Physics Department Open House

Laboratory Tour Stops and Public Seminars

The lab tours and seminars will start every half hour at 2 pm, 2:30 pm … 4:30pm

	Professors	Room	Research Areas
2nd floor			
	Todd Ditmire B. Manuel Hegelich	2.200 A	Texas Petawatt Laser Lab, Tabletop particle acceleration and more!
	Mark Raizen	2.204	Controlled atomic motion
	Elaine Li	2.416	Nano-photonics and quantum materials
	Mike Downer	2.408	Laser driven plasma accelerator
	Greg Sitz	2.420	Surface Dynamics
3rd floor			
	Ken Shih	3.110	Nano materials
	Alex Demkov	3.110	Quantum materials and computation
	Keji Lai	3.108	Nanoscale Electronics

4th floor RLM entrance level: undergraduate research posters

9th floor: Theory presentations in 9.222

2:00 - 2:30 : Matthew Klimek “Testing the standard model at large hadron collider”
2:30 - 3:00 : Michael Marder “Physics, Fracking, Fuel, and the Future"
3:00 - 3:30 : Austin Gleeson “Relativity: copacetic and right
3:30 - 4:00 : Sonia Paban “Quantum fluctuation and galaxies”
4:00 - 4:30 : Philip Morrison “ What do magnetic field lines really look like”
4:30 - 5:00 : Thomas Carroll “Neutrino physics: with and without the neutrinos”

	Professors	Room	Research Areas
10th floor			
	Christina Markert	10.110	Quark-gluon plasma
12th floor			
	Maxim Tsoi	12.322	Spin-Based Electronics
13th floor			
	Alex de Lozanne	13.302	Cool Atomic Microscope
	John Markert	13.306 C	Superconductivity and Magnetism
14th floor			
	E. L. Florin	14.304W	Mechanical Properties of Cells
	Vernita Gordon	14.216W	Biofilms and Cell Membranes
	Harry Swinney	14.304E	Ocean Wave Dynamics

UT Physics

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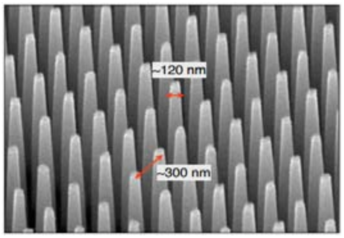
RLM 2^{nd} Floor
Physics Department Open House



Controlled atomic motion and quantum entanglement

Prof. Mark Raizen, RLM 2.204

By starting with a cold source of atoms, a supersonic pulse of helium atoms cooled to 100 mK, and using a fast heating oven source which can be pulsed with the supersonic nozzle, our group is able to sympathetically cool interesting atoms and molecules. By combining this technique with a new slowing method developed in conjunction with the Narevicius group (Lavert-Ofir, PCCP, 2011) at the Weizmann Institute, we are able to cool and slow any atomic element or molecule that has a magnetic moment. We predict that the combination of these techniques will far exceed laser cooling in terms of flux of ultra-cold atoms, and phase space density.

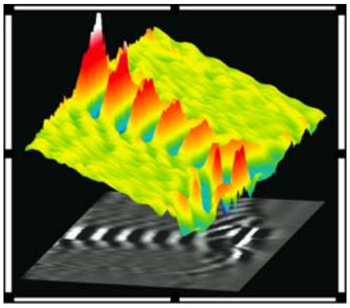
In a recent example, we have developed a new and efficient method for isotope separation based on laser activation and deflection in a magnetic field [1,2]. This will replace a method dating back to the 1930's, and will provide much-needed isotopes for medicine. In particular, targeted therapy with isotopes holds great promise in treating certain forms of cancer.

A common method of detecting neutral atoms is a Langmuir-Taylor detector where an atom strikes a hot wire made of a high work function metal and ionizes the atom. The ion flux produced by the wire is then measured as a current. Unfortunately, the work function of most metals is too low to detect many atoms of interest. To solve this issue, we are creating a neutral atom detection system based on a nanopillar array, where the electric field produced by the array will ionize the atom rather than the metal. This setup will allow us to tune the voltage applied to the nanopillars, meaning that we can selectively ionize excited atoms or molecules giving us a universal detector which can work with any atom in the periodic table.

Laser-Driven Plasma Accelerators

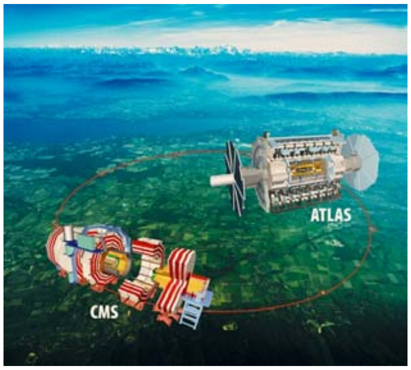
Prof. Michael Downer, RLM 2.408

Our group has developed a new type of particle accelerator that surfs particles on plasma waves driven by intense femtosecond (10^{-15} second) laser pulses. The picture shows such a plasma wave, captured holographically in our laboratory. We recently broke a world record by accelerating electrons to 2 GeV in 7 centimeters. These tabletop devices, ten thousand times smaller than conventional accelerators, will be the next generation's ultrafast coherent x-ray sources for molecular-level biology, chemistry and condensed matter studies.



