UNIVERSITY OF TOLEDO

Department of Physics and Astronomy

Programs of Study

The University of Toledo (UT) Department of Physics and Astronomy offers M.S., M.S.E. (Master of Science and Education), and Ph.D. degrees in physics with specializations in astronomy and astrophysics, atomic and molecular physics, biophysics, condensed-matter physics and materials science, medical physics, and photonics. The M.S. in physics is a professional master's degree, preparing students for responsible positions in industrial and academic/government research support. It has flexible course requirements, requires a thesis, and usually requires two years of full-time study to complete. A joint Ph.D. in physics/M.S. in electrical engineering is also available. The Ph.D. has a number of required courses and takes five to seven years to complete. Requirements include residence for at least two consecutive semesters, successful completion of a qualifying and a comprehensive examination, completion of a thesis, and successful defense of the thesis.

A major graduate research focus is in experimental and theoretical studies of thin films, especially photovoltaics, magnetic nanostructures, and surface growth. A second major focus is in astronomy/astrophysics, with studies of stellar atmospheres and envelopes, star formation, interstellar matter, and climate on Mars. The atomic and molecular physics focus includes studies of quantum-condensed phases, Rydberg state lifetimes, and accelerator-based optical spectroscopy. The medical and biological physics includes accelerator-based research in radiation oncology and DNA bonding and structure. The plasma physics focus is on the self-consistent kinetic description of low-pressure discharges, especially under external electric and magnetic field influence. The photonics research focuses on the design of optical integrated circuits and waveguides. The department has a collective strength and focus on advanced computational methods in treating astrophysical, atomic, plasma, and materials problems.

Research collaboration on-campus includes chemists and chemical, electrical, and mechanical engineers. Department faculty members serve as the core of UT's Center for Photovoltaic Electricity and Hydrogen recently established by a major state of Ohio grant with matching support from several industrial collaborators.

Research Facilities

Thin-film materials laboratories include high- and ultrahigh-vacuum deposition systems using glow-discharge and hot-wire deposition, sputtering, and MBE, and incorporate in situ spectroscopic ellipsometry. Other materials and device characterization include the magnetooptical Kerr effect, Raman, photoluminescence, AFM/STM, SEM/EDS, quantum efficiency, and current-voltage dependence under solar simulation. Ritter Observatory houses a 1-meter reflecting telescope that is used for studies of variable stellar spectra. Some UT astronomers' research programs are based on observations made at external ground- and space-based facilities. Atomic physics research is done with 300-keV heavy-ion and 80-keV negative-ion accelerators. Lasers are also used for thin-film scribing and thin-film index-of-refraction measurements. Computing facilities include UNIX workstations and three cluster computing systems. Supercomputer access is provided through the Ohio Supercomputing Center via Internet 2.

Financial Aid

Assistantship stipends for the twelve-month period beginning August 2005 are $19,000. Scholarships/stipend enhancements and fellowships are available for exceptionally qualified students. Students who advance in the program are eligible for research assistantships, some of which pay higher stipends. Assistants spend about 20 hours per week on their duties.

Cost of Study

Graduate assistants do not pay tuition. They contribute $1221 per year to University-provided medical insurance and pay a general fee of $532 each semester. Stipends are subject to U.S. federal (about 15 percent) and Ohio state (much lower) income tax.

Living and Housing Costs

Major apartment complexes, smaller apartment buildings, houses, rooms, and duplexes are all listed on the University housing Web site (http://www.residencelife.utoledo.edu/). For example, complexes within 1 mile of campus or served by campus shuttle buses offer one-bedroom apartments for $350 to $425 per month. Food and entertainment costs are low compared with those in larger cities.

Student Group

As of the fall semester of 2005, the department included 57 graduate students, of whom 10 were women, 30 were international students, and 51 had research or teaching assistantships. Of those who did not have assistantships, 2 had fellowships and the rest were self-supporting. Most were pursuing the Ph.D. degree. Qualities sought in applicants include intellectual curiosity, strong motivation for advanced study, and physical and mathematical reasoning ability.

