DEPARTMENT OF PHYSICS AND ASTRONOMY

Chair: Joel W. Walker, Ph.D. (jwalker@shsu.edu) (936) 294-4803

Website: Department of Physics and Astronomy (http://www.shsu.edu/academics/physics/)

Program Summary

Physics and Astronomy are for creative and curiously-minded students who want a shot at cracking Nature's secret source code — people who are excited by questions like “What happened right after the Big Bang?”, “How does time warp near a black hole?”, or “Can atomic systems coexist in multiple realities at once?”

Physics and Astronomy are for inventive and enterprising students who want to design humanity's future — people who are motivated by questions like "Can clean fusion energy propel equitable access to technology and resources?", "How will quantum computing revolutionize our link with information?", or "When will self-sustaining communities be established on Mars?"

Physicists work to understand the most basic laws of nature in the most simple and general way possible. Physicists likewise apply this understanding to solving engineering and design problems in every facet of modern life. Our faculty specialize in Materials Science (exploring properties of dense atomic systems computationally and with x-ray / atomic-force imaging, and designing superior molecular compounds for engineering applications like batteries and superconductors) and Particle Physics (theory and high-performance computer simulation involving elementary constituents of matter and their interactions, the Large Hadron Collider in Switzerland, the search for dark matter, and mysterious properties of the neutrino).

Astronomers seek to understand our place in the Universe, and to unravel clues about its history from light reaching us across the expanse of space. Our faculty take a special interest in the data-based improvement of approaches to science education, and have research expertise in the topics of stellar spectroscopy and ionized gas in spiral galaxies. The university observatory houses several telescopes for in-person stargazing, and our indoor planetarium provides immersive simulations of the night sky as viewed from any location and date.

Academic Programs

The department offers a Bachelor of Science degree in Physics plus several options for Pre-Engineering. Physics and Engineering go together very well, because so much of Engineering Design is built upon the underlying foundation of Physics.

Pre-Engineering includes more Math (especially Calculus) than Engineering Technology does, and it leads to very different careers. The Accreditation Board for Engineering and Technology (ABET) says that Engineering programs often focus on theory and conceptual design, while Technology programs usually focus on application and implementation. Engineers often do work involving original research and development, and many continue on to Masters or Doctoral programs in Engineering. Technologists are most likely to work in construction, manufacturing, product design, testing, or technical services and sales.

In the Dual Degree, or "3+2" program, students earn degrees in both Physics and Engineering. This starts with three years at SHSU, completing the Core Curriculum, the Calculus and Physics introductory sequence, and a portion of the upper division Physics Curriculum. Students then apply to any accredited Engineering program at an institution of their choice for the last two years of degree work. One option is UT Tyler, where a transfer agreement guarantees admission for students with a 2.5 GPA. After completion of the Engineering Degree, credits are retroactively transferred back to SHSU so that the Physics Degree can be awarded simultaneously.

The "2+2" Pre-Engineering Tracks in Civil, Mechanical, and Electrical Engineering are four-year degrees where students transfer to an accredited Engineering Program (such as UT Tyler) after completing two years at SHSU.

The Bachelor of Science degree in Physical Science with Secondary Certification is available to students seeking careers in secondary education.

The Minor in Physics pairs well with other Science, Technology, Engineering, and Mathematics (STEM) majors. It also complements a number of cross-over careers such as Science Journalism, and K-12 Science Education.

Career Opportunities

A degree in Physics or Pre-Engineering leads to many profitable career options because it develops marketable attributes and skills that employers are greatly interested in. This includes mental flexibility, capacity for critical though, abstraction and generalization, training in creative problem solving, intuition for mechanical and electrical systems, and proficiency in advanced mathematics, data analysis, and computer applications (including programming).

According to the American Institute of Physics (AIP), across the country, 95% of Physics Bachelors are either employed or enrolled in graduate school one year after graduation. PhD students in physics and astronomy usually receive a full tuition waiver plus a substantial wage or stipend. In the private sector, about 35% of graduates do engineering, 25% do computing or information, and 15% take other STEM-related jobs, all with competitive starting

salaries. A shortage of high-school physics instructors means that plenty of attractive and well-paid teaching positions are currently accepting applications across the state.

