PHYSICS, B.A.

WELCOME TO THE UW-MADISON DEPARTMENT OF PHYSICS

We have a long history of providing our students with a great educational experience. Our physics department awarded its first Ph.D. in 1899. Since then, our students have earned degrees in virtually every area of physics, and our faculty have played key roles in a myriad of important research efforts.

Physics is the science of the properties of matter, radiation, and energy in all forms. As such, it is the most fundamental of the sciences. It provides the underlying framework for the other physical sciences and engineering and for understanding physical processes in biological and environmental sciences.

CHOOSE TO BE A PHYSICS MAJOR

WHY STUDY PHYSICS?

- **Intellectual Satisfaction.** First, and foremost, physics satisfies our deep desire to understand how the universe works. Physics is interesting.
- **Intellectual Challenge.** By striving for fundamental understanding, the physicist accepts the challenge to move past a merely descriptive approach of our world and probes deeply into how and why it works.
- **Physics Produces New Technology.** Today's esoteric physics research will become tomorrow's technological advances.
- **Technical Expertise.** Physicists exploit forefront technologies in their pursuits.
- **Flexibility.** In a fast-paced and changing world, it is much more important to have a broad substantive education than to be trained in a specific skill. We teach people how to think, and how to apply and extend what they know to new types of problems.
- **Physics is Analytical and Quantitative.** People who can reason analytically and quantitatively are essential for the success of almost any pursuit.

YOUR FUTURE IS SO BRIGHT...

A degree in physics helps prepare you for employment in industry, research, government, and academia. A bachelor's degree from the undergraduate physics program will provide an overall view of both classical and modern physics along with problem-solving ability and the flexibility to continue learning.

Your education can:

- Prepare you for employment in industrial or governmental laboratories.
- Prepare you for graduate studies for master's or doctoral degrees in experimental or theoretical physics.
- Provide a broad background for further work in other sciences, such as materials sciences, aerospace, astronomy, computer science, geophysics, meteorology, radiology, medicine, biophysics, engineering, and environmental studies.
- Provide a science-oriented liberal education. This training can be useful in some areas of business administration, law, or other fields where a basic knowledge of science is useful.
- Provide part of the preparation you need to teach physics. To teach physics in high school, you will also take education courses to become certified. You will need a doctoral degree to become a college or university professor.

PHYSICS MENTOR PROGRAM

Any student contemplating becoming a physics major is encouraged to obtain a faculty mentor. A mentor is a faculty member with whom students can discuss physics, courses, careers, graduate schools, aspirations, etc. Mentors are not primarily academic advisors. Information is available at the department office.

OTHER PROGRAMS

AMEP

A program in applied mathematics, engineering and physics (AMEP) (http://guide.wisc.edu/undergraduate/letters-science/mathematics/applied-mathematics-engineering-physics-bs-amep) is described in its own section of The Guide.

Astronomy-Physics

Students interested in an astronomy–physics major should contact the astronomy department (http://guide.wisc.edu/undergraduate/letters-science/astronomy).

Education-Physics

A student working toward the Bachelor of Science–Education degree may major or minor in physics. Interested students should contact the School of Education (http://guide.wisc.edu/undergraduate/education). Upon request, the physics department will assign an advisor.

Medical-Physics

A suggested curriculum for students interested in graduate study in medical physics is available in the medical physics (https://www.medphysics.wisc.edu) department office.

HOW TO GET IN

TO DECLARE A PHYSICS MAJOR

Students must declare the physics major by filing out a major declaration form, signed by a physics undergraduate advisor. They should talk with one of the undergraduate advisors as soon as they know they might have an interest in the physics major. Students can declare their physics major at any time after completing their first physics course on the UW–Madison campus, and we encourage them to do this as early as possible. They must have a 2.5 GPA in physics and math courses taken at UW–Madison at the time they declare. In all cases, the major must be declared before the semester of graduation. The form can be obtained at the department office in 2320 Chamberlin Hall. Note: Students should bring a copy of their current course history when they talk with the undergraduate advisor.