Student Outcomes

Examples of professional situations of recent graduates include postdoctoral fellowships at Vanderbilt, LSU, Johns Hopkins, Malin Space Science Systems, and Space Telescope Science Institute. Several recent photonics and materials science graduates are employed in Silicon Valley and other industrial jobs.

Location

The University's attractive campus is located in an urban, residential setting, near good shopping and excellent housing. The city's principal cultural attraction is the Toledo Museum of Art, which is served by University shuttle buses. Toledo has upper-division minor-league baseball and ice hockey teams. Major recreational areas on Lake Erie are within an hour's drive.

The University and The Department

As a member of the State of Ohio System, the University of Toledo is recognized as one of the nation's major regional universities. The Department of Physics and Astronomy is recognized as one of its flagship departments. The department has strong research collaborations with the Department of Chemistry and the College of Engineering through interdisciplinary research in materials science.

Applying

Applications should be submitted to the Graduate School, UH 3240, University of Toledo, Toledo, Ohio 43606-3390, or online at http://www.utoledo.edu/grad-school/OhioMentorApply.htm. The aptitude section of the Graduate Record Examinations is required of international students and of domestic students whose GPA is less than 2.7 on a 4-point scale. Applications for assistantships should be completed six months before intended first enrollment, although later applications can sometimes be accepted.

Correspondence and Information

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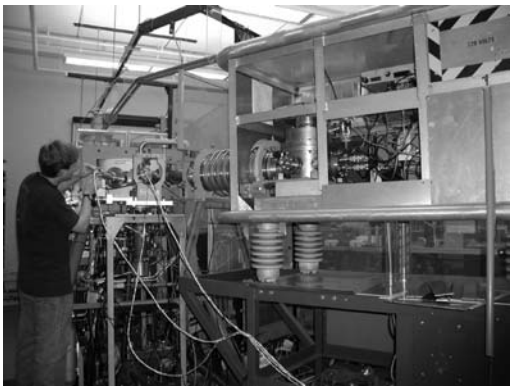
THE FACULTY AND THEIR RESEARCH

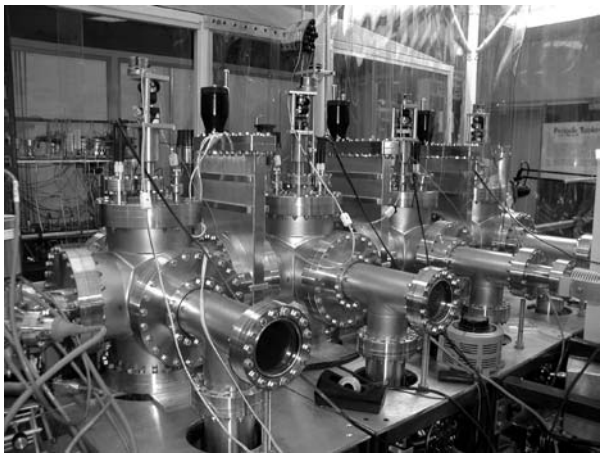
Astronomy
Lawrence Anderson-Huang, Professor; Ph.D., Berkeley, 1977. Stellar atmospheres.
Jon Bjorkman, Associate Professor; Ph.D, Wisconsin, 1992. Theory of stellar envelopes and winds.
Karen Bjorkman, Professor; Ph.D., Colorado, 1989. Circumstellar matter/stellar winds.
Bernard Bopp, Professor; Ph.D., Texas, 1973. Science education.
Steven Federman, Professor; Ph.D., NYU, 1979. Interstellar chemistry.
Philip James, Distinguished University Professor; Ph.D., Wisconsin, 1966. Martian climate and weather.
Nancy Morrison, Professor; Ph.D., Hawaii, 1975. Stellar spectroscopy: massive stars.
Tom Megeath, Assistant Professor; Ph.D., Cornell, 1993. Star formation and infrared astronomy.
Adolf Witt, Distinguished University Professor; Ph.D., Chicago, 1967. Interstellar dust.

