that is a factor of several or more over standard Monte Carlo radiative transfer (standard MC). Other accelerated Monte Carlo radiative transfer methods exist: e.g., those of Fleck & Canfield (1984) and Densmore et al. (2007). But I believe that CMC will have the advantage of greater generality. I believe that it can be used in many radiative transfer cases: e.g., static, moving, time-independent, time-independent, those having complex 3-dimensional geometries, and those having complex velocity fields. It also seems to me that CMC should be relatively easy to implement in existing codes. Conceptually, CMC seems simpler to me than other accelerated Monte Carlo radiative transfer methods that I know of. Whether, CMC will be an effective radiative transfer technique or not requires further development of my ideas. Whether it is competitive or not in speed-ups with other accelerated Monte Carlo methods also remains to be seen.

The essence of CMC is to use standard MC to solve the radiative transfer in optically thick cells and then use the cell solutions and standard MC radiative in the optically thin cells to solve the radiative transfer for the whole atmosphere. The cell solutions involve calculating photon transmission probabilities and other quantities which are mostly needed for the thermal state solution. Because standard MC is used, CMC is a hybrid method like the method of Densmore et al. (2007). The complete self-consistent solution of radiative transfer and thermal state for all cells is obtained by a Lambda-iteration (e.g., Mihalas 1978, p. 147–150): radiative transfer and thermal state solutions are done in an alternating iteration in which each depends on the other until both solutions converge to unchanging state.

A second project is to complete a study of energy deposition estimators for Monte Carlo radiative transfer (Jeffery 2012). Work on this project was nearly complete in 2007 and just needs some finishing up.

A third project which I plan to undertake at some time is to write a review of the formalism of the Sobolev method of radiative transfer (e.g., Rybicki & Hummer 1978). The Sobolev method is a radiative transfer technique that can be used in moving atmospheres with steep velocity gradients. It is an approximate technique and some of its limitations are probably not eradicable in any useful way. But on the other hand, it is a simple technique to code, is quite accurate in some cases, and gives great insight into how radiative transfer events actual happen which is useful working with other radiative transfer methods. I have made contributions to Sobolev method technique (Jeffery 1988, 1989, 1990, 1993, 1995a, 1995b) and written a partial review of the formalism (Jeffery & Branch 1990) and believe I am well qualified to write a fuller review. It may be that no more significant extensions to the Sobolev method can be developed since other techniques (difference equation and Monte Carlo radiative transfer techniques) are probably already better for any extensions that can be imagined. On other hand, the Sobolev method is still very useful for certain applications. A review of general Sobolev method formalism may a good capstone for the history of its evolution.

I hope to make progress on my current projects in the summer of 2012.

### 3. *Research Projects for the Future and for Students*

I believe my intended future research program has many projects for undergraduate and graduate students. First, I intend to continue working on Monte Carlo radiative transfer. Because of its great flexibility, potential for high physical realism, relatively simple coding, and high parallelizability, Monte Carlo radiative transfer is likely to become more and more important in astrophysical radiative transfer and, perhaps, become the dominant technique for multi-dimensional radiative transfer. Much of my work will be in the development of Monte Carlo radiative transfer techniques (e.g., the above-mentioned CMC). Other works will consist of parameterized analyses of spectrum formation and of supernova spectra.

I do not at present envisage developing a large code for detailed state-of-art radiative transfer. Already existing codes such as difference-equation code PHOENIX (Hauschildt & Baron 1999, and references therein; Baron & Hauschildt 2004, and references therein) and the Monte Carlo code SEDONA (Kasen et al. 2006) have too great a lead to be challenged by me even with significant student assistance. I envisage developing small codes that can be used to test new Monte Carlo techniques and investigate particular problems in radiative transfer.

Students could help in the development of Monte Carlo codes and in the analysis projects taking the lead in particular projects as appropriate.

A second project is to develop a new Sobolev radiative transfer code that to support the Sobolev method review discussed above (see the above subsection *Current Research Interests and Program*). The code would provide demonstration calculations for a wide range of cases where the Sobolev method can be applied. The Sobolev code that I developed myself and used in past work (e.g., Jeffery et al. 1992; Kirshner et al. 1993) is designed only

for supernovae in the photospheric epoch and is too inflexible and kludgy to generalize. The new Sobolev code I envisage would be useful for many kinds of moving atmospheres including the nebular epoch of supernovae and asymmetric atmospheres. The code will be written from scratch in fortran 95 (or a more advanced fortran version) and would be available for public distribution.

I believe that there are many projects for students in the development and use of the new Sobolev method code: e.g., writing subroutines, validating the code, running example calculations, and, perhaps, taking the lead in writing the code.

Aside from original research, I also have an educational projects in which student participation would be useful. Student could help the continuing development of the online lectures I am working on (see above subsection *Introduction* and on developing another set of lectures on the the history of cosmology (see **TEACHING EXPERIENCE AND INTERESTS**, subsection *History of Astronomy/Cosmology* below). Student participation could include finding or creating images, researching aspects, and writing text, questions, and classroom activities.

My basic research needs would be for a UNIX workstation for myself, suitable computing resources for students, and computer systems support. Access to and assistance in using high performance, parallel-processor computing for myself and students would be considerable boon to my plans for Monte Carlo radiative transfer research.

The research plans outlined above would greatly benefit from undergraduate and graduate student participation. I foresee many projects and sub-projects for students. In particular, since Monte Carlo codes have wide applications in astrophysics and other areas, student experience developing and using such codes should be very valuable. Many human hours of study and work, and much creativity are needed. I expect students to produce papers and theses. Since there are a range of research tasks from elementary (but educational) to advanced, students of all levels could take a role in those tasks and their rewards.

#### 4. *Last Word*

My long term plan is to continue working on supernovae, related astrophysical objects, and radiative transfer. I should add, however, that I am interested in broadening my research into other areas of astrophysics and science and in beginning new collaborations.

### **RESEARCH EXPERIENCE:**

I obtained my M.Sc. and Ph.D. degrees in theoretical astrophysics under the supervision of Peter G. Sutherland at McMaster University in the period 1981–1988. My M.Sc. thesis (Jeffery 1983) was on deflagrating white dwarfs as models for Type Ia supernovae (SNe Ia). (Supernovae [SNe] comes in types Ia, Ib, Ic, Ic hypernova, and II.) Parameterized one-dimensional hydrodynamic calculations were done of deflagration wave propagation. The results were published in the paper of Jeffery & Sutherland (1985).

For my Ph.D. thesis (Jeffery 1988), I developed a procedure for analyzing polarimetric data obtained from supernovae. This procedure was specifically intended to be used for the

study of supernova asymmetry. The novel ingredient in the analysis procedure is the use of the Sobolev-P method. The Sobolev-P method is a generalization of the Sobolev method of radiative transfer that I developed in order to treat polarized radiative transfer in both lines and continuum. The Sobolev-P method has been developed for general axisymmetric systems (Jeffery 1989) and for three-dimensional systems (Jeffery 1990). I have done several analyses of the SN 1987A polarimetric data using the Sobolev-P method (Jeffery 1987, 1988, 1989, 1991a, 1991b). As an aid for further analyses, I prepared a catalog of the SN 1987A polarimetric data corrected for interstellar polarization (Jeffery 1991c). The Sobolev-P method is now probably outdated by Monte Carlo polarized radiative transfer, but it was useful in the time it was developed.

While working at the University of Oklahoma in the period 1988–1991, at first as a postdoctoral research associate with David Branch and later in other capacities, I participated in several collaborative projects. David Branch, W. Drucker, and I wrote a small paper analyzing the Si II line velocities of SNe Ia (Branch, Drucker, & Jeffery 1988). David Branch and I wrote a paper on supernova spectrum analysis technique (using Sobolev method radiative transfer) that includes an analysis of the optical spectra of SN 1987A (Jeffery & Branch 1990). I participated in a collaboration headed by R.P. Kudritzki of the Institut für Astronomie und Astrophysik of the University of Munich and David Branch that applied NLTE radiative transfer techniques developed in Munich to the study of SNe Ia (Branch et al. 1991). For the period from 1988 September to 1989 July, I was a visiting researcher at University of Munich, where I developed a software package for updating the large files of atomic data needed for NLTE calculations. David Branch and I also collaborated with A.V. Filippenko and K. Nomoto on an analysis of a spectrum of SN 1987M, a Type Ic supernova (Jeffery et al. 1991).

From 1991 June to 1993 August, I was a postdoctoral research associate at the Harvard-Smithsonian Center for Astrophysics with Prof. R.P. Kirshner. There I primarily worked on parameterized LTE analyses of supernova spectra (Jeffery et al. 1992, 1994; Kirshner et al. 1993). I also collaborated on the NLTE analysis of the nebular spectra of the peculiar SN Ia SN 1991bg (Ruiz-Lapuente et al. 1993) and applied the relativistic Sobolev method of Hutsemékers & Surdej (1990) to homologously expanding atmospheres which include supernova atmospheres (Jeffery 1993).

In the period 1993 September to 1994 April, I was a visiting researcher with Peter G. Sutherland at McMaster University. While there I worked principally on radiative transfer techniques. The major project was to develop an expansion opacity formalism for Sobolev method calculations (Jeffery 1995b). The second project was to improve the relativistic Sobolev method by including time-dependent effects in the optical depth formula (Jeffery 1995a). These projects were undertaken to improve supernova spectrum calculations, but the results should have a wider application in astrophysical radiative transfer.

From 1994 April to 1995 June, I held a fellowship from the Spanish Ministerio de Educación y Ciencia in the Dept. d'Astronomia i Meteorologia of the University of Barcelona. While in Barcelona, I completed the two projects I had begun at McMaster University.

From 1995 August to 1996 August, I was a visiting assistant professor of astronomy at

Vanderbilt University. While there, I taught a history of astronomy course (in fall, spring, and summer semesters), worked on a set of written lectures on the history of astronomy, and aided one of the graduate students on a project to calculate the polarized emission from the dusty environment around young stellar objects using a Monte Carlo code.

From 1996 October to 1998 July, I was a postdoctoral research associate at Oak Ridge National Laboratory (ORNL) where I was part of the ORNL Program in Atomic and Molecular Astrophysics. In the first year of this appointment, I worked primarily on the analysis of nebular SN Ia spectra in collaboration with Weihong Liu and my supervisor David Schultz (director of the Controlled Fusion Atomic Data Center and group leader of Atomic Physics Theory). The work was published in the papers of Liu et al. (1997a,b,c, 1998). In this work we attempted to use the then best available evaluated atomic data. Sub-Chandrasekhar mass white dwarf explosion models for SNe Ia were favored by our analysis. Currently, Chandrasekhar mass white dwarf explosion models are strongly favored. In the second year of my appointment, I developed a simple  $\gamma$ -ray transport procedure for supernovae (Jeffery 1998a,b). I also worked on relativistic radiative transfer theory and a catalog of SN Ia spectra. The first of these projects was never completed. The second eventually evolved into my supernova spectrum database SUSPEND:

<http://www.nhn.ou.edu/~jeffery/astro/sne/spectra/spectra.html> .

Further development of SUSPEND was undertaken at the University of Oklahoma in 2005–2007 (see below).

In the period 1998 August to 1999 June, I was a visiting assistant professor in the physics department of the University of Nevada, Las Vegas. While there, I completed an unpublished paper presenting in detail a simple analytical theory of radioactive decay energy deposition and its connection to the exponential/quasi-exponential behavior of late-time supernova light curves (Jeffery 1999). The theory is not original to me—it had been known to the experts in the field for 20 or so years. But being not aware of any detailed presentation anywhere, I thought it useful to provide one. The paper has turned out to be modestly useful and has collected 15 citations through 2010.

From 1999 August to 2000 May, I was a visiting assistant professor in the Department of Physics & Astronomy of Middle Tennessee State University in Murfreesboro. While there I collaborated on a paper giving a simple theory of line formation in a supernova atmosphere illuminated from above by radiation from circumstellar interaction (Branch et al. 2000).

After a year as visiting professor in the Department of Physics at the Idaho State University (2000 August–2001 May) (where no research work was done), I spent a month as a visitor at the University of Oklahoma in the summer of 2001 (June 17–July 14). There I began work on a bipolar jet model for supernova polarization and was a minor collaborator on the analysis of SN Ib spectra (Branch et al. 2002) and on a paper on the analytic inversion of supernova lines in the Sobolev approximation (Kasen et al. 2002).

In the 2001 fall, I became a visiting assistant professor in the Physics Department of New Mexico Tech (NMT) in Socorro, New Mexico. At this institution I collaborated on a review paper on supernova spectra (Branch et al. 2003) and continued to develop the bipolar jet model. The bipolar jet model in a limited sense was used in the analysis of

the peculiar SN Ic hypernova SN 2002ap (Kawabata, Jeffery et al. 2002, 2003b). I helped out on the analysis of spectra and spectropolarimetry of SN Ic hypernova SN 2003dh (Kawabata et al. 2003a) which was an extremely important supernova in that established unequivocally the connection of gamma-ray bursts and supernovae (e.g., Matheson et al. 2003). Also, at NMT I worked on started working on Monte Carlo radiative transfer.

From 2003 August to 2004 May, I was a visiting assistant professor at University of Nevada, Las Vegas for the second time. While there I continued to work on the bipolar jet model and completed an unpublished paper on it (Jeffery 2004). I had no money for page charges, and so the paper was never submitted to a journal. The bipolar jet model has not attracted much interest: there has been only one citation through 2010. I also aided on the analysis of the peculiar SN Ia SN 2002ic which showed an interaction with a hydrogen-rich wind (Deng et al. 2004).

From 2004 August to 2005 May, I was a lecturer in physics and astronomy at Washburn University in Topeka, Kansas. My teaching duties and the further development of my online lectures on introductory astronomy (see the section **TEACHING EXPERIENCE AND INTERESTS**, subsection *Introductory Astronomy*) precluded any significant research during my time at Washburn.

For the period 2005 August to 2007 May, I was at the University of Oklahoma (OU) working as postdoctoral research associate with Professors Eddie Baron and David Branch. During this time I worked on various projects. The main projects in which I took the lead were the development of Monte Carlo radiative transfer techniques, of local normalization and DIFF techniques, and of my supernova spectrum database SUSPEND

(see <http://www.nhn.ou.edu/~jeffery/astro/sne/spectra/spectra.html>)

and a project on the analysis of the peculiar SN Ia SN 2003fg.

The main Monte Carlo work was the development of an accelerated Monte Carlo radiative transfer method that I called giant steps. Giant steps was being developed in collaboration with Paolo Mazzali and Eddie Baron (Jeffery & Mazzali 2007). The giant steps work was interrupted by learning that a similar accelerated Monte Carlo method had been developed long ago by Fleck & Canfield (1984). The method of Fleck & Canfield seems to have been relatively unknown in astrophysical radiative transfer until circa 2009 (e.g., Min et al. 2009). Whether giant steps will ever be further developed depends on whether it offers some advantage over the method of Fleck & Canfield. In fact, even before learning of the method of Fleck & Canfield, I had already grown dissatisfied with giant steps. It seemed that there is no useful way to generalize it beyond static atmospheres. Since my own radiative transfer interests are in moving atmospheres, this limitation is severe for me. I have turned my attention to a new idea cell Monte Carlo (CMC) which is discussed in the section **CURRENT RESEARCH INTERESTS AND PROGRAM** (subsection *Current Research Interests and Program*) above.

Other Monte Carlo work was on energy deposition estimators in Monte Carlo radiative transfer (jeffery 2012) and, in collaboration with Eddie Baron, on the solution of the NLTE rate equations using a Monte Carlo method. The later project turned out to be rather unprofitable and may never be completed.

The work on local normalization, DIFF techniques, and SUSPEND was intended

to lead to a statistical study of supernova spectra both observed and synthetic. The local normalization procedure essentially removes the continuum behavior by flattening the spectra. The DIFF techniques are goodness-of-fit tests for comparing locally normalized spectra. This work is reported on by Jeffery et al. (2007). A DIFF package containing programs for local normalization and the DIFF was under development, but perhaps will not be completed. The original and locally normalized spectra for many well observed SNe Ia and hydrogen-deficient supernovae (SNe I Ib, Ib, Ic, and Ic hypernova) have been archived in SUSPEND. These spectra will be useful in my own continuing research work.

The analysis of the peculiar SN Ia SN 2003fg is reported in Jeffery, Branch, & Baron (2006). This SN Ia, first observed and analyzed by Howell et al. (2006), was the intrinsically brightest SN Ia observed up to that time and was probably the most massive up to that time as well. (Brighter and more massive ones not recognized as such with confidence may have been observed before, of course.) The analysis done by Jeffery et al. confirmed the result of Howell et al. that it was probably the most massive SN Ia observed at that time and that its mass may have been about 2 solar masses. Most SNe Ia probably have masses of about 1.4 solar masses which is called the Chandrasekhar mass: larger SNe Ia are super-Chandrasekhar. SN 2003fg was first SN Ia with strong evidence that it was super-Chandrasekhar. The large mass of SN 2003fg is a challenge to the modeling of SN Ia progenitors and explosions. It may be that SN 2003fg will be a key to understanding SNe Ia. On the other hand, it may be just an extremely odd SN Ia with few implications for SN Ia studies. Further work will have to tell. The paper of Jeffery et al. was eventually rejected for publication, but the authors believe that there is nothing wrong with the paper. It is a paper whose major interest lies in its details rather than its conclusions. It has been cited for details by later papers (e.g., Maeda & Iwamoto 2009; Scalzo et al. 2010) and cited 9 times in refereed papers through 2011.

While at OU, I also helped out with projects with David Branch on supernova spectrum analysis (Branch et al. 2006a,b, 2007a,b, 2008; Parrent 2007) using the code SYNOW (e.g., Fisher 2000; Branch et al. 2005). With Eddie Baron, I have helped out on a paper (Baron et al. 2008) that reports synthetic spectra for a three-dimensional SN Ia explosion model calculated by Eduardo Bravo and Domingo García-Senz. The radiative transfer calculations (which were done by Eddie Baron) were done using PHOENIX

(see <http://www.hs.uni-hamburg.de/EN/For/ThA/phoenix/index.html>)

developed by Peter Hauschildt et al. (e.g., Hauschildt & Baron 1999, and references therein; Baron & Hauschildt 2004, and references therein). PHOENIX is a state-of-the-art non-local-thermodynamic-equilibrium (NLTE) code. I also helped out on papers with M. Parthasarathy: one on SN 1987A (Parthasarathy et al. 2006) and another a review of possible SN Ia progenitors (Parthasarathy et al. 2007).

In the period 2007 August to 2010 June, I was at the University of Idaho in a senior instructor position. My teaching duties (5 and 1/3 courses per academic year and summer courses and summer labs) and course development projects slowed research work to a crawl. However, I did continue thinking about CMC (see above) as time allowed.

From 2010 August to 2011 May, I was an instructor in the Department of Physics & Astronomy of Northern Arizona University. I had little time to devote to research while

there. I was a coauthor of Wang et al. (2012) to which I made some editorial and very minor content contributions.

From 2011 August to 2012 May, I am a visiting assistant professor in the Physics Department of the University of Evansville. While here I have little time for research. My only effort so far was reviewing again the paper by Wang et al. (2012) just before submission to the *Astrophysical Journal*.

## TEACHING EXPERIENCE AND INTERESTS:

In the following subsections, I detail my teaching history (subsection 1), describe my online setup for courses and online courseware (subsection 2), and then give short outlines of my past approaches and/or goals for some of the courses I have taught (subsection 3 on). The outlines are for conceptual physics, energy in physics and society, history of astronomy/cosmology, introductory astronomy, introductory physics, mathematical physics, modern physics, and quantum mechanics. For a complete listing of the courses I have taught and when and where I taught them, see my section **COURSES TAUGHT** above.

I should state here that I am interested in teaching a broad range of introductory and undergraduate courses. Courses of particular interest to me are introductory physics, introductory astronomy, history of astronomy/cosmology, energy and society, mathematical physics, computational physics, thermodynamics and statistical mechanics, hydrodynamics, modern physics, and quantum mechanics. I am already experienced in teaching some of these courses: see following subsections and the section **COURSES TAUGHT** above. At the more advanced or graduate level, I would like to teach courses in stellar structure, stellar atmospheres and radiative transfer, and supernovae.

I should point out that although I have considerable experience from my teaching assistant years and my time at Middle Tennessee University, University of Idaho, and Northern Arizona University in teaching elementary physics laboratories, I have no experience with undergraduate astronomy laboratories nor with small telescopes. I am, however, interested in acquiring astronomy laboratory expertise and in instructing courses with astronomy laboratories.

### 1. *Teaching History*

I was employed for eight years (1979–1987) as a teaching assistant at McMaster University. During this employment, I demonstrated first year undergraduate physics laboratories for some years and for some years marked undergraduate physics courses in quantum mechanics and introductory astronomy for science students. For one semester (1991 spring), I was a visiting instructor at the University of Oklahoma, where I taught the introductory physics calculus-based course in electricity, magnetism, and optics, and also led a honors college recitation group for the introductory physics calculus-based course in mechanics. During the spring semester of 1993, I was a co-instructor (with William Press and Abraham Loeb) at Harvard University for a course in introductory astronomy for non-science students.

At Vanderbilt University (1995–1996), I taught a one-semester history of astronomy course for general undergraduate students during the fall, spring, and summer semesters. The history of astronomy course was one of a special set of courses in Vanderbilt's Arts and Science College called Science and the World Courses. All Arts and Science undergraduate students were required to take one such course at some time in their undergraduate years. The course as I taught it covered the essentials of naked-eye astronomy, prehistoric astronomy, ancient Mesopotamian astronomy, Greek astronomy, Islamic astronomy, and astronomy from the Renaissance to modern times. The emphasis was on theories, the role of the scientific method, and connections of astronomy to other sciences and society. For further information about this course, see below subsection *History of Astronomy/Cosmology*.

While at Vanderbilt, I was also instructor in the 1995 fall semester for the undergraduate seminar course in astrophysics (a one-credit-hour course) and in the 1996 spring semester for a special topics three-credit-hour course for graduate students in astrophysical radiative transfer. I also participated in the Vanderbilt Dyer Observatory public nights which were held monthly. I recall giving at least one public talk.

In the period 1998–1999, I taught a course in introductory astronomy focused on the solar system at the University of Nevada, Las Vegas (UNLV). This course was an elective for non-science students and counted as a science course for fulfilling the UNLV undergraduate general education core requirements. I taught two sections per semester with over 200 students in the 1998 fall semester and over 150 in the 1999 spring semester. In 1999 spring, John Kilburg (the UNLV physics computer staff person) and I developed an online home work procedure with automated marking. This tool is now, of course, out-of-date.

From 1999 August to 2000 July, I taught at Middle Tennessee State University (MTSU) in Murfreesboro, Tennessee. In the fall, spring, and summer semesters, I taught the introductory physics algebra-based course in mechanics and thermodynamics: two sections in fall and spring; one section in summer. This course was a three-credit-hour course. The course was taught according to a group-learning, problems-laboratory syllabus created by MTSU professor Victor Montemayor. All MTSU first-semester introductory algebra-based physics courses were taught using this syllabus at that time. The students in the course studied lecture material individually from an website (created by Prof. Montemayor):

<http://www.mtsu.edu/~phys2010/> .

They reported to a classroom/laboratory twice a week for 2.5 hours where they worked through problems on computer spreadsheets and completed laboratory exercises in groups. They were graded on the laboratory reports, quizzes, two experimental group projects, three in-class tests, and a comprehensive final.

Also at MTSU, I taught two sections in the 1999 fall semester of the introductory physics algebra-based laboratory course in electrical circuits, optics, and radiation. This was a one-credit-hour course.

In 2000 spring, I taught a triple section of a general physical science course to introduce non-science students to physics, chemistry, astronomy, and geology. This was a four-credit-

hour course. The course included a weekly two-hour laboratory. There were 12 labs in total: they included both physics and chemistry labs. I taught two sections of the laboratory part of the course.

In 2000 fall, I went to Idaho State University in Pocatello, Idaho as a visiting professor. I taught 3 courses in the 2000 fall semester: second semester introductory physics calculus-based (engineering physics), second semester undergraduate quantum mechanics, and first semester graduate quantum mechanics. In the 2001 spring semester, I taught the first semester introductory physics calculus-based (engineering physics), first semester undergraduate quantum mechanics, and the colloquium in physics course for senior and graduate students.

In period 2001 August to 2003 May, I was at New Mexico Tech in Socorro, New Mexico as a visiting professor. In the 2001 fall semester, I taught first semester introductory physics calculus-based and graduate classical mechanics. For the graduate class, Goldstein's *Classical Mechanics*, 3rd Edition was used. Although a classic text, I feel that Goldstein (even its revised 3rd edition) is probably not the best that can be done for modern students. A computationally oriented course, perhaps using the Sussman and Wisdom book (*Structure and Interpretation of Classical Mechanics*, 2001), would I believe introduce students to advanced concepts and at the same time allow a greater connection to application. I also have come to feel that physics students today do not get enough computational experience.

In 2002 spring, I taught introductory quantum mechanics for 3rd year students and the 4th year astrophysics course. The latter has no set material, and so I taught astrophysical radiative transfer which is my specialty. In this course I introduced some computational exercises and added a journal club feature. In 2002 summer, I taught second semester introductory physics calculus-based and also the physics part of a survey of science course for Tech's masters degree in science teaching: a degree for K-1-12 teachers.

In 2002 fall, I again taught first semester introductory physics calculus-based and first semester graduate quantum mechanics. For the latter course, I chose Walter A. Harrison's *Applied Quantum Mechanics* as the course text. Although a good book in certain respects, I found it too sketchy on formalism for physics students. In 2003 spring, I taught second semester graduate quantum mechanics using *Lectures on Quantum Mechanics* by Gordon Baym. For the graduate quantum mechanics courses, I also added a journal club feature. I feel it is important for graduate students to look at the current literature in any course that they are taking.

From 2003 August to 2004 May, I was back at University of Nevada, Las Vegas (UNLV) teaching the introductory astronomy course on the solar system that I taught there in 1998-1999.

From 2004 August to 2005 May, I was at Washburn University where I taught introductory astronomy courses on the solar system and on stars and galaxies, and a course in physical sciences (with Sue Salem) in the 2004 fall and 2005 spring semesters. For the physical sciences course, I taught the physics and astronomy parts and Sue Salem taught the chemistry part. Also at Washburn, I served as the Physics Department's representative on the University Library Committee: the committee members report on library activity to the departments and direct book orders from the department to the library collection

personnel.

From 2005 August to 2007 July, I was at the University of Oklahoma (OU) in a non-teaching postdoctoral position. I did, however, interact with undergraduate students who were working on projects with my supervisors David Branch and Eddie Baron and who were coauthors on some of the papers of these projects (Branch et al. 2006b, 2007a,b, 2008; Parrent 2007). I also gave several talks to the supernova research group which includes all the undergraduates working with David Branch and Eddie Baron. As an example, the following is the online version of the talk I gave on my experiences interviewing for a job at the University of Texas Pan-American:

[http://www.nhn.ou.edu/~jeffery/aalib/057\\_panam/panam.html](http://www.nhn.ou.edu/~jeffery/aalib/057_panam/panam.html) .

From 2007 August to 2010 June, I was at the University of Idaho (UI) in Moscow, Idaho. For 2007–2008 as a temporary lecturer and after as a senior instructor. At UI, I taught introductory physics both algebra-based and calculus-based (for large sections), mathematical physics, modern physics, undergraduate quantum mechanics, introductory astronomy, and a special topics course in classical mechanics and quantum mechanics. I also taught one of the three modules of the core science course *The Physics of Everyday Life*. My module was entitled *Energy in Physics and Society*. Some details of these courses are given in the subsections below.

In addition to my teaching duties, I served on the UI physics department recruitment and retention committee (2008 fall) and the UI parking committee (2009 August to 2010 June).

From 2010 August to 2011 May, I worked as an instructor in the Department of Physics and Astronomy at Northern Arizona University (NAU). In 2010 fall, I taught introductory astronomy to a large section of 180 students, mathematical physics, and a calculus-based, 1-credit-hour laboratory course on electricity and magnetism. I also taught a section of an algebra-based laboratory module on electricity and magnetism and supervised the 4 other sections taught by TAs. These labs were part of an algebra-based course on electricity and magnetism of which I was not the instructor. In 2011 spring, I taught introductory astronomy again, a graduate course in quantum mechanics (though the material is essentially that of second semester undergraduate quantum mechanics), and the calculus-based, 1-credit-hour laboratory course on electricity and magnetism again. I also supervised the teaching assistants for several sections of the algebra-based laboratory module on electricity and magnetism.

In addition to my teaching duties at NAU, I was one of the faculty advisors for the NAU chapter of the Society of Physics Students (SPS). The other advisor was William Delinger. Acting as an advisor was not very difficult since the NAU SPS students were self-starters. However, I did attend SPS meetings and keep myself up to date with their activities and gave a talk to them on my life in astronomy.

From 2011 August to 2012 May, I am a visiting assistant professor in the Physics Department of the University of Evansville. In 2011 fall, I taught introductory astronomy and conceptual physics and was lab instructor for 3 sections of introductory physics labs. In 2012 spring, I am teaching 2 sections of first-semester, calculus-based introductory physics and am the instructor for 3 sections of introductory physics labs. I am also acting as the

advisor for student, Ryan Darwish, doing an individual study project. The product of this project is expected to be written and oral reports evaluating the current state of the foundations of quantum mechanics.

## 2. *Online Setup for Courses and Online Courseware*

Webpages for the courses I have or am teaching are linked from URL

<http://www.nhn.ou.edu/~jeffery/#Courses> .

The course webpages either are or are linked to the course syllabi. From the webpages, students can access the course schedule (if one exists), their marks (listed at their request only and only by confidential aliases, but not when university policy forbids), and, in some cases, homeworks and answers to past homeworks and exams. The course webpages are usually only updated when I am teaching or preparing to teach a course.

For many courses I have taught, I have developed problem books: some quite complete and others very incomplete. When sufficiently developed, the problem books are available to other instructors on request in electronic book form as free courseware. Currently, I have problem books for classical mechanics at the Goldstein level, conceptual physics, energy in physics and society, history of astronomy/cosmology (not yet ready for online access), introductory astronomy for non-science students, introductory physics, mathematical physics, modern physics, and quantum mechanics. Most of these problem books can be downloaded in pdf format at URL

<http://www.nhn.ou.edu/~jeffery/#Courses> .

Only the introductory physics problem book is really sufficient for a full course at present. All the problems have complete solutions, but solutions are not available in the online problem books.

## 3. *Conceptual Physics*

Conceptual physics is a course for non-science students. A large realm of physics is covered, but with relatively low mathematics content. I have taught this course once (University of Evansville, 2011 fall). On that occasion I used the well known textbook *Conceptual Physics* by Paul G. Hewitt. It is an excellent book and I will probably use it again. However, eventually I intend to replace the textbook with online lectures similar to those that I have developed for introductory astronomy (see below subsection *Introductory Astronomy*). I have developed a problem book for conceptual physics that will accompany the online lectures: see

[http://www.nhn.ou.edu/~jeffery/course/c\\_concep/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_concep/problem.pdf) .

The problem is not extensive enough at present for an entire conceptual physics course.

## 4. *Energy in Physics and Society*

The *Energy in Physics and Society* course module (taught 2009 fall, 2008 fall, 2007 fall) is one of three modules making up the course *The Physics of Everyday Life* taught at the University of Idaho. This course is aimed at non-science students and is one of the

University of Idaho's core science courses. For the course, I rely heavily on other sources including Wikipedia articles and *Energy at the Crossroads* by Vaclav Smil. I have prepared online lectures for this module which are at URL

[http://www.nhn.ou.edu/~jeffery/course/c\\_energy/energy.html](http://www.nhn.ou.edu/~jeffery/course/c_energy/energy.html) .

These lectures are still in development. An example of a useful, but not finalized, online lecture is

[http://www.nhn.ou.edu/~jeffery/course/c\\_energy/energy1/world\\_en.html](http://www.nhn.ou.edu/~jeffery/course/c_energy/energy1/world_en.html)

which is on world energy resources and consumption. The problem book for the module is at

[http://www.nhn.ou.edu/~jeffery/course/c\\_energy/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_energy/problem.pdf) .

I would very much like to expand the *Energy in Physics and Society* module into an entire course for non-science students on energy and society. This course would introduce the physics notion of energy and some formulae and then would go into society's uses and needs for energy and the world's energy problems. Such a course would be I think immensely relevant and interesting for students.

I would also like to develop more advanced courses on commercial energy that would be of interest to science, engineering, economics, and society policy students. An example textbook for such a course would be Gilbert Masters's *Renewable and Efficient Electric Power Systems*.

##### 5. *History of Astronomy/Cosmology*

At Vanderbilt University (1995–1996), I taught a one-semester history of astronomy course for general undergraduate students during the fall, spring, and summer semesters.

As mentioned above in the subsection *Teaching History*, the course as I taught it covered the essentials of naked-eye astronomy, prehistoric astronomy, ancient Mesopotamian astronomy, Greek astronomy, Islamic astronomy, and astronomy from the Renaissance to modern times. The emphasis was on theories, the role of the scientific method, and connections of astronomy to other sciences and society.

As a resource for a history of astronomy course, I was developing a manuscript, *Lectures on the History of Astronomy*, in the form of T<sub>E</sub>X files which reached about 30% completion.

I have now a decreased interest in developing a pure history of astronomy course. A pure history of astronomy course for non-science students involves some topics that I think would be of little interest to them. Also a one-semester course is too short to do all of astronomy from prehistory to today, except in a rather superficial way.

I would now prefer to develop a history of cosmology course. A one-semester course focusing on this narrower topic can adequately cover from the beginning of scientific cosmology to today I believe. Also and most importantly, cosmology is one of the two most interesting fields of astronomy both for laymen and professionals. The other most interesting field is the search for extraterrestrial life and intelligence.

My history of cosmology course as I envision it would be on philosophical and

scientific cosmologies. Mythical cosmologies would only briefly be mentioned. The course breaks naturally into two parts: from the Greek Pre-Socratic philosophers to just before Newton and from Newton until today. The first part I believe I am already sufficiently knowledgeable on for a 1.0 version. The second part would take some more learning on my part.

For my online introductory astronomy lectures (see below subsection *Introductory Astronomy*), I have developed a lecture on the history of astronomy to Galileo: see URL

<http://www.nhn.ou.edu/~jeffery/astro/astlec/lec004.html> .

This lecture is the seed from which I would develop a history of cosmology course. I would also cannibalize the incomplete manuscript *Lectures on the History of Astronomy* that I began developing at Vanderbilt University.

Wikipedia is a great resource for developing a history of cosmology course. It has useful articles that can be used as first sources and more importantly a vast store of images. A history of cosmology course for non-science students must depend heavily on images for classroom lectures.

I am interested in involving undergraduates as assistants in developing the history of cosmology course. They could help developing the resource base and understanding base needed to complete the course. They could also help by creating diagrams and images.

## 6. *Introductory Astronomy*

I have taught introductory astronomy courses several times. The courses included solar system courses, stars and galaxies courses, and all-astronomy courses. I did this teaching at the University of Nevada, Las Vegas, Washburn University, the University of Idaho, and Northern Arizona University.

My webpage for the introductory astronomy course is

[http://www.nhn.ou.edu/~jeffery/course/c\\_astint/ast.html](http://www.nhn.ou.edu/~jeffery/course/c_astint/ast.html)

and my problem book for the course is at

[http://www.nhn.ou.edu/~jeffery/course/c\\_astint/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_astint/problem.pdf) .

For introductory astronomy courses, I have been developing a set of online lectures that are used as a lecturing tool and for individual study by students. This project began at the University of Nevada, Las Vegas in 2003 and has continued to the present. The lectures obviate the need for students to take notes or buy a textbook since lectures are the course notes and textbook. Making the lectures the lecturing tool, course notes, and course textbook unifies the source material for the class. The lectures are also my own complete notes for the class. Many spectacular and informative astronomical images are integrated into the lectures and are updated as needed. The lecture site is

<http://www.nhn.ou.edu/~jeffery/astro/astlec/lecture.html> .

The online lectures are actually projected on a screen to large lecture sections. The lectures do form a complete narrative, but absolutely, positively they are **NOT** read in class. I concentrate on explaining images and graphs and occasionally tables. Often I

will stop on keywords to explain something. Questions for the class to answer by vote are inserted the text. Typically, I just scroll through much of the narrative, paraphrasing and simplifying it in my lecturing. The students quickly adjust to not reading most of the words on the screen. The complete narrative is there for their private study. Since the lectures are given in a darkened room in order to see the images, student notetaking is not easily done and is not needed since, as mentioned above, the online lectures are the course notes.

I find the online lectures work well. The defects of the large lecture format are still present. Student attention can fatigue and concepts forgotten quickly. But the students have complete web access to the online lectures, and so can make up anything missed. In long 75-minute lectures, I typically take a break from lecturing and give the students some participatory exercise for a few minutes while I wander the classroom interacting with them.

I should note that the online lectures were developed to suit my own lecturing style which in turn has been modified to suit the online lectures. It is not known that any other instructors would care to adopt the online lectures. However, I have given blanket permission for use for non-commercial and/or educational purposes of all of the online lectures material.

The solar system lectures are about 90% complete and the star and galaxies lectures are about 70% complete. Even uncomplete they are adequate for all the intro astronomy courses that I teach. The online lectures require continual updating, of course. Examples of fairly well-developed online lectures are *The Earth* which can be viewed at

<http://www.nhn.ou.edu/~jeffery/astro/astlec/lec011.html>

and *Cosmology* which can be viewed at

<http://www.nhn.ou.edu/~jeffery/astro/astlec/lec031.html> .

The images for the online lectures not of my own creation are public domain or drawn from sources that permit educational use with credit: e.g., NASA, the National Optical Astronomical Observatories, and Wikipedia.

### 7. *Introductory Physics*

I have taught introductory physics courses many times. The courses included both calculus-based and algebra-based courses.

My webpage for the introductory physics calculus-based course is

[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/intrc.html](http://www.nhn.ou.edu/~jeffery/course/c_intro/intrc.html)

and for the introductory physics algebra-based course is

[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/intra.html](http://www.nhn.ou.edu/~jeffery/course/c_intro/intra.html) .

My problem book for introductory physics is at

[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_intro/problem.pdf) .

I am moving in the direction of activity-based introductory physics courses. There

is a lot of evidence that the activity-based method is the superior teaching method. A full activity-based course integrates lectures, demonstrations, private work, group work, and laboratories. Such a full activity-based course is more than an individual instructor can develop. It takes the collective agreement and effort of a department. Probably, it can never be fully implemented for very large sections consisting of a hundred or more students. But I am doing what I can by myself.

I made a first attempt at a partial activity-based course in 2010 spring at the University of Idaho. The course as implemented has to rank as a qualified failure. Student achievement went up modestly as measured by examinations, but student evaluations of me and the course were low. I will not be repeating many features of the 2010 spring course.

What I envision for future intro physics courses is a mixture of group work and lecturing in class with a lot encouragement for readings and problem solving alone and in groups outside of class. For the group work, I would like groups of typically 3 or 4 students to work together to solve problems. Among others things that students can do in group work is to try the problems alone and then mark each other (i.e., give each other peer review) and argue their way to an optimum solution. The lecture part would be mainly the derivations and concepts, the group work mainly the examples. I certainly want to get the students to argue concepts too in group work. In the group work time, I would circle in TA mode. Working at New Mexico Tech in 2001–2003, I set up group work like this informally in recitation periods. It worked well in my recollection.

For the calculus-based intro physics course, I am developing a set of lectures in pdf format. I certainly will **NOT** project these lectures on a screen. In physics courses, presentations that are too smooth are not effective in my experience. The act of writing words, derivations, and formulae on the board with all of the hesitations and occasional mistakes seems necessary to hold student interest. But the lectures are intended to be my script in lecturing and complete notes for students. The students should probably still take some notes in class, but mainly for the attention and learning effect.

The lectures are still in development. Those that at least partially exist can be found at

[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/introl/000.html](http://www.nhn.ou.edu/~jeffery/course/c_intro/introl/000.html) .

An example of a complete lecture is the one on energy: see

[http://www.nhn.ou.edu/~jeffery/course/c\\_intro/introl/007\\_en.pdf](http://www.nhn.ou.edu/~jeffery/course/c_intro/introl/007_en.pdf) .

The first aim of the lectures are to give me a set of lectures fine-tuned to my own understanding of the material. I believe that many of the standard textbooks, although excellent in many respects, often gloss over some of the fine points of introductory physics including points of physics reasoning. One notices this very strikingly when preparing and giving lectures. To give a simple example, the ideal normal force used in introductory physics has no force law formula although one knows that it is never attractive and that it is a contact force. It is a constraint force known by its effect. Lack of a normal force law formula means that the normal force value can only be determined using Newton's 2nd or 3rd laws. But I have never seen this point (i.e., that the ideal normal force can only

evaluated from 2nd and 3rd laws) explicitly stated in a textbook. The point is obvious, but even obvious points are not obvious to intro physics students.

Getting across to students some of the fine points I am thinking of is a challenge. But I think it is one that must be undertaken if the students are to really “get” physics.

Completing the lectures will take some years. At present, I have about 80% of the first semester of intro physics covered by the lectures, but little of the second semester. I hope that eventually I will be able to dispense with textbooks altogether. This will save students money. The lectures are freely available for noncommercial and educational use.

### 8. *Mathematical Physics*

The mathematical physics course (taught 2007 fall, 2010 fall) is aimed at the junior level for physics and mathematics majors.

My webpage for the mathematical physics course is

[http://www.nhn.ou.edu/~jeffery/course/c\\_math/math.html](http://www.nhn.ou.edu/~jeffery/course/c_math/math.html)

and my problem book for this course is at

[http://www.nhn.ou.edu/~jeffery/course/c\\_math/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_math/problem.pdf) .

The textbook for 2007 fall and 2010 fall was *Essential Mathematical Methods for Physicists* by Hans J. Weber & George B. Arfken. A complete coverage of the textbook would take three semesters, and I have only covered a third or less of the textbook in times I have taught the course. The selection of topics, however, can vary from semester to semester.

Although Weber & Arfken is a good textbook, if I ever teach mathematical physics again, I think I would like to prepare my own online lectures for the course text. These would save students money and would exactly correspond to my spoken lectures.

### 9. *Modern Physics*

The modern physics course (taught 2008 spring) is, of course, essentially the physics of the first half of the 20th century.

My webpage for the modern physics course is

[http://www.nhn.ou.edu/~jeffery/course/c\\_modern/modern.html](http://www.nhn.ou.edu/~jeffery/course/c_modern/modern.html) .

I am using primarily my quantum mechanics problem book for this course: see

[http://www.nhn.ou.edu/~jeffery/course/c\\_quantum/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_quantum/problem.pdf) .

For the modern physics course for 2008, I selected as textbooks *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles* by Robert Eisberg and Robert Resnick and *The Fabric of the Cosmos* by Brian Greene. The first is a rather more advanced textbook than traditional for modern physics courses. Although I think that it worked out well in some respects, I will probably not use it again for this course since it required rather too much adaptation on my part and it is also dated in some respects. The Eisberg-Resnick book, however, is very good at explaining many of the details and it gives a coverage of almost all the topics traditionally brought up in a modern physics course. The second

textbook is, I believe, an excellent popular book on contemporary fundamental physics. It is intended to give the students a painless introduction to its subjects. Both textbooks were required to be read in their entirety according to scheduled readings. Marks were given for completed readings. Some of the student reading would be superficial, but I still think it is a good idea for students read books cover-to-cover so that they at least get a notion what all is there. I only lectured on parts of the Eisberg-Resnick book.

I decided to emphasize breadth and description rather than depth and math in modern physics courses—which is, of course, the usual procedure. I do not make a heavy emphasis on difficult mathematical derivations and developments. There are some of derivations, of course.

#### 10. *Quantum Mechanics*

I have now taught introductory quantum mechanics at the undergraduate and graduate several times and have achieved some degree of comfort with the material.

My webpage for the undergraduate quantum mechanics course is

[http://www.nhn.ou.edu/~jeffery/course/c\\_quantum/qm.html](http://www.nhn.ou.edu/~jeffery/course/c_quantum/qm.html)

and my problem book for this course is at

[http://www.nhn.ou.edu/~jeffery/course/c\\_quantum/problem.pdf](http://www.nhn.ou.edu/~jeffery/course/c_quantum/problem.pdf) .

For the 2nd semester, I have posted some of my handwritten notes: see the links from URL

[http://www.nhn.ou.edu/~jeffery/course/c\\_quantum/qm.html#Semester 2](http://www.nhn.ou.edu/~jeffery/course/c_quantum/qm.html#Semester 2).