Program Specific Information

Sam Houston State University is a wonderful place to study Physics, Astronomy, and Pre-Engineering. We provide an outstanding educational environment, with small class sizes, extensive personalized attention, and expert instruction. Our students build strong resumes with hands-on faculty-directed research experiences (in topics such as Particle Physics, Materials Science, and Astronomy Education), and have the option to work as paid assistants for introductory laboratory sessions. Most of our students receive scholarship assistance directly from the department and its donors, in amounts up to $5,000 per year for outstanding candidates.

All students interested in Physics or Pre-Engineering enroll in the Physics Bootcamp (PHYS 1401) during their first semester on campus. This lets interested students see what physics is all about as early as possible, with no prerequisites. It ensures that they have math skills required in the next two years, and helps them understand what those skills are good for in Physics and Engineering. It develops confidence, teamwork, camaraderie, and a sense of belonging in the department. A weekly group-based problem-solving practice session is integrated. The Bootcamp is typically offered each Fall and Spring term.

Vision & Mission

The Department of Physics and Astronomy at Sam Houston State University will be a preferred source of technically equipped employees and scholars, and a vital participant in the global pursuit of fundamental scientific knowledge.

- Faculty will make meaningful professional contributions to their respective research disciplines and actively mentor their students in the practice of scientific investigation.
- Students majoring in physics and pre-engineering, and minoring in astronomy, will be effectively prepared to confront the quantitative, conceptual, and analytical challenges associated with a related career or continuing education.
- All students, including those from other degree programs, will be exposed to the sciences in a manner which nurtures curiosity and develops critical thinking and problem-solving skills that may be usefully projected onto their various professional endeavors and roles in society.

Curriculum

Required Courses For Major

The Bachelor of Science degree requires at least 38 hours in Physics as follows:

Code	Title	Hours
Course Requirements		
PHYS 1401	Physics Boot Camp	4
PHYS 1411	Introduction To Physics I	4
PHYS 1422	Introduction To Physics II	4
PHYS 3370 & PHYS 4110	Introduction to Theoretical Physics and Advanced Undergraduate Laboratory I	4
PHYS 3391 & PHYS 3111	Modern Physics I and Modern Physics Laboratory I	4
PHYS 4366	Introduction to Quantum Mechanics	3
PHYS 4368	Electricity And Magnetism	3
PHYS 4370	Classical Mechanics	3
PHYS 4371	Thermodynamics and Statistical Mechanics	3
PHYS 4395	Undergraduate Research	3
Select 1 or more advanced electives:		3-12
PHYS 3395 & PHYS 3115	Electronics & Circuit Analysis and Electronics and Circuit Analysis Lab	
PHYS 4333 & PHYS 4113	Light And Optics and Light And Optics	
PHYS 4367	Introduction to Solid State Physics	
PHYS 4396	Selected Topics In Physics	
ASTR 3303	Life in the Universe	
ASTR 3383	Cosmic Catastrophes	
Total Hours		**38-47**

All Physics majors meet the requirements for a minor in mathematics.

- Bachelor of Science, Major in Physics/Engineering Dual Degree (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/bs-physics-engineering-dual-degree/)
- Bachelor of Science, Major in Physics (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/bs-physics/)
- Bachelor of Science, Major in Physics: Civil Engineering 2+2 (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/bs-physics-civil-engineering/)
- Bachelor of Science, Major in Physics: Electrical Engineering 2+2 (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/bs-physics-electrical-engineering/)
- Bachelor of Science, Major in Physics: Mechanical Engineering 2+2 (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/bs-physics-mechanical-engineering/)
- Minor in Astronomy (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/minor-astronomy/)
- Minor in Physics (http://catalog.shsu.edu/undergraduate/colleges-academic-departments/science-and-engineering-technology/physics-and-astronomy/minor-physics/)

Employment as a Research or Teaching Assistant

Physics Majors may be paid to participate in faculty-lead research projects (funded by grants from the National Science Foundation or NASA, for example), to help students in introductory physics courses with their laboratory assignments, or to work in the campus tutoring center.

