

# Physics and Astronomy

## Chair

Gregory G. Howes

## Director, Undergraduate Studies

Jane M. Nachtman

## Director, Graduate Studies

Allison N. Jaynes

## Director, Research Operations

Casey DeRoo

**Undergraduate majors:** physics (BA, BS); applied physics (BS); astronomy (BA, BS)

**Undergraduate minors:** physics; astronomy

**Graduate degrees:** MS in physics; MS in astronomy; PhD in physics

**Faculty:** <https://physics.uiowa.edu/people>

**Website:** <https://physics.uiowa.edu/>

## Facilities

The department has a number of well-equipped laboratories and observatories. Faculty, students, and staff access national supercomputers via the internet, and have access to high performance computing clusters on campus. The central machine shop is fully equipped and staffed by skilled instrument makers and machinists, and there are electronics and machine shops for use by advanced students and research staff.

Experimental research is conducted in astronomy (optical, radio, and X-ray), atomic and molecular physics, condensed matter physics, elementary particle physics, laser physics, medical physics, plasma physics, and space physics. Extensive facilities are available for the construction of specialized research equipment and for data processing and analysis.

State-of-the-art semiconductor materials and devices are grown in two molecular beam epitaxy machines. Ultrafast laser techniques are developed and used to probe electron transport, energy relaxation, recombination, and spin dynamics in the novel nanostructures grown in these machines. Experiments are also conducted on laser-induced coherent phenomena and coherent control of charge carriers in semiconductor nanostructures. The experimental condensed matter program is closely coordinated with the condensed matter theory group.

Plasma physics is an active area of experimental and theoretical research. Laboratory experiments studying plasma processes of importance in various space and astrophysical plasmas are performed in a Q machine, including experiments on waves and instabilities in dusty plasmas. Additional laboratory and microgravity experiments with dusty plasmas include studies of Coulomb crystals, shocks, and complex fluids. Glow discharges for plasma processing applications are studied using laser diagnostics and numerical simulations. Wave propagation and plasma particle dynamics are

also studied in collisionless plasmas through laboratory experiments. Laser techniques are developed for measuring plasma flow and following particle orbits. Plasma theory efforts include analytical and numerical investigations of magnetic reconnection and turbulence in space and astrophysical plasmas; collaboration with laboratory and space plasma experimental groups in strongly coupled dusty plasmas, waves, and instabilities; and free electron lasers and hydrodynamic turbulence.

State-of-the-art laser systems are available for high-resolution spectroscopic measurement and ultrafast studies of molecular structure, for collisional relaxation and nonlinear optical effects in atomic and molecular systems, and for plasma diagnostics.

Experimental research in elementary particle physics is carried out at Fermi National Accelerator Laboratory, Stanford Linear Accelerator Center, CERN in Switzerland, and other international laboratories. The present generation of high-energy experiments has been designed to probe both the strong nuclear force and the weak interactions.

The department is well-equipped for research and instruction in observational astronomy. The primary optical instrument is a fully automated 15-inch telescope at a dark-sky site in Arizona. The telescope is equipped with CCD cameras and a variety of filters. There are 3-meter and 4.5-meter radio telescopes on the roof of Van Allen Hall, which are used for instruction and student research projects.

Research programs in galactic and extragalactic radio astronomy are carried out using the facilities of the National Radio Astronomy Observatory, including the Very Large Array and the Very Long Baseline Array, one element of which is 10 miles north of campus. Current long-term research activities include studies of the center of the Milky Way galaxy; investigations of extragalactic radio sources; the formation of powerful winds in young, luminous stars; radio-wave scattering in the interstellar and interplanetary media; and interacting binary stars. There is a research program in X-ray astronomy and a laboratory for instrument development. Research topics in X-ray astronomy concentrate on observations of X-ray emission from black holes and supernova remnants, using existing spacecraft.

Active theoretical research is carried on in astrophysics; atomic, molecular, and optical physics; condensed matter physics; elementary particle physics; laser physics; mathematical physics; nuclear physics; plasma physics; and space physics. An active mathematical physics seminar fosters the exchange of ideas between mathematics and physics.

The primary emphasis of Iowa's program in experimental and theoretical space physics is on studies of cosmic and heliospheric physics, magnetospheric physics, and magnetosphere-ionosphere interactions. Facilities are available for designing and constructing spaceflight instruments. Investigators in the department have flown instruments for studying plasmas, energetic charged particles, auroral images, plasma waves, and radio emissions on a wide variety of terrestrial and planetary spacecraft, including Pioneer 10 and 11, Dynamics Explorer, Voyager 1 and 2, Galileo, Polar, Cassini, and Mars Express.