Physics
Jacques Amar, Associate Professor; Ph.D., Temple, 1985. Condensed matter/materials science.
Brian Bagley, Professor; Ph.D., Harvard, 1968. Optics/materials science.
Randy Bohn, Emeritus Professor; Ph.D., Ohio State, 1969. Solid-state physics.
Song Cheng, Associate Professor; Ph.D., Kansas State, 1991. Atomic physics.
Robert Collins, Professor and NEG Endowed Chair in Silicate and Materials Science; Ph.D., Harvard, 1982. Condensed matter/materials science.
Alvin Compaan, Professor and Chair; Ph.D., Chicago, 1971. Condensed-matter physics/materials science.
Larry Curtis, Distinguished University Professor; Ph.D., Michigan, 1963. Atomic spectroscopy.
Robert Deck, Emeritus Professor; Ph.D., Notre Dame, 1961. Nonlinear optics.
Xunming Deng, Professor; Ph.D., Chicago, 1990. Materials science/photovoltaics.
David Ellis, Professor; Ph.D., Cornell, 1964. Theoretical atomic physics.
Bo Gao, Associate Professor; Ph.D., Nebraska–Lincoln, 1989. Theoretical physics.
Victor Karpov, Professor; Ph.D., Polytechnic (Russia), 1979. Condensed matter/theoretical physics.
Sanjay V. Khare, Assistant Professor; Ph.D., Maryland, 1996. Theoretical condensed matter/materials science.
Thomas Kvale, Professor; Ph.D., Missouri–Rolla, 1984. Experimental atomic physics.
Scott Lee, Professor; Ph.D., Cincinnati, 1983. Biological physics and high-pressure physics.
R. Ale Lukaszew, Associate Professor; Ph.D., Wayne State, 1996. Condensed matter/materials science.
Sylvain Marsillac, Assistant Professor; Ph.D., Nantes (France), 1996. Materials science/photovoltaics.
Richard Schectman, Emeritus Professor; Ph.D., Cornell, 1962. Atomic physics.
Constantine Theodosiou, Professor; Ph.D., Chicago, 1977. Atomic and plasma physics.

Graduate students at the base of the Ritter Observatory telescope preparing for a night of observations.



Graduate student working on one of the two ion accelerators used for research in the department.



Multiple UHV chamber system for plasma-enhanced CVD and sputter deposition of triple-junction, amorphous silicon solar cells.

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SELECTED PUBLICATIONS

Yu, J., **J. G. Amar,** and A. Bogicevic. First principles calculations of steering forces in epitaxial growth. *Phys. Rev. B* 69:113406, 2004.

Yu, J., and **J. G. Amar.** Short-range attraction, surface currents, and mound formation in metal (111) epitaxial growth. *Phys. Rev. B* 69:04526, 2004.

Amar, J. G., and M. N. Popescu. Asymptotic capture number and island-size distributions for one-dimensional irreversible submonolayer growth. *Phys. Rev. B* 69:033401, 2004.

Deck, R. T., A. L. Sala, Y. Sikorski, and **B. G. Bagley.** Loss in a rectangular optical waveguide induced by the crossover of a second waveguide. *Opt. Laser Technol.* 34:351–6, 2002.

Mirkov, M. G., **B. G. Bagley,** and R. T. Deck. Design of multichannel optical splitter without bends. *Fiber Integr. Opt.* 20:241–55, 2001.

Sala, A. L., R. T. Deck, and **B. G. Bagley.** Use of depressed index cladding layers to tailor the chromatic dispersion and birefringence of planar geometry waveguides. *IEEE Photonics Technol. Lett.* 12:305–7, 2000.

Walker, C., et al. **(J. E. Bjorkman).** The structure of brown dwarf circumstellar disks. *Mon. Not. R. Astron. Soc.* 351:607, 2004.