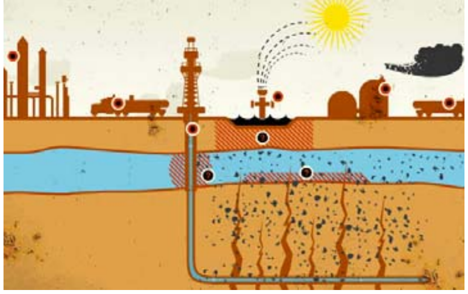
Theory Talks, RLM 9.222

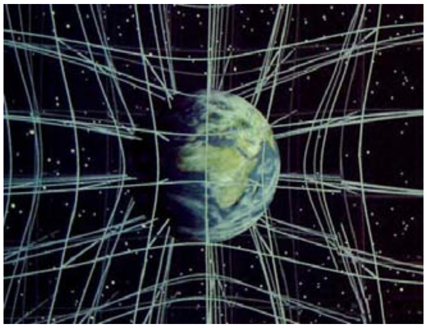
Physics Department Open House



Matthew Klimek: Testing the Standard Model at the Large Hadron Collider at 2:00-2:30

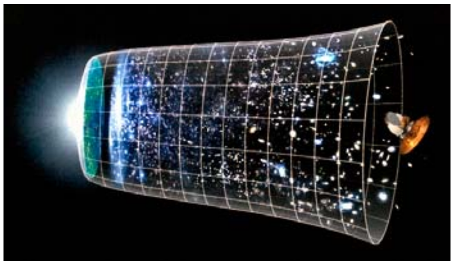
Prof. Michael Marder: Physics, Fracking, Fuel, and the Future at 2:30-3:00

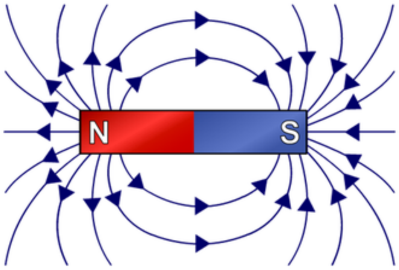




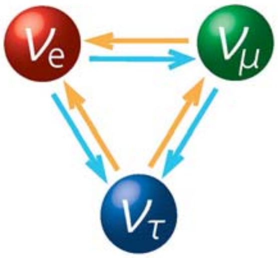
Prof. Austin Gleeson: Relativity - Copacetic and Right at 3:00-3:30

Prof. Sonia Paban: From Quantum Fluctuations to Galaxies at 3:30-4:00





Prof. Philip Morrison: What Do Magnetic Field Lines Really Look Like? at 4:00-4:30



Thomas Carroll: Neutrino Physics: With and without Neutrinos at 4:30-5:00

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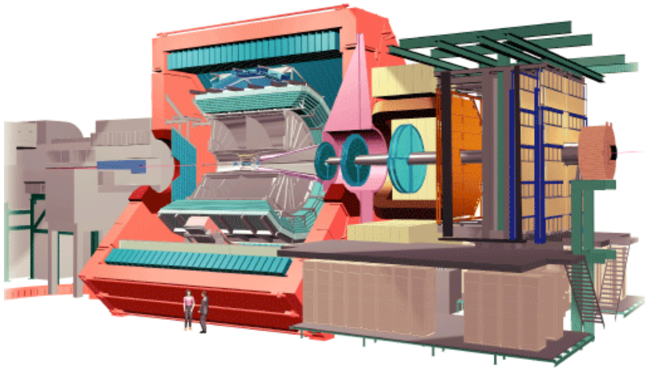
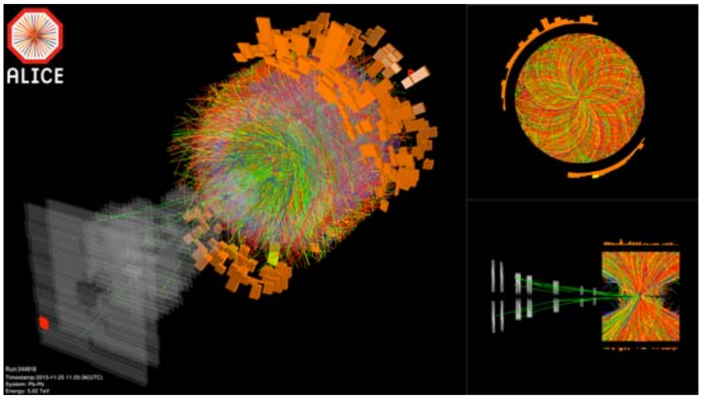
Experimental High Energy Nuclear Physics

Physics Department Open House

Search for the Quark-Gluon Plasma

Prof. C. Markert RLM 10.305





The heavy ion physics group investigates the creation of a new state of matter called the Quark Gluon Plasma (QGP), which should have existed in the early universe. For this purpose we create a "little bang" in the laboratory by smashing heavy ions into each other at the LHC at CERN and at the RHIC accelerator at the Brookhaven National Laboratory. The ALICE and STAR experiments detect thousands of particles within a collision, and the data are analyzed to shed light on the earliest moments of the collisions in which it is believed that new types of strongly interacting matter, such as quark-gluon plasma, are produced. It is believed that up to a few micro-seconds after the Big Bang, the Universe was in a quark–gluon plasma state. The group studies charm and bottom hadrons and hadronic resