



Physics

“In science there is only physics. All the rest is stamp collecting.” – Ernest Rutherford

Physics lies at the foundation of our technological world, from computers to the growing understanding of the human genome. The realm of the physicist is the entire universe, from its largest scale to the underlying structure of matter itself. Yet, physics is not so much a body of knowledge as it is a disciplined way of looking at the natural world and asking questions about it. As a physics student at Randolph-Macon College, you will engage in a personal exploration of the world about you, guided by a dedicated faculty within the tradition of the liberal arts and sciences. You will not just learn physics. You will do physics. You will learn to interrogate the universe and unlock its secrets, with both theoretical and experimental tools.

Your curriculum has been carefully designed to offer the same broad scope of study you would find at many large research universities, but with a personal touch. Basic course work includes classical and quantum mechanics, electromagnetism and optics, thermodynamics and statistical mechanics, electronics and instrumentation. Advanced study provides individual attention for each student. Research is not the private domain of the faculty – a research project in an area of your particular interest is required of all students. Your senior seminar will hone your skills at analyzing a new problem, and how to effectively communicate results of your research. Faculty interest in fields as diverse as nondestructive evaluation of materials, astronomy and astrophysics, cosmology, magnetic properties of materials, sports physics, and computational physics, assures that your interests will find an able mentor to help guide your study. Recent student projects have included construction and use of two radio telescopes, evaluating effective solar heating strategies for developing societies in the third world, construction and testing of demonstration equipment like a “vacuum bazooka”, modeling the chaotic rotation of Saturn’s moon Hyperion, etc.

The liberal arts provide a rewarding context for the study of physics. According to a survey conducted by the American Institute of Physics, approximately 43% of all undergraduate physics majors nationwide attend colleges like Randolph-Macon. Students with a bachelor’s degree in physics are more likely to receive financial support for graduate study in physics than those seeking advanced study in other disciplines.

Randolph-Macon physics graduates have demonstrated remarkable flexibility and success in a variety of careers. Surveys of our alumni over the past decades show that about half of them have gone on to pursue graduate degrees in physics or other fields. Some have used their physics training to pursue careers in computer-related fields, in industry, or in education. Several have returned to graduate study after several years’ employment in government, university, or industrial laboratories.

More important than tangible prospects for future success, you will find that studying physics in a liberal arts and sciences environment is intellectually satisfying in its own right. The society of the coming decades will be shaped by the scientific and technological advances of the present. The sciences, in particular physics, have influenced significantly our history, politics, literature, and the fine arts. At Randolph-Macon College, you learn physics accompanied by studies with faculty and students in these other areas. You and they will gain the ability to think about problems and explore the issues of the day from a well-rounded perspective.

“Everything should be made as simple as possible. But not simpler.” - Albert Einstein

The physics major is challenged by a curriculum designed to equally develop both theoretical and experimental skills. The beginning student explores classical physics, learning to use the language of mathematics to express relations between physical properties. Laboratory work emphasizes the nature of measurement and uncertainty, giving students hands-on experience with a variety of modern and classic apparatus and techniques while also developing their skills in technical writing and analysis. As you progress, the study expands to include contemporary physics and relativity, as well as an exposure to modern electronics and instrumentation. Concurrent studies in mathematics include calculus, differential equations, and multivariable calculus. Integrated throughout is the appropriate use of computers as measurement instruments and as computational and modeling tools. Departmental computer resources are fully integrated into the World Wide Web and the Internet.

Advanced students develop more sophisticated analytic skills in both classical and contemporary physics. Elective courses and the capstone research project and senior seminar allow you to work closely with individual faculty. Upper level classes typically enroll two to five students, allowing further personal interaction and growth. We emphasize the education of the physicist as a complete individual, and can be flexible enough to meet the needs of individual students, while maintaining a high level of intellectual engagement and scientific rigor. Course work is directed and evaluated by members of the faculty – teaching assistants are not used.

Course offerings

Astronomy

Astrophysics

*Historical and Philosophical Foundations
of Astronomy*

Observational Astronomy

Atmospheres and Weather

Introductory Physics

Analog Electronics

Digital Electronics

Modern Physics

Mathematical Physics

Special Topics: High Energy & Particle Physics, General Relativity, Cosmology, Science of Structures, etc.

Intermediate Mechanics

Electricity and Magnetism

Continuum Mechanics

Magnetic Materials and Devices

Quantum Mechanics

Statistical and Thermal Physics

Physical Optics

Solid State Physics

Senior Seminar in Physics

Physics Research

Special Programs

Qualified students with an interest in engineering may participate in a choice of cooperative programs between Randolph-Macon and either Columbia University or the University of Virginia.

Teacher certification in physics is available upon completion of the physics major and a minor in education. The Randolph-Macon teacher certification program has been identified by the state of Virginia as a model of excellence in the preparation of schoolteachers.

