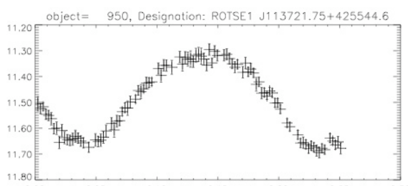
Astrophysics

Titanic processes produce tremendous variation in the energy output of dying stars. By studying supernovae or gamma-ray bursts, the fundamental interaction of gravity can be probed. Stars with less extreme, yet still dramatic, variations can reveal much about stellar structure. Some also serve as tools with which to study distant galaxies and the universe itself. Undergraduates have the opportunity to use data from the newest generation of robotic, wide-field telescopes to find and study these kinds of variables. Undergraduates Kelly Pearson and Courtney Fagg have set up software to study data from the ROTSE telescopes at McDonald Observatory and Los Alamos Lab. Several potential pulsating or contact binary systems have been identified, and work continues toward characterizing each candidate.

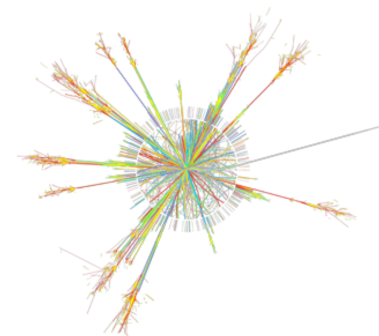


Our universe contains roughly 5 times as much "dark" matter as the visible matter that makes up stars, planets and people. The unknown nature of this peculiar matter and a topic of intense research. We can detect the presence of this dark matter in our own galaxy, the Milky Way, by measuring how it affects the spatial distribution of neutral hydrogen, which we see via the radio waves it emits. Undergraduate Kelvin Varghese completed work to assemble and commission the Department's 2.1m radio telescope last year. Students can now measure the galaxy's neutral hydrogen distribution.

Physics Pedagogy

Undergraduates can also develop novel tools to improve instruction in the physics. Physics major Ken Ueda built Chua's circuit to demonstrate chaos in the classroom. The project is a robust operational amplifier realization of Chua's circuit which relies on an effective negative resistor for its necessary non-linearity. This circuit is designed to be built with readily available electronics components. Ken ordered the parts, constructed the circuit, and packaged it in a compact self-contained battery-powered enclosure for use as a classroom demonstration with an oscilloscope. Ken's original contribution was to add an audio amplifier chip, a speaker, and a volume control potentiometer so that an audience could hear the repeated period doubling characteristic of chaos while viewing the same phenomenon on the oscilloscope. The chaotic region where the oscilloscope trace is a fractal strange attractor sounds much like the autobaud noise from a FAX machine. Ken has improved and utilized his chaos circuit in a workshop with high school teachers.

Undergraduate Research in Physics



- Particle Physics
- Applied Physics
- Astrophysics
- Physics Pedagogy

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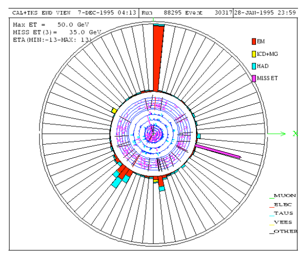
The Research Experience

Undergraduate students can benefit from a variety of research projects. Real-world experience provides an excellent preparation for life after SMU. Techniques and state-of-the-art technologies used in a research environment prepare a student for a variety of career paths. Projects leading to publication bring a valuable distinction to a student's resume in today's competitive world. Research complements coursework and can inform student career choices. SMU's undergraduate research program provides several interesting projects in particle physics, applied physics, astrophysics and physics pedagogy.

Particle Physics

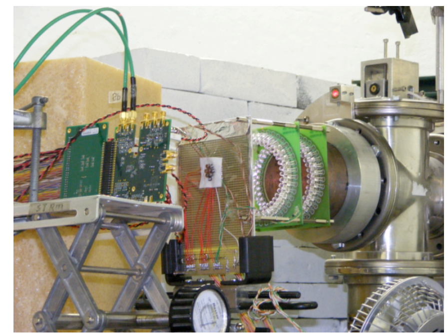
We are constantly exposed to a steady drizzle of ephemeral particles ("muons") produced in Earth's upper atmosphere that travel downward to sea level at close to light speed. Various properties indicative of their quantum mechanical nature can be measured in the undergraduate laboratory. Muons, like electrons, behave like minute, spinning magnets giving them a property termed the "gyromagnetic ratio". We can measure this with a sandwich of scintillating plastic slabs and a copper plate absorber all placed inside a special magnet. Undergraduate Amy Hand developed custom software to design the magnet. Student Alex Weckiewicz is building the magnet, and the students anticipate measuring the gyromagnetic ratio this year.



Most of the visible matter in the universe is composed of subatomic protons and neutrons, which are in turn comprised of quarks. Although hypothesized over 40 years ago, there remains considerable mystery about the origin of quark masses. One quark, discovered in 1995 and named 'top', has very unusual properties. Precisely measuring its mass may illuminate the way mass is 'created'. Using data from the Fermilab Tevatron accelerator, undergraduate Brad Stanley participated in SMU’s effort to measure this mass by calibrating the energy ‘resolution’ for daughter particles called neutrinos.

Applied Physics

Our opto-electronics laboratory is a state-of-the-art facility that carries out many intricate projects for the ATLAS detector at the Large Hadron Collider (LHC). There are three highly experienced, full time research staff in the lab. Design and development capabilities for Application Specific Integrated Circuits (ASICs) have recently been added to the lab, with special attention to radiation tolerance. One undergraduate project involves the testing of ASICs.



Other projects include the development of an instrument which provides multi-channel optical power measurement with data logging capability for fiber optics studies. Students can also study an optical readout scheme for our planned research into neutrinos at the U.S. Deep Underground Science and Engineering Laboratory (DUSEL). In 2006, undergraduates Rozmin Daya and Andrew Peppard began a study of the timing and spatial resolution of GPS units for coincidence measurements off-line. Current students are involved in efforts to calibrate our lab's picoammeter and to measure the bit error rate in a 10 Gbit/s serial transmission.