I am beginning to develop a set of online pdf lectures for introductory quantum mechanics entitled *Speakable Quantum Mechanics* (SQM)—the title indicating aspiration rather than achievement. SQM would replace a course textbook eventually. The beginnings of SQM are at

[http://www.nhn.ou.edu/~jeffery/course/c\\_quantum/qml/000.html](http://www.nhn.ou.edu/~jeffery/course/c_quantum/qml/000.html) .

Developing SQM will improve my own understanding of quantum mechanics and when sufficiently complete would save students some money. I also think that SQM will be better for my own teaching than any undergraduate quantum mechanics textbook I am familiar with. The one I am most familiar with is Griffiths. In many ways it is an excellent book, but familiarity breeds quibbles. There are mysteries and inelegances in my view that I could cure.

At present, SQM has barely been started. I hope to make progress in the 2012 spring semester. However, I expect that it will take several semesters of teaching both semesters of introductory quantum mechanics to complete SQM. I do not anticipate that SQM will develop into a publishable book.

**TEACHING PHILOSOPHY:**

Learning is life.

We do it from the beginning to the end—as individuals, as humankind. We learn alone, we together. Much of learning comes from the world in general, society in general. But there must be schools and universities for advanced learning. Places where it is safe to be a student—where there are teachers from all levels of the hierarchy—fellow students, official teachers, advisors, administrators. Places where learning is the focus and where there is a community of learning. Very few persons can master the advanced subjects of modern society alone—there aren't the resources, there isn't the community of support. Books alone were never enough, the Web alone will never be enough.

So what's a teacher? One who presents the subjects. The official ones are the ones who have mastered significant parts of subjects and have, at least, a broad view that allows them to present subjects in specific courses and in whole curriculums.

The teacher keeps the material coming. I have this mental image—parent bird, baby bird—the worms have to be kept coming. Neither students nor teachers would ever get through a semester of courses without the rigor of being yoked together in lectures, assignments, tests, finals.

But not just worms. The teacher has to guide students over material quickly that great minds took centuries to fathom. So the teacher doesn't recreate the subject in its total history. The teacher tries to help the student to recreate the subject as it is in the student's mind. That recreation will be incomplete compared to current understanding—usually vastly incomplete—but it should be open-ended in the direction of completion—which is a direction the student may never follow—but he/she should know where to begin.

Teaching methods? I apologize for quoting Feynman, but when asked what methods he used, he said he used all methods. Well one can't quite do that. One should be open to all methods. A teacher's own experience and experiments should always be growing. A teacher's colleagues are an essential resource. I'm always running to my colleagues. Then there is the vast field of pedagogy research to consult which alas I've little consulted—but my travels have shown I'm not alone in that regard. I have, however, taken note of what I've heard at seminars on pedagogy and am trying more and more to implement modern pedagogy strategies as discussed below. But all pedagogy comes down to getting the students to think about the subject in its whole, but definitely day to day in the bits that are being covered.

Lecturing is the standard teaching method and has its well known flaws—inattention, instant forgetting. But those aren't fatal flaws at all. A lot can be learnt in lecturing. Especially lecturing enlivened by the enthusiasm of the teacher, demonstrations, and give and take with the students. A steady course of lectures keeps the subject going forward. And lectures complemented by readings, assignments, and tests completes a reasonable course.

But like many others I think the activity-based method that integrates lectures, individual work, group work, demonstrations, and laboratories is the superior method for most students in large introductory courses. I also, however, believe activity-based courses have to be well organized and done well to achieve superiority. I think it takes the collective agreement and effort of a department faculty to do full activity-based courses well.

Nevertheless, I am implementing elements of the activity-based method in introductory physics courses.

In my own subject physics, I believe in a tough, thorough program of studies. It is what the students in the services courses need and what physics majors want. The deficiency I see in the current undergraduate physics program is the lack of an integrated computational component. I think physics majors should learn a programming language at the start of their undergraduate program and make use of it throughout that program.

To be a good teacher, one has to like students and be ready to help with their needs—those they know about and those they don't.

## REFERENCES:

- Baron, E., & Hauschildt, P. H. 2004, *A&A*, 427, 987
- Baron, E., Jeffery, D. J., Branch, D., Bravo, E., García-Senz, D., & Hauschildt, P. A. 2008, *ApJ*, 672, 1038, arXiv:0709.4177v1
- Branch, D., Baron, E., Hall, N., Melakayil, M., & Parrent, J. 2005, *PASP*, 117, 545
- Branch, D., Baron, E., & Jeffery, D.J. 2003, in *Supernovae and Gamma-Ray Bursters*, ed. K. W. Weiler (Berlin: Springer-Verlag), 47, arXiv:astro-ph/0111573
- Branch, D., Benetti, S., Kasen, D., Baron, E., Jeffery, D.J., et al. 2002, *ApJ*, 566, 1005, arXiv:astro-ph/0106367
- Branch, D., Drucker, W., & Jeffery, D. J. 1988, *ApJ*, 330, L117.
- Branch, D., Dang, L. C., Hall, N., Ketchum, W., Melakayil, M., Parrent, J., Troxel, M. A., Casebeer, D., Jeffery, D. J., & Baron, E. 2006b, *PASP*, 118, 560, arXiv:astro-ph/0601048v1
- Branch, D., Jeffery, D. J., Blaylock, M., & Hatano, K. 2000, *PASP*, 112, 217, arXiv:astro-ph/9911099
- Branch, D., Jeffery, D. J., Parrent, J., Baron, E., Troxel, M. A., Stanishev, V. Keithley, M., & Bruner, C. 2008, *PASP*, 120, 135, arXiv:0712.2436v1
- Branch, D., Jeffery, D. J., Young, T. R., & Baron, E. 2006a, *PASP*, 118, 791, arXiv:astro-ph/0604047
- Branch, D., Parrent, J., Troxel, M. A., Casebeer, D., Jeffery, D. J., Baron, E., Ketchum, W., & Hall, N. 2007b, in *The Multicoloured Landscape of Compact Objects and their Explosive Origins*, AIP Conf. Pro. 924, Vol. 1 Cefalù, Sicily, 2006 June 11—24, ed. L. A. Antonelli et al. (Melville, New York: American Institute of Physics), 342
- Branch, D., Pauldrach, A. W. A., Puls, J., Jeffery, D. J., & Kudritzki, R. P. 1991, in *ESO/EIPC Workshop: SN 1987A and other Supernovae*, ed. I. J. Danziger & K. Kjær (Garching: ESO), 437
- Branch, D., Troxel, M. A., Jeffery, D. J., Hatano, K., Musco, M., Parrent, J., Baron, E., Dang, L. C., Casebeer, D., Hall, N. & Ketchum, W. 2007a, *PASP*, 2007, *PASP*, 119, 857, arXiv:0706.0081v1
- Deng, J., Kawabata, K. S., Ohyama Y., Nomoto, K., Mazzali, P., Wang, L., Jeffery,