ENGINEERING AND OTHER NON-L&S MAJORS SEEKING AN ADDITIONAL MAJOR IN PHYSICS

An undergraduate in any college other than Letters & Science (L&S) needs to complete the physics requirements for the physics major, and the L&S residence and quality of work in the major requirements. None of the other requirements of L&S need to be satisfied. Students majoring in any other program that is not in L&S require formal approval from the other college to declare the additional major in physics. This process may delay declaring the major in physics.
UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (http://guide.wisc.edu/undergraduate/#requirementsforundergraduatetystudytext) section of the Guide.

Requirements Detail
- Breadth—Humanities/Literature/Arts: 6 credits
- Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits
- Breadth—Social Studies: 3 credits
- Communication Part A & Part B *
- Ethnic Studies *
- Quantitative Reasoning Part A & Part B *

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

NON–L&S STUDENTS PURSUING AN L&S MAJOR
Non–L&S students who have permission from their school/college to pursue an additional major within L&S only need to fulfill the major requirements and do not need to complete the L&S breadth and degree requirements above.

REQUIREMENTS FOR THE MAJOR
The physics major requires 35 credits from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>PHYSICS 247</td>
<td>A Modern Introduction to Physics (recommended) 1</td>
<td>5</td>
</tr>
<tr>
<td>PHYSICS 207</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 201</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>E M A 201 &amp; E M A 202</td>
<td>Statics and Dynamics 2</td>
<td></td>
</tr>
<tr>
<td>E M A 201 &amp; M E 240</td>
<td>Statics and Dynamics 2</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 248</td>
<td>A Modern Introduction to Physics (recommended)</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 208</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 202</td>
<td>General Physics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 249</td>
<td>A Modern Introduction to Physics (recommended)</td>
<td></td>
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<tr>
<td>PHYSICS 205</td>
<td>Modern Physics for Engineers</td>
<td></td>
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<tr>
<td>PHYSICS/ E C E 235</td>
<td>Introduction to Solid State Electronics</td>
<td></td>
</tr>
<tr>
<td>PHYSICS 241</td>
<td>Introduction to Modern Physics</td>
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</tbody>
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Core Physics

L&S Breadth
- Humanities, 12 credits: 6 of the 12 credits must be in literature
- Social Sciences, 12 credits
- Natural Sciences, 12 credits: must include one 3+ credit course in the biological sciences; must include one 3+ credit course in the physical sciences

Liberal Arts and Science Coursework

Depth of Intermediate/ Advanced work

Major
- Declare and complete at least one (1) major

Total Credits
- 120 credits

UW-Madison Experience
- 30 credits in residence, overall
- 30 credits in residence after the 90th credit

Minimum GPAs
- 2.000 in all coursework at UW–Madison
- 2.000 in intermediate/advanced coursework at UW–Madison

COLLEGE OF LETTERS & SCIENCE BREADTH AND DEGREE REQUIREMENTS: BACHELOR OF ARTS (B.A.)

Students pursuing a bachelor of arts degree in the College of Letters & Science must complete all of the requirements below. The College of Letters & Science allows this major to be paired with either a bachelor of arts or a bachelor of science curriculum. View a comparison of the degree requirements here. (https://pubs.wisc.edu/home/archives/ug15/images/babs2009.pdf)

BACHELOR OF ARTS DEGREE REQUIREMENTS

Requirements Detail

Mathematics
- Fulfilled with completion of University General Education requirements Quantitative Reasoning a (QR A) and Quantitative Reasoning b (QR B) coursework. Please note that some majors may require students to complete additional math coursework beyond the B.A. mathematics requirement.