Carciofi, A. C., **J. E. Bjorkman,** and A. M. Magalhaes. Effects of grain size on the spectral energy distribution of dusty circumstellar envelopes. *Astrophys. J.* 604:238, 2004.

Whitney, B. A., K. Wood, **J. E. Bjorkman,** and M. Cohen. 2-D radiative transfer in protostellar envelopes: II. An evolutionary sequence. *Astrophys. J.* 598:1079, 2003.

Bjorkman, K. S. Spectropolarimetric variability in hot stars: 15 years of monitoring, and what we've learned. In *Astronomical Polarimetry: Current Status and Future Prospects. Proceedings of the ASP Conference.* San Francisco: ASP, in press.

Wisniewski, J. P., **K. S. Bjorkman,** and A. M. Magalhaes. Identifying circumstellar disks in LMC/SMC clusters. In *Astronomical Polarimetry: Current Status and Future Prospects. Proceedings of the ASP Conference.* San Francisco: ASP, in press.

Miroshnichenko, A. S., and **K. S. Bjorkman** et al. Properties of galactic B[e] supergiants. IV. Hen 3-298 and Hen 3-303. *Astron Astrophys.* 436:653, 2005.

Miroshnichenko, A. S., et al. **(K. S. Bjorkman).** Fundamental parameters and evolutionary state of the Herbig Ae star candidate HD 35929. *Astron. Astrophys.* 427:937, 2004.

Pogodin, M. A., et al. **(K. S. Bjorkman** and **N. D. Morrison).** A new phase of activity of the Herbig Be star HD 200775 in 2001: Evidence for binarity. *Astron. Astrophys.* 417:715–23, 2004.

Wisniewski, J. P., **K. S. Bjorkman,** and A. M. Magalhaes. Evolution of the inner circumstellar envelope of V838 Monocerotis. *Astrophys. J. Lett.* 598:L43, 2003.

Collins, R. W. Ellipsometry. In *The Optics Encyclopedia,* vol. 1, pp. 609–70, eds. T. G. Brown, et al. Weinheim, Germany: Wiley-VCH Verlag, 2004.

Collins, R. W., et al. Evolution of microstructure and phase in amorphous protocrystalline, and microcrystalline silicon studied by real time spectroscopic ellipsometry. *Sol. Energy Mater. Sol. Cells* 78:143–80, 2003.

Chen, C., I. An, and **R. W. Collins.** Multichannel Mueller matrix ellipsometry for simultaneous real-time measurement of bulk isotropic and surface anisotropic complex dielectric functions of semiconductors. *Phys. Rev. Lett.* 90:217402, 2003.

Roussillon, Y., et al. **(A. D. Compaan** and **V. G. Karpov).** Blocking thin film nonuniformities: Photovoltaic self-healing. *Appl. Phys. Lett.* 84:616, 2004.

Compaan, A. D., et al. 14% sputtered thin-film solar cells based on CdTe. *Phys. Status Solidi B* 241:779–82, 2004.

Liu, X., **A. D. Compaan,** N. Leyarovska, and J. Terry. Cu K-edge EXAFS in CdTe before and after treatment with $CdCl_2$. *Mater. Res. Soc. Symp. Proc.* 763:139–44, 2003.

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Karpov, V. G. Critical disorder and phase transition in random diode arrays. *Phys. Rev. Lett.* 91:226806, 2003.

Kodambaka, S., and **S. V. Khare** et al. Dislocation-driven surface dynamics on solids. *Nature* 429:49, 2004.

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Covington, A. M., D. Calabrese, J. S. Thompson, and **T. J. Kvale.** Measurement of the electron affinity of lanthanum. *J. Phys. B* 31:L855, 1998.

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Schectman, R. M., and **S. R. Federman** et al. Oscillator strengths for ultraviolet transitions in Cl II and Cl III. *Astrophys. J.* 621:1159, 2005.

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Vijh, U. P., **A. N. Witt,** and K. D. Gordon. The dust in Lyman break galaxies. *Astrophys. J.* 587:533, 2002.

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