Student Organizations

The Society of Physics is a nationally recognized organization. Students organize science discussions, service projects, construction of demonstrations, graduate school preparation, field trips, tutoring, events hosting potential students, and attendance at professional meetings.

Scholarships

The Physics and Astronomy Department awards scholarships on a competitive basis. Almost all students enrolled in the major receive some assistance, and students with strong GPAs and financial need may be eligible for the prestigious Burroughs or Steele Scholarships, with award amounts from $3,500 to $5,000 per year. Interested applicants should inquire with the department at (936) 294-1601. Other Federal and University scholarships are also available, and additional information may be obtained at the Office of Academic Scholarships (http://www.shsu.edu/dept/financial-aid/scholarships/) or by telephone (936) 294-1672.

Astronomy

ASTR 3303. Life in the Universe. 3 Hours.
Students explore the evolution of life on Earth from an astronomical perspective and investigate the likelihood that this could happen elsewhere in the universe. This course also explores the possibility of communicating with intelligent species elsewhere in our galaxy and how humanity could best go about doing so. This course is typically taught every other spring term.
Prerequisite: PHYS 1403 or PHYS 1404.

ASTR 3383. Cosmic Catastrophes. 3 Hours.
Students build on knowledge of basic astronomical concepts discussed in previous coursework. Topics may include supernovae, neutron stars, black holes, gamma-ray bursts, worm holes, extra dimensions, and determination of the origin, state, and fate of the universe. This course is typically taught every other fall term.
Prerequisite: PHYS 1403 with a C or better.

Physics

PHYS 1101. General Physics Laboratory I. 1 Hour. [TCCN: PHYS 1101]
Laboratory taken in conjunction with PHYS 1301.
Prerequisite: MATH 1410 or MATH 1316 or MATH 1420 .

PHYS 1102. General Physics Laboratory II. 1 Hour. [TCCN: PHYS 1102]
Laboratory taken in conjunction with PHYS 1302.

PHYS 1105. Classical Physics and Thermodynamics Lab. 1 Hour. [TCCN: PHYS 1105]
Laboratory taken in conjunction with PHYS 1305.

PHYS 1301. General Physics-Mechanics and Heat. 3 Hours. [TCCN: PHYS 1301]
A modern treatment is made of the laws and principles of motion, force, momentum, energy, and rotation. This course is intended for science majors whose degree plan does not require a calculus-based treatment. The PHYS 1101 experimental laboratory course should be taken concurrently.
Prerequisite: MATH 1410 or MATH 1316 or MATH 1420.

PHYS 1302. General Physics-Sound, Light, Electricity, and Magnetism. 3 Hours. [TCCN: PHYS 1302]
The course is a continuation of PHYS 1301, covering the subjects of electricity and magnetism, including circuits applications. The course is intended for science majors whose degree plan does not require a calculus-based treatment. The PHYS 1102 experimental laboratory course should be taken concurrently.
Prerequisite: PHYS 1301 and MATH 1316 or MATH 1410 or MATH 1420.

PHYS 1305. Classical Physics and Thermodynamics. 3 Hours. [TCCN: PHYS 1305]
Students study the fundamentals of motion, forces, energy, and heat at a conceptual level. The course is intended for students who are not science majors, including those on primary and middle school education tracks.

PHYS 1401. Physics Boot Camp. 4 Hours.
Students engage in a review of the essential mathematical and problem solving skills required for the first two years of the physics, pre-engineering, and certain engineering-technology degree plans. Applications focus on the context of physics and engineering examples, starting from first principles. All students considering a physics or pre-engineering major should enroll in the Bootcamp during their first semester on campus. A weekly group problem solving practice session is integrated.