Foreign Language
- Complete the fourth unit of a foreign language; OR
- Complete the third unit of a foreign language and the second unit of an additional foreign language

Note: A unit is one year of high school work or one semester/term of college work.
Physics, B.A.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PHYSICS 311</td>
<td>Mechanics</td>
</tr>
</tbody>
</table>

Select one of the following options: 3 credits

**Option 1:**
- PHYSICS 322 Electromagnetic Fields

**Option 2:** 3 credits
- E C E 220 Electrodynamics I
- E C E 320 Electrodynamics II
- E C E 420 Electromagnetic Wave Transmission

Select one of the following: 3 credits
- PHYSICS 415 Thermal Physics
- CHEM 561 Physical Chemistry
- M E 361 Thermodynamics

Select one of the following: 3-6 credits
- PHYSICS 448 & PHYSICS 449 Atomic and Quantum Physics and Atomic and Quantum Physics (recommended)
- PHYSICS 531 Introduction to Quantum Mechanics

Laboratory 5 credits

Select 6 credits from the following: 6 credits
- Full registered credit per course:
  - PHYSICS 307 Intermediate Laboratory-Mechanics and Modern Physics
  - PHYSICS 308 Intermediate Laboratory-Electromagnetic Fields and Optics
  - PHYSICS 407 Advanced Laboratory
- Two credits applies for each of these courses:
  - PHYSICS 321 Electric Circuits and Electronics
  - PHYSICS 623 Electronic Aids to Measurement
  - PHYSICS 625 Applied Optics
  - N E 427 Nuclear Instrumentation Laboratory
  - N E 428 Nuclear Reactor Laboratory
- One credit applies for each of these courses:
  - E C E 305 Semiconductor Properties Laboratory
  - E C E 313 Optoelectronics Lab

Select additional electives to reach 35-credit minimum for the major:

**Advanced Physics Electives** 5 credits
- PHYSICS 301 Physics Today 6 credits
- PHYSICS 325 Wave Motion and Optics
- PHYSICS 406 Special Topics in Physics
- PHYSICS/ENVIR ST 472 Scientific Background to Global Environmental Problems
- PHYSICS/B M E/H ONCOL/MED PHYS 501 Radiological Physics and Dosimetry
- PHYSICS 507 Graduate Laboratory
- PHYSICS/E C E/N E 525 Introduction to Plasmas
- PHYSICS/E C E/N E 527 Plasma Confinement and Heating
- PHYSICS 535 Introduction to Particle Physics

**PHYSICS 545** Introduction to Atomic Structure
- PHYSICS/E C E 546 Lasers
- PHYSICS 551 Solid State Physics
- PHYSICS/B M E/MED PHYS/PHMCOL-M/RADIOL 619 Microscopy of Life

1. It is recommended that students follow one of the sequences PHYSICS 247–PHYSICS 248, PHYSICS 207–PHYSICS 208, or PHYSICS 201–PHYSICS 202 for the first two courses, and PHYSICS 249 or PHYSICS 241 is strongly recommended for the third course. But any combination can be used to satisfy the requirements, except that students may not transfer into the PHYSICS 247–PHYSICS 248–PHYSICS 249 sequence from another introductory sequence.

2. A maximum of 5 credits from E M A 201, E M A 202 and M E 240 count toward the 35 required.

3. A maximum of 3 credits from E C E 220 and E C E 320 and E C E 420 apply toward the 35 required.

4. A maximum of 3 credits from CHEM 561 and CHEM 562 apply toward the 35 required.

5. For nonphysics courses, students will receive only the credit applied as lab toward the 35 credits requirement.

6. It is recommended that the student’s program include the seminar PHYSICS 301 Physics Today.

### RESIDENCE AND QUALITY OF WORK IN THE MAJOR
- 2.000 GPA in all PHYSICS and major courses
- 2.000 on at least 15 credits in upper-level work taken in residence: courses in Core, Laboratory, and Advanced Physics Electives
- 15 credits in PHYSICS, taken on campus

### DISTINCTION IN THE MAJOR
Distinction in the Major requires no declaration, and is awarded at the time of graduation. Students may not receive Distinction and Honors in the same major. To receive Distinction in the Major, students must have met the following requirements:

- 3.300 university GPA
- 3.300 GPA in all major and major subject (physics) courses
- 6 additional credits in advanced-level physics beyond the minimum required for the major.