The physics department participates enthusiastically in the College's Honors Program. Department faculty have presented courses in the honors program on stellar astronomy, the history and technology of the space program, science fact and fiction in film, and the science of structures, time and theology. Physics majors who participate in the Honors Program may complete their departmental honors with research in physics and astronomy.

A minor in astrophysics, unique to Randolph-Macon College, affords students in the natural sciences a unique perspective for understanding the physical universe. Principles of classical and contemporary physics are applied to the study of the cosmos. Astronomy and astrophysics courses may be used as electives towards the major in physics.

The department offers student employment opportunities, allowing students to help with setup and maintenance of laboratory and lecture demonstration apparatus, and to work on special projects within the department. The public programs of the Keeble Observatory are conducted by students of the College, under the supervision of the Director of the Observatory, Dr. George Spagna, Jr.

Facilities

The Physics Department is housed within the Copley Science Center. Our laboratories are fully equipped for both instruction and research. Students in the electronics laboratory can design and analyze integrated circuit systems using modeling software, and then proceed to build and test them. Classrooms – including an innovative studio classroom – and laboratories provide wireless Internet access, bringing the world within reach of every student and allowing them to explore a range of phenomena once thought unavailable to the undergraduate.

The Keeble Observatory, adjacent to the Copley Science Center, serves as a teaching laboratory for the physics department. This facility houses a 30 centimeter Cassegrain telescope which can be used for observation, CCD photography, photometry, and spectroscopy. A 3 meter radio telescope next to the Observatory scans the sky at 21 cm wavelength, while a dipole array on the roof of Copley studies the Sun and Jupiter at 15 meter wavelength. These observatory facilities are primarily available for student use, either for course work or research projects.

Physics majors and minors are afforded personal study space within the department. Reference materials, books, and journals in the College's McGraw-Page Library are supplemented by a departmental collection of texts and journals, which reflect particular interests of the faculty.

Career and Post Graduate Opportunities

Opportunities for entry-level employment for those holding a physics bachelor's degree are excellent; indeed, 40% of the 2006 graduating class nationwide found immediate employment, while 54% went on to immediate graduate study. According to the American Institute of Physics, graduates with bachelor's degrees received a median salary of \$45,000 in 2006 (the most recent year for which complete data are available) for jobs in science, technology, engineering, and mathematics fields. For 2008-2009, on-campus recruiters nationwide reported typical offers (from 25th to 75th percentile) for physics bachelors ranging from \$40,000 to \$63,000. Private sector jobs represent 57% of the reported employment of those with a physics bachelor's degree, while a significant 13% went on as high school teachers. Historically, those working in the private sector earn more than in other sectors.

Of those who elected graduate study immediately, 64% went on in physics or astronomy, while 16% pursued graduate programs in engineering. The remaining 20% enrolled in programs as diverse as law or medicine. Physics bachelor's who continue their education in physics and astronomy tend to be better supported by their graduate departments than the students who pursue other fields. Also, physics bachelor's who enroll in a PhD program, regardless of field, tend to be better supported than students enrolling in a master's program.

Perhaps the most important long-term opportunity is that many careers will be available beyond the entry level for the technically trained liberal arts graduate. Problem solving and communications skills have helped our graduates to become leaders in many new and exciting fields which often did not exist at the time they enrolled at Randolph-Macon College.

Some recent graduates and their current positions

- Ronald Pandolfi, 2009, Physics PhD Program at UC-Merced
- Robert Pullen, 2008, staff scientist, Naval Surface Warfare Center Dahlgren Division
- Christopher Bass, 2008, Medical Physics Program at VCU
- Katherine Rueff, 2007, PhD Program in Astrophysics, University of Notre Dame
- Brandon Sumpter, 2007, Civil Engineering Graduate Studies at George Mason University
- Paulo Garcia, 2006, PhD Program in Biomedical Engineering at Virginia Tech
- Elizabeth Griffin, 2006, high school physics teacher
- Jay Jung, 2004, Physics PhD Program at the University of Stony Brook
- Keith Weber, 2002, Baltimore County Police Department crash team investigation group

Faculty profiles:

William T. Franz, Professor; B.S. Muhlenberg College, M.S., Ph.D. University of Delaware. Areas of interest: science education, high temperature superconductivity, electronics, solar energy, physics of recording processes, physics of sports, atmospheric physics.

Recent Publications and presentations:

- William T. Franz, "Review of Donald Scarl's How to Solve Problems," *Journal of College Science Teaching*, 2001.
- David G. Fisher and William T. Franz, "Undergraduate laboratory demonstration of aspects of phase transitions using Curie temperature determination in amorphous ferromagnetic materials," *American Journal of Physics*, **63**, 248-251 (March 1995)

- William T. Franz, “Meteorology on the World Wide Web,” presented at Chesapeake Section of American Association of Physics Teachers, Harrisonburg, VA (1996)

George F. Spagna, Jr. Associate Professor and Director of the Keeble Observatory; B.S., M.S., Ph.D. Rensselaer Polytechnic Institute. Areas of interest: astronomy and astrophysics, the interstellar medium and star formation, numerical modeling, physics and astronomy education, physics demonstrations and laboratory apparatus, science and theology.

Recent Publications and presentations:

- George Spagna, Invited Presentation, Desmond Tutu Center, General Theological Seminary, New York, 2007 November 9, at the 68th annual meeting of the Guild of Scholars of the Episcopal Church, “Toward a Quantum Theology”
- George Spagna, in *Scientific American’s Ask the Experts: Answers to the Most Puzzling and Mind-Blowing Science Questions*, Harper Collins General Books Group, New York, (Scientific American Editors). Page 13, “What is a Blue Moon?” Page 19, “Why and How do Planets Rotate?”
- George F. Spagna, Jr. and Elizabeth Barnaby Keeney, “Science,” *Handbook of American Popular Culture, 3rd Edition*, Thomas Inge and Dennis Hall, Editors (2001)
- George F. Spagna, Jr., Use of Spreadsheets in the Introductory Course at a 4-year Liberal Arts College, in *Conference on the Introductory Physics Course on the Occasion of the Retirement of Robert Resnick*, Jack Wilson, Editor. (1997)
- George F. Spagna, Jr., “Mail Planes, Moon Shots, and the Exploration of Space” *Virginia Community College System – Science Peer Group Conference*, Invited Presentation, 2001 February 23

Deonna F. Woolard, Associate Professor and Chair, B.S. Bethany College, M.S., Ph.D. College of William and Mary. Areas of interest: nondestructive evaluation of materials, photoelasticity, thermoelasticity, thermography, civil and mechanical engineering applications.

Recent Publications and presentations:

- “Thermographic Inspection of Carbon Composites Used in Aerospace Vehicles”, Invited talk at Roanoke College, March 24, 2009.
- “Theoretical Heat Transfer Model of Carbon Composites using Thermal Quadrupoles,” Invited Seminar Speaker for the National Institute of Aerospace, Hampton, VA, January 28, 2009.
- Deonna F. Woolard and K. Elliott Cramer, “Line Scan Versus Flash Thermography: Comparative Study on Reinforced Carbon-Carbon,” *Thermosense XXVII*, G. Raymond Peacock, Douglas D. Burleigh, and Jonathan J. Miles, Editors, Proceedings of SPIE, **5782**, pp. 315-323 (2005).
- “Thermographic Inspection of Reinforced Carbon-Carbon,” Invited talk for the November meeting of the Old Dominion Section of The American Society for Nondestructive Testing, Mechanicsville, Virginia, November 22, 2004.
- Deonna F. Woolard and K. Elliott Cramer, “The Thermal Photocopier: A New Concept for Thermal NDT,” *Thermosense XXVI*, Douglas D. Burleigh, K. Elliott Cramer, and G. Raymond Peacock, Editors, Proceedings of SPIE, **5405**, pp. 366-373 (2004).

- Deonna Woolard and Mark Hinders, “Model for Quantifying Photoelastic Fringe Degradation by Imperfect Retroreflective Backings,” *Applied Optics*, **39**, pp. 2043-2053 (May 1, 2000).
- Deonna Woolard and Mark Hinders, “Stress Separation Errors Resulting from Imperfect Backings,” *Proceedings of SEM Annual Conference on Theoretical, Experimental, and Computational Mechanics*, pp. 605-608 (SEM 1999).
- D.F. Woolard and M.K. Hinders, “Coating for Combined Thermoelastic and Photoelastic Stress Measurement,” *Nondestructive Evaluation of Bridges and Highways III*, Steven B. Chase, Editor, Proceedings of SPIE, **3587**, pp. 88-96 (1999).
- Deonna Woolard, Mark Hinders, and Christopher Welch, “Combined Thermoelastic and Photoelastic Full-Field Stress Measurement,” *The Review in Progress in Quantitative Nondestructive Evaluation*, **18**, pp. 1431-1438 (Plenum Press, New York, 1999).

Matthew Francis, Visiting Assistant Professor, B.A. Central College, Ph.D. Rutgers University.
Areas of interest: cosmology, gravitational physics, nonlinear dynamics

Recent Publications and presentations:

- E. Fertig and M. R. Francis, Heterogeneous networks of coupled switches and oscillators. (Current project)
- M. R. Francis and A. Kosowsky, Post-Newtonian parameters for generalized Einstein-Æther models. (Current project)
- M. R. Francis, R. Bean, and A. Kosowsky, Impact of Systematic Errors on Sunyaev-el’dovich Effect Surveys, JCAP 0512 (2005), 001. astro-ph/0511161