PHYS 1403. Stars & Galaxies. 4 Hours. [TCCN: PHYS 1403]
Students study the universe beyond the solar system. Topics may include the nature of stars, stellar evolution, galaxies, quasars, cosmology, the universe as a whole, and theories about the origin and fate of the universe. Students are introduced to tools astronomers use to determine such properties as temperatures, compositions, motions, masses, and evolution of astronomical objects. Note: PHYS 1403 and PHYS 1404 may be taken in either order. Course Equivalents: PHYS 1312 .

PHYS 1404. Solar System Astronomy. 4 Hours. [TCCN: PHYS 1404]
Students study the solar system as well as other planetary systems. Topics may include the nature of science, apparent motions in the sky, the historical development of the laws governing the solar system, the structure and membership of solar system objects, the formation of the solar system, and extrasolar planets and our understanding of other solar systems. Note: PHYS 1403 and PHYS 1404 may be taken in either order. Course Equivalents: PHYS 1311 .

PHYS 1411. Introduction To Physics I. 4 Hours. [TCCN: PHYS 2425]
Students are introduced to the topics of classical mechanics, including linear motion, forces, rotation, and conservation laws. Considerable attention is given to the solution of problems with the emphasis placed on fundamental concepts. Students must register concurrently for the integrated weekly laboratory problem-solving session. Calculus I (MATH 1420) may be taken concurrently by students who have completed Physics Bootcamp (PHYS 1401).
Prerequisite: MATH 1420.

PHYS 1422. Introduction To Physics II. 4 Hours. [TCCN: PHYS 2426]
Students are introduced to the topics of electricity and magnetism, including Maxwell?s equations, the Lorentz force, and basic electrical circuits. Considerable attention is given to the solution of problems with the emphasis placed on fundamental concepts. Students must register for the integrated weekly laboratory problem-solving session. Completion of Calculus II (MATH 1430) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 1411 and MATH 1430.

PHYS 2426. Heat, Waves & Modern Physics. 4 Hours.
An introduction to topics in heat and wave motion including sound and light. The quantitative description of phenomena is emphasized. The laboratory continues as an integral part of the course.
Prerequisite: PHYS 1411 and MATH 1420.

PHYS 3111. Modern Physics Laboratory I. 1 Hour.
Laboratory taken in conjunction with PHYS 3391. Students reproduce key experimental outcomes underlying 20th century physics.
Prerequisite: PHYS 1422.

PHYS 3115. Electronics and Circuit Analysis Lab. 1 Hour.
Laboratory taken in conjunction with PHYS 3395. Students construct and analyze advanced circuits including both classical and semiconductor-based components.
Prerequisite: PHYS 1422 .

PHYS 3117. Astronomy Laboratory. 1 Hour.
Laboratory taken in conjunction with PHYS 3397. 1 Credit.

PHYS 3360. Statics And Dynamics. 3 Hours.
Students study equilibrium, using concepts of force and torque. Vectors, calculus and differential equations are used. Completion of Calculus II (MATH 1430) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 1411 and MATH 2440.

PHYS 3370. Introduction to Theoretical Physics. 3 Hours.
Students study the essential techniques of mathematical analysis required for the latter two years of the physics degree plan. The course focuses on physics applications of series (Taylor, Fourier, Laurent), vector calculus, generalized coordinates, differential equations, special functions, and complex analysis. Students register concurrently for the PHYS 4110 laboratory. Completion of Calculus III (MATH 2440) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 1422 and MATH 2440.

PHYS 3391. Modern Physics I. 3 Hours.
Students explore the historical breakdown of classical physics that occurred at the beginning of the 20th century, presaging the introduction of Relativity Theory and Quantum Mechanics. Significant treatment of probability and statistics is integral to the understanding of these topics. Completion of Calculus III (MATH 2440) is recommended, though it may be taken concurrently. PHYS 3111 must be taken concurrently.
Prerequisite: MATH 2440 and PHYS 1422.