- D. J., Iye, M., Tomita, H., & Yoshii, Y. 2004, *ApJ (Letters)*, 605, L37, arXiv:astro-ph/0311590.
- Densmore, J. D., Urbatscha, T. J., Evans, T. M., & Buksas, M. W. 2007, *Journal of Computational Physics*, 222, 485
- Fisher, A. 2000, Ph.D. thesis, University of Oklahoma
- Fleck, Jr., J. A., & Canfield, E. H. 1984, *Journal of Computational Physics*, 54, 508
- Hauschildt, P. H., & Baron, E. 1999, *J. Comp. Applied Math.*, 109, 41, arXiv:astro-ph/9808182
- Howell, D. A., et al. 2006, *Nature*, 443, 308
- Hutsemékers, D., & Surdej, J. 1990, *ApJ*, 361, 367
- Jeffery, D. J. 1983, M.Sc. thesis, McMaster University
- Jeffery, D. J. 1987, *Nature*, 329, 419
- Jeffery, D. J. 1988, Ph.D. thesis, McMaster University
- Jeffery, D. J. 1989, *ApJS*, 71, 951
- Jeffery, D. J. 1990, *ApJ*, 352, 267
- Jeffery, D. J. 1991a, in *ESO/EIPC Workshop: SN 1987A and other Supernovae*, ed. I. J. Danziger & K. Kjær (Garching: ESO), 257
- Jeffery, D. J. 1991b, *ApJ*, 375, 264
- Jeffery, D. J. 1991c, *ApJS*, 77, 405
- Jeffery, D. J. 1993, *ApJ*, 415, 734
- Jeffery, D. J. 1995a, *ApJ*, 440, 810
- Jeffery, D. J. 1995b, *A&A*, 299, 770
- Jeffery, D. J. 1998a, in *Stellar Evolution, Stellar Explosions, and Galactic Chemical Evolution: Proc. Second Oak Ridge Symposium on Atomic & Nuclear Astrophysics*, ed. A. Mezzacappa (Bristol: Institute of Physics Publishing), 65, arXiv:astro-ph/9802229
- Jeffery, D. J. 1998b, arXiv:astro-ph/9811356
- Jeffery, D. J. 1999, arXiv:astro-ph/9907015
- Jeffery, D. J. 2004, arXiv:astro-ph/0406440
- Jeffery, D. J. 2012, in preparation
- Jeffery, D. J., & Branch, D. 1990, in *Jerusalem Winter School for Theoretical Physics, Vol. 6, Supernovae*, ed. J. C. Wheeler, T. Piran, & S. Weinberg (Singapore: World Scientific), 149
- Jeffery, D. J., Branch, D., & Baron, E. 2006, arXiv:astro-ph/0609804v3
- Jeffery, D. J., Branch, D., Filippenko, A. V., & Nomoto, K. 1991, *ApJ*, 377, L89
- Jeffery, D. J., Ketchum, W., Branch, D., Baron, E., Elmhamdi, A., & Danziger, I. J. 2007, *ApJS*, 171, 493, arXiv:astro-ph/0607084v3
- Jeffery, D. J., Leibundgut, B., Kirshner, R. P., Benetti, S., Branch, D., & Sonneborn, G. 1992, *ApJ*, 397, 304
- Jeffery, D. J., & Mazzali, P. A. 2007, in *The Multicoloured Landscape of Compact Objects and their Explosive Origins*, AIP Conf. Pro. 924, Vol. 1 Cefalù, Sicily, 2006 June 11—24, ed. L. A. Antonelli et al. (Melville, New York: American Institute of Physics), 401, arXiv:astro-ph/0611002v1
- Jeffery, D. J., & Sutherland, P. G. 1985, *Ap&SS*, 109, 277

- Jeffery, D. J., et al. 1994, ApJ, 421, L27
- Kasen, D., Branch, D., Baron, E., & Jeffery, D. J. 2002, ApJ, 565, 380, arXiv:astro-ph/0108403
- Kasen, D., Thomas, R.C., & Nugent, P. 2006, ApJ, 651, 366, arXiv:astro-ph/0606111
- Kawabata, K. S., Jeffery, D. J., et al. 2002, ApJ, 580, L39, arXiv:astro-ph/0205414v3
- Kawabata, K. S., Deng, J., Wang, L., Mazzali, P., Nomoto, K., Maeda, K., Tominaga, N., Umeda, H., Iye, M., Kosugi, G., Ohyama, Y., Sasaki, T., Höflich, P., Wheeler, J. C., Jeffery, D. J., et al. 2003a, 593, L19, arXiv:astro-ph/0306155
- Kawabata, K. S., Jeffery, D. J., et al. 2003b, *The Proceedings of the IAU 8th Asian-Pacific Regional Meeting, Volume II*, ed. S. Ikeuchi, J. Hearnshaw, & T. Hanawa (San Francisco: Astronomical Society of the Pacific), 333-334
- Kirshner, R. P., Jeffery, D. J., et al. 1993, ApJ, 415, 589
- Liu, W., Jeffery, D. J., & Schultz, D. R. 1997a, ApJ, 483, L107
- Liu, W., Jeffery, D. J., & Schultz, D. R. 1997b, ApJ, 486, L35
- Liu, W., Jeffery, D. J., & Schultz, D. R. 1998, ApJ, 494, 812
- Liu, W., Jeffery, D. J., Schultz, D. R., Quinet, P., Shaw, J., & Pindzola, M. S. 1997c, ApJ, 489, L141
- Maeda, K., & Iwamoto K. 2009, MNRAS, 394, 239
- Matheson, T., et al. 2003, ApJ, 599, 394
- Mihalas, D. 1978, *Stellar Atmospheres*, (San Francisco: W. H. Freeman and Company)
- Min, M., Dullemond, C. P., Dominik, C., de Koter, A., & Hovenier, J. W. 2009, A&A, 497, 155
- Parrent, J., Branch, D., Troxel, M. A., Casebeer, D., Jeffery, D. J., Ketchum, W., Baron, E., Serduke, F. J. D., & Filippenko, A. V. 2007, PASP, 119, 135
- Parthasarathy, M., Branch, D., Baron, E., & Jeffery, D. J. 2006, *Bulletin of the Astronomical Society of India*, 34, 385, arXiv:astro-ph/0611033
- Parthasarathy, M., Branch, D., Jeffery, D. J., & Baron, E. 2007, *New Astronomy Reviews*, 51, 524–538, arXiv:astro-ph/0703415
- Ruiz-Lapuente, P., Jeffery, D. J., et al. 1993, *Nature*, 365, 728
- Rybicki, G. B., & Hummer, D. G. 1978, ApJ, 219, 654
- Scalzo, R. A., et al. 2010, ApJ, 713, 1073
- Wang, X., Wang, L., Filippenko, A.V., et al. 2012, ApJ, in press, arXiv:1110.5809v2

## REFERENCES FOR DAVID JEFFERY

Prof. David Branch (research and teaching reference)  
University of Oklahoma  
Homer L. Dodge Department of Physics and Astronomy  
440 West Brooks, Rm 131  
Norman, Oklahoma 73019  
U.S.A.  
Tel: 405-325-3961

FAX: 405-325-7557  
Email: [branch@nhn.ou.edu](mailto:branch@nhn.ou.edu)  
Homepage: <http://www.nhn.ou.edu/~branch/research/>  
Departmental Homepage: <http://www.nhn.ou.edu/>

Prof. Christine Berven (teaching reference)  
Department of Physics  
University of Idaho  
Moscow, ID 83844-0903  
U.S.A.  
Tel: 208-885-6194  
Fax: (208)884-4055  
Email: [berven@uidaho.edu](mailto:berven@uidaho.edu)  
Homepage: <http://www.phys.uidaho.edu/berven>

Prof. Mark James (teaching reference)  
Northern Arizona University  
Department of Physics and Astronomy  
NAU Box 6010  
Flagstaff, Arizona 86011-6010  
U.S.A.  
Tel: 928-523-8710  
FAX: 928-523-1371  
Email: [Mark.James@nau.edu](mailto:Mark.James@nau.edu)  
Homepage: <http://www.physics.nau.edu/~james/>

Prof. J. Craig Wheeler (research reference)  
The University of Texas at Austin  
Department of Astronomy, RLM 5.208  
Austin, TX 78712-1081  
U.S.A.  
Tel: 512-471-6407  
FAX: 512-471-6016  
Email: [wheel@astro.as.utexas.edu](mailto:wheel@astro.as.utexas.edu)  
Homepage: <http://www.as.utexas.edu/~wheel/>