Saginaw Valley State University
Physics Department Research Interests

Overview

As a smaller department at a primarily educational institution, we cannot expect to compete with the research efforts at a school like Michigan State University or University of Michigan in terms of the number of published papers or presentations at conferences. On the other hand, at SVSU you will have the opportunity to work closely with faculty on fundamental research projects. In some cases, you may be able to begin work at the end of your first year here. Indeed, such work is a requirement for the Bachelor's degree (3 credits of Phys 497). These research experiences are incredibly valuable as you prepare for a career or to pursue graduate studies. The available research areas at SVSU are diverse and cover both experimental and theoretical work. Below is a brief summary of faculty interests and ideas.

Interests by Faculty

Prof. Ming-Tie Huang - Experimental Atomic Physics

1. Capturing atoms with laser light:
Capture gas rubidium atoms with a Magneto-Optical-Trap (MOT). A MOT uses near resonance laser pumping with six circularly polarized laser beams tuned to slightly below the resonant frequency, under a quadruple magnetic field, to slow down (and thus cool down) the atoms, capture and confine them in a small volume near the zero field region. The atoms can be cooled down to be below one mK for detailed studies.
2. Even parity resonances of laser excited lithium with synchrotron radiation:
Ground state lithium atoms are first excited by linearly polarized laser light. They are then collided with synchrotron radiation to reach even parity resonances. Those even parity resonances are then studied as a function of synchrotron radiation energy and the angle between the polarization axis of laser light and that of synchrotron radiation. The study will reveal the detailed electron correlations.

Profs. Marian Shih & Frank Chen - Experimental Optical Physics

Our research is the experimental field of coherent optics applications. We do experiments with lasers and other temporally coherent light sources, preferably with the intention of developing a measurement technique that might someday be useful in a practical real-life setting. For example, we spend a lot of time doing interferometry, which is the measurement technique for measuring small phase differences in light. Some very useful applications of interferometry are the measurement of extremely tiny deformations or variations in thickness, variations that other techniques are not sensitive enough to detect. Our research interests also include holography, in which we capture variations in phase by recording an interference fringe pattern. The holograms that we make in the laboratory are not the beautiful, spectacular holograms that you see in the museums for art's sake. The holograms that we make in the laboratory lack visual appeal because they are scientific holograms for the purpose of capturing the subtle numerical variations in the phase of light waves in order to extract useful information about what the light has traveled through. If you have ever heard Electrical Engineers talk about how the Fourier Transform is indispensible for studying communications theory, then you will perhaps appreciate that we spend a lot of time working in the field of Fourier Optics, which is its two dimensional analog in the spatial domain.

Possible Research Topics:

1. The Fraunhofer diffraction of coherent light as a quality control measurement method to measure the thickness of different gauges of thin wire.
2. Studying the wavelength dependence of the far-field diffraction pattern to characterize the consumer DVD.
3. Application of Armitage and Lohmann's optical information processing technique of production of a color image from a black and white photographic film, via spatial filtering decoding process.
4. Computer programming, plotting, and photographic reduction steps in the fabrication process of an off-axis Fresnel zoneplate.
5. The zeroth white light interference fringe as a measurement technique of very thin transparent objects.
6. Characterization of the spectral and coherence properties of tunable laser diodes as an assessment for suitability for temporally incoherent holography.

Prof. Rajan Murgan - Theoretical High Energy Physics

I work on problems in the field of high energy physics. Specifically, my present research activities focus on a special type of mathematical models that have found various applications in physics from condensed matter to string theory. These models are known in literature as integrable models. Examples include the Heisenberg spin chain and certain types of quantum field theory. An integrable model is exactly solvable, namely one will not need to depend on approximation or pertubation methods to determine the spectrum. I have also done some numerical studies on such models using Mathematica. Numerical work would serve as a good starting point for undergraduate students to pick up essential basics required in original research, both in experimental and theoretical work.

Prof. Matthew Vannette - Experimental Condensed Matter Physics

My research is focused on the growth and characterization of single-crystal transition metal compounds. The primary interest lies in gaining a better understanding of the dynamics of magnetic phase transitions. However, the techniques employed permit the study of a much broader range of materials from semiconducting to superconducting, metals to insulators, magnetically ordered to non-magnetic. Students working with me will learn sample growth (basic glass work, vacuum systems, interpreting binary phase diagrams), how to perform measurements (resistivity, magnetic susceptibility, magnetic moment, and heat capacity), and how to interpret the data. These skills are broadly applicable to nearly any experimental work in the sciences. In addition to my efforts directly related to condensed matter physics, I am interested in developing new or novel uses of experimental techniques. This term I will embark on a cross-disciplinary project with Dr. Art Martin in biology as we attempt to measure the claw grip strength of crayfish engaged in dominance fights.

Prof. Christopher Nakamura - Physics Education

My research interests are in Physics Education Research (PER), which centers on questions at an interface between physics, psychology and education. PER is generally a fairly applied field that has an explicit goal: to improve the learning and teaching of physics. My recent research efforts have centered on exploring the use of interactive web-based technologies to aid in learning physics. An important, commonly used web-based learning environment is the online homework system. Automatically assessing the correctness of students numerical answers to physics problems is very simple, but provides little insight into students reasoning. Assessing understanding and the correctness of the reasoning that lies behind the number is generally more interesting than the number itself. My short-term goals therefore center on exploring the use of machine learning and data mining to explore the utility of automated assessment of students responses to short-answer questions. This research approach seeks to identify emergent groupings in sets of responses to physics questions, and then determine the feasibility of automatically classifying future responses based on these groupings. This capability has the potential to extend the utility of online homework systems considerably. A student who works with me can expect to learn about qualitative analysis of text data, some of the basic ideas behind common machine learning and data mining algorithms, modern theoretical and experimental work in understanding how students learn physics, and current ideas about how to best teach physics ideas. A number of forums for motivated students to present and publish research results exist. While conducting research in PER can be worthwhile for a wide variety of students, those interested in teaching high school or introductory college physics professionally will likely find PER particularly relevant.

Other Opportunities

You should not be discouraged from suggesting a possible research avenue to members of the department. We all enjoy physics and thinking about problems and questions and how to solve or answer them. Sometimes just sitting with someone and talking about nothing at all leads to a nice little project that brings a bit of fun to all involved. These sorts of experiences for undergraduates only exist at certain institutions. The Physics Department at SVSU is committed to providing these opportunities to all of our students.