PHYS 3395. Electronics & Circuit Analysis. 3 Hours.
Students study advanced circuit analysis, including analog filters, digital integrated circuits such as op-amps, selected discrete components such as diodes and transistors, and applications to various digital and analog systems. The PHYS 3115 laboratory must be taken concurrently. Completion of Calculus III (MATH 2440) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 1422 .

PHYS 3397. Astronomy. 3 Hours.
Students continue their study of the solar system, sun, stars, and stellar systems, their motions, structure, energy sources and evolution, star clusters, interstellar matter, galaxies, and cosmology. The PHYS 3117 laboratory must be taken concurrently.
Prerequisite: PHYS 3117 must be taken concurrently.

PHYS 3398. Astronomy-Honors. 3 Hours.

PHYS 4110. Advanced Undergraduate Laboratory I. 1 Hour.
Laboratory taken in conjunction with PHYS 3370. Students are introduced to methods of analysis (e.g. statistical distributions, likelihoods, and error propagation) and technologies (e.g. programming with Python, symbolic algebra and visualization with Mathematica, typesetting with LaTeX, and the Linux operating system) commonly used in graduate study and research applications.

PHYS 4113. Light And Optics. 1 Hour.
Laboratory taken in conjunction with PHYS 4333. Students reproduce key experimental outcomes with lensing, reflection, interference and diffraction. Credit 1.

PHYS 4331. Physics For Forensic Sciences. 3 Hours.
Forensic science makes use of a number of physical techniques. Students are provided with an understanding of the physics used in forensic science that enhances the standard introductory physics course. Topics covered may include interior and exterior ballistics, optics, stress and strain, elementary fluid mechanics.

PHYS 4333. Light And Optics. 3 Hours.
The wave theory of light is emphasized. Phenomena such as interference, diffraction, reflection, transmission, and polarization are treated with quantitative detail. The PHYS 4113 laboratory must be taken concurrently. Completion of Calculus III (MATH 2440) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 1422 .

PHYS 4366. Introduction to Quantum Mechanics. 3 Hours.
The subject of quantum mechanics describes the wave nature of matter, which is relevant at atomic scales. Topics may include the harmonic oscillator, potentials, symmetries, rotation and spin, the hydrogen atom, and atomic spectra. Completion of Differential Equations (MATH 3376) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 3391 and MATH 3376 with a grade of C or better.

PHYS 4367. Introduction to Solid State Physics. 3 Hours.
Students are introduced to the concepts of crystal structure, diffraction, reciprocal lattices, binding, phonons, the free electron Fermi gas, semi-conductors, energy bands, Fermi surfaces, point defects, and optical properties of crystals. Completion of Differential Equations (MATH 3376) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 3391.

PHYS 4368. Electricity And Magnetism. 3 Hours.
Students engage in a more advanced treatment of the classical theory of Electricity and Magnetism which extends the material covered in PHYS 1422. Maxwell's equations are studied in integral and differential form. Topics may include electro- and magneto-statics and dynamics, potentials, fields, waves, and applications to materials. Completion of Differential Equations (MATH 3376) is recommended, though it may be taken concurrently.
Prerequisite: MATH 3376 and PHYS 1422.

PHYS 4370. Classical Mechanics. 3 Hours.
Students engage in a more advanced treatment of the classical theory of Mechanics which extends the material covered in PHYS 1411. Newton's second law is treated as a differential equation to study kinematics, oscillations, and conservation laws. Lagrangian dynamics are introduced, along with generalized coordinates. Additional topics may include orbital motion, rigid bodies, coupled systems, and effective potentials. Completion of Calculus III (MATH 2440) is recommended, though it may be taken concurrently.
Prerequisite: MATH 3376.

PHYS 4371. Thermodynamics and Statistical Mechanics. 3 Hours.
Students study foundational concepts of classical thermodynamics, including the first and second laws, properties of gases, entropy, and thermodynamic functions. These concepts are formally connected to and derived from their origins in statistical mechanics. Completion of Differential Equations (MATH 3376) is recommended, though it may be taken concurrently.
Prerequisite: PHYS 3391 and MATH 3376.