### THESIS OF DISTINCTION
An exceptional original thesis will be designated as a Thesis of Distinction upon recommendation by the department.

### MATHEMATICS
MATH 221–MATH 222–MATH 234 or equivalents are necessary since they are prerequisites for other courses.

### CHEMISTRY
A college course in chemistry is advised for all physics students.
COMPUTING
Students should become familiar with scientific programming using a language such as C or FORTRAN. The computer sciences department offers introductory courses (such as 302). The Division of Information Technology (DoIT) also offers short courses to introduce programming.

HONORS IN THE MAJOR
Students may declare Honors in this Major in Physics in consultation with their major advisor.

HONORS IN THE PHYSICS MAJOR REQUIREMENTS
To earn a B.A. or B.S. with Honors in the Major in Physics students must satisfy both the requirements for the major (above) and the following additional requirements:

- Earn a 3.300 university GPA
- Earn a 3.300 GPA in all PHYSICS courses, and all courses accepted in the major
- Complete 12 credits for Honors in courses counting in the major, to include:
  - 9 credits at the advanced level
  - A two-semester Senior Honors Thesis in PHYSICS 681 Senior Honors Thesis and PHYSICS 682 Senior Honors Thesis for a total of 6 credits

UNIVERSITY DEGREE REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Degree</td>
<td>To receive a bachelor’s degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.</td>
</tr>
<tr>
<td>Residency</td>
<td>Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. &quot;In residence&quot; means on the UW–Madison campus with an undergraduate degree classification. &quot;In residence&quot; credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.</td>
</tr>
<tr>
<td>Quality of Work</td>
<td>Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.</td>
</tr>
</tbody>
</table>

LEARNING OUTCOMES
The physics curriculum is intended to provide a broad and thorough understanding of the fundamental properties and interactions underlying physical phenomena (including mechanical behaviors, electrical and magnetic sources and interactions, light and optics, heat, relativity of space time, quantum mechanics, atomic and nuclear structure, solid state matter, etc). Many students who major in physics as undergraduates enter graduate schools for work leading to the M.S. or Ph.D. degrees. Others seek employment in a wide range of fields in government, business, and industry. Since current research, both pure and applied, involves interdisciplinary efforts, the broad training of physics with its stress on fundamentals proves to be a valuable experience.

ADVISING AND CAREERS
PHYSICS UNDERGRADUATE ADVISORS
Professor Dan McCammon
6207 Chamberlin Hall
608-262-5916

Professor Stefan Westerhoff
4209 Chamberlin Hall
608-262-3989

Professor Michael Winokur
5106 Chamberlin Hall
608-262-5425

AMEP Advisor
Professor Cary Forest
3277 Chamberlin Hall
608.263.0486

CAREER RESOURCES
The UW Department of Physics encourages our majors to begin working on their career exploration and preparation soon after arriving on campus. We partner with the L&S Career Services office to help you leverage the academic skills learned in your major and liberal arts degree, explore and try out different career paths, participate in internships, prepare for the job search and/or graduate school applications, and network with professionals in the field (alumni and employers).

Letters & Science graduates are in high demand by employers and graduate programs. It is important to us that our students are career ready at the time of graduation, and we are committed to your success.

Career Resources:
- Why the liberal arts? (http://ls.wisc.edu/about/why-liberal-arts)
- Set up a Career Advising Appointment (http://careers.ls.wisc.edu/Undergraduate-Advising.htm)
- L&S Career Services (http://careers.ls.wisc.edu/students.htm): We launch our students higher, sooner
- INTER-LS 210 L&S Career Development: Taking Initiative (1 credit, targeted to first- and second-year students)
- Learn how we’re transforming career preparation: L&S Career Initiative (http://ls.wisc.edu/about/lsci?p=careerinitiative.html)

Additional Resources:
- Link to physics department advising page (https://www.physics.wisc.edu/undergrads/resources/advising)
- Link to physics department student jobs and research opportunities (https://www.physics.wisc.edu/resources/employment/student-jobs)
PEOPLE

FACULTY

Yang Bai (https://www.physics.wisc.edu/people/yangbai), Associate Professor

Baha Balantekin (https://www.physics.wisc.edu/people/bahabalantekin), Professor

Vernon Barger (https://www.physics.wisc.edu/people/vernon-dbarger), Professor

Stas Boldyrev (https://www.physics.wisc.edu/people/stanislavboldyrev), Professor

Victor Brar (https://www.physics.wisc.edu/people/victorbrar), Assistant Professor

Duncan Carlsmith (https://www.physics.wisc.edu/people/duncancarlsmith), Professor

Daniel Chung (https://www.physics.wisc.edu/people/daniel-jchung), Professor

Susan Coppersmith (https://www.physics.wisc.edu/people/susan-coppersmith), Professor

Sridhara Dasu (https://www.physics.wisc.edu/people/sridharadasu), Professor

Jan Egedal (https://www.physics.wisc.edu/people/janegedal), Associate Professor

Mark Eriksson (https://www.physics.wisc.edu/people/markeriksson), Professor

Lisa Everett (https://www.physics.wisc.edu/people/lisa-leverett), Professor

Gary Shiu (https://www.physics.wisc.edu/people/garyshiu), Professor

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Justin Vandenbroucke (https://www.physics.wisc.edu/people/justinvandenbroucke), Assistant Professor

Maxim Vavilov (https://www.physics.wisc.edu/people/maxim-gvavilov), Professor

Thad Walker (https://www.physics.wisc.edu/people/thad-gwalker), Professor

Stefan Westerhoff (https://www.physics.wisc.edu/people/stefanwesterhoff), Professor and Undergraduate Advisor

Michael Winokur (https://www.physics.wisc.edu/people/michael-jwinokur), Professor and Undergraduate Advisor

Sau Lan Wu (https://www.physics.wisc.edu/people/sau-lanwu), Professor

Deniz Yavuz (https://www.physics.wisc.edu/people/denizyavuz), Professor

Ellen Zweibel (https://www.physics.wisc.edu/people/ellen-gzweibel), Professor

James Lawler (https://www.physics.wisc.edu/people/james-elawler), Professor

Alex Levchenko (https://www.physics.wisc.edu/people/alexlevchenko), Assistant Professor

Chun Lin (https://www.physics.wisc.edu/people/chun-clin), Professor

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Marshall Onellion (https://www.physics.wisc.edu/people/marshall-fonellion), Professor

Kimberly Palladino (https://www.physics.wisc.edu/people/kimberly-jpalladino), Associate Professor

Yibin Pan (https://www.physics.wisc.edu/people/yibinpan), Associate Professor

Mark Rzchowski (https://www.physics.wisc.edu/people/markrzchowski), Associate Chair and Professor

Mark Saffman (https://www.physics.wisc.edu/people/marksaffman), Professor

John Sarff (https://www.physics.wisc.edu/people/john-ssarff), Professor

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Ellen Zweibel (https://www.physics.wisc.edu/people/ellen-gzweibel), Professor

Albrecht Karle (https://www.physics.wisc.edu/people/albrechtkarle), Department Chairperson and Professor
THE PHYSICS CLUB
The University Physical Society (UPS)—also known as the Physics Club—is a student organization for people interested in physics and related fields.