PHYS 4395. Undergraduate Research. 3 Hours.
Students conduct original research under the direct supervision of a faculty member. Projects may be supervised by non-physics faculty with departmental approval. Each student is expected to demonstrate initiative in planning, performing, and reporting work done on the selected topic. The course may be repeated for up to a total of 6 credit hours with departmental approval.
Prerequisite: Consent of Department Chair.

PHYS 4396. Selected Topics In Physics. 3 Hours.
Students study various advanced topics of contemporary interest in physics. The course is offered upon demand, and content is dependent upon faculty availability and student interest. May be repeated for additional credit with distinct course content.
Prerequisite: Consent of the instructor.

PHYS 4398. Senior Thesis. 3 Hours.
This is a directed elective for upper-division students majoring in Physics and/or minoring in Astronomy who seek to couple original research or guided independent study with an exercise in technical writing. Research activities in the fundamental or applied sciences, including science education, and/or a topically similar literature review, are supervised by a member of the Physics and Astronomy faculty. Findings are presented in an organized written form of suitable length with appropriate attention to scholarly norms, e.g. in the handling of data and citation of prior works.
Prerequisite: Approval of the Supervising Faculty Member.

Director/Chair: **Joel W Walker**

Dalgis Barras, PHD (dmd073@shsu.edu), *Lecturer of Physics*, *Department of Physics & Astronomy*, PHD, LSU & A&M College; BS, Florida Int'L Univ

James Blackman Dent, PHD (jxd087@shsu.edu), *Associate Professor of Physics*, *Department of Physics & Astronomy*, PHD, Texas A&M University; BS, Missouri Univ of Sci and Tech

Hui Fang, PHD (hfang@shsu.edu), *Professor of Physics*, *Department of Physics & Astronomy*, PHD, Univ of Houston-Main; ME, Univ of Houston-Main; MS, Zhejiang University; BS, Zhejiang University

Barry Friedman, PHD (phy_baf@shsu.edu), *Professor of Physics*, *Department of Physics & Astronomy*, PHD, Univ of Illinois-Urbana; MS, Univ of Illinois-Urbana; BA, Rice University

Daniel Taylor Horenstein, MS (dth041@shsu.edu), *Lecturer of Physics and Astronomy*, *Department of Physics & Astronomy*, MS, Georgia State University; BA, Columbia University

Carol Renee James, PHD (phy_crj@shsu.edu), *Professor of Physics*, *Department of Physics & Astronomy*, PHD, Univ of Texas At Austin; MA, Univ of Texas At Austin; BA, Rice University

Doo Jin Kim, PHD (dxk045@shsu.edu), *Lecturer of Physics and Astronomy*, *Department of Physics & Astronomy*, PHD, Univ of Maryland-College Park; MS, Indiana University; BS, Seoul National University

Gan Liang, PHD (phy_gnl@shsu.edu), *Professor of Physics*, *Department of Physics & Astronomy*, PHD, Rutgers University; BS, Beijing University

Scott T Miller, PHD (stm009@shsu.edu), *Professor of Physics*, *Department of Physics & Astronomy*, PHD, Univ of Maryland-College Park; MS, Univ of Maryland-College Park; BA, Rutgers University; BS, Rutgers University

William Madsen Shepherd, PHD (shepherd@shsu.edu), *Assistant Professor of Physics*, *Department of Physics & Astronomy*, PHD, Univ of Calif-Irvine; MS, Northwestern University; MS, Northwestern University; BA, Northwestern University; BA, Northwestern University; BA, Northwestern University

Joel W Walker, PHD (jwalker@shsu.edu), *Professor and Chair of Physics*, *Department of Physics & Astronomy*, PHD, Texas A&M University; PHD, Texas A&M University; BS, Harding University; BS, Harding University

Nelka Chithrani Wijesinghe, PHD (ncw020@shsu.edu), *Lecturer of Physics*, *Department of Physics & Astronomy*, PHD, Univ of Houston-Main; MS, Univ of Houston-Main; BSC, Univ of Peradeniya