WHAT DOES THE PHYSICS CLUB DO?
The Physics Club organizes events such as seminars, tours, trips, and socials for its members. Physics Club volunteers also offer free drop-in tutoring to students in introductory physics and astronomy classes. In addition, we maintain subscriptions to science related magazines such as Scientific American, Astronomy, and Physics Today, which are kept in the club's room located at 2328 Chamberlin Hall. Every Friday afternoon, we meet with the physics colloquium speaker to learn about the process of becoming a scientist. In addition, UPS sponsors a variety of other events. For example, in the past, we have taken a field trip to Fermilab, sponsored a racquetball tournament, and have frequently gathered for social events such as ice skating, movie night, and bowling.

WHY SHOULD YOU JOIN THE PHYSICS CLUB?
By joining the Physics Club you'll be meeting many physics majors, who are, in general, really cool people to hang out with. If you are thinking about declaring a physics major, this is the place to come for helpful advice about taking classes and finding undergraduate job in the physics department. If you join, you can get access to the Physics Club room, 2328 Chamberlin Hall. Joining also adds you to the club email list, so you can be notified about club sponsored events.

PERKS OF BEING A PHYSICS CLUB MEMBER
When you join the Physics Club, you get access to an excellent room, 2328 Chamberlin Hall. This room contains a refrigerator, reference shelves of textbooks, couch, tables, and chairs, a phone, blackboards, and a microwave. We have a several computers in the room. You can get your own key to the room and visit at your leisure, and stay as long as you like. Plus, you get the added bonus of knowing people who are in your classes.

University Physical Society
2328 Chamberlin Hall
ups.physics.wisc.edu
ups-officers@googlegroups.com
To Join:
Drop by Room 2328 Chamberlin Hall and pick up a membership form.
Turn in a completed form with your $5 annual dues to a UPS club officer.

RESOURCES AND SCHOLARSHIPS
STUDENT AWARDS
The Fay Ajzenberg-Selove Award is presented to undergraduate women majoring in physics, astronomy, or physics/astronomy for the purpose of encouraging women to continue their careers in science. Dr. Ajzenberg-Selove, who received her Ph.D. in physics in 1952, is currently a professor emerita the University of Pennsylvania.

The Dr. Maritza Irene Stapanian Crabtree Award in physics was established by William Crabtree to honor his wife, Dr. Maritza Crabtree, who graduated with a physics degree in 1971. This annual award benefits undergraduate students in physics based equally on merit and need. The Bernice Durand Undergraduate Research Scholarship was established by Vice Provost/Physics Professor Bernice Durand to promote meaningful undergraduate research opportunities and to...
support and encourage women and ethnic minorities as undergraduate majors in the departments of physics and astronomy.

The Henry and Eleanor Firminhac Physics Undergraduate Scholarship is given to undergraduates in physics with financial need as the primary consideration. Funding provided by Ralph Firminhac in honor of his parents.

The L. R. Ingersoll Prize is given for distinguished achievement in introductory physics. This prize is underwritten by a fund established by the family and friends of the late Professor Ingersoll, a distinguished physicist and teacher at the university who served as department chair for many years.

The Liebenberg Family Research Scholarship is for physics, AMEP (applied mathematics, engineering, and physics) or astronomy/physics majors. This scholarship opportunity was initiated by the Liebenberg family for the purpose of promoting undergraduate summer research opportunities.

The Albert Augustus Radtke Scholarship Award is given to outstanding junior or senior students majoring in physics or AMEP. This award was made possible by a bequest of the late Mrs. Elizabeth S. Radtke in honor of her husband, a 1900 degree recipient from UW–Madison.

For more information. Go to www.physics.wisc.edu/awards (https://www.physics.wisc.edu/awards) or contact info@physics.wisc.edu.

Application Process. The deadline for student application materials is March 15th. No late applications will be accepted.

To Apply. Please submit a statement of interest and how this award would help your education. If it is an award that is for financial need (Crabtree and Firminhac) you need to emphasize what the need is. If the award you are applying for also has a merit requirement, the department will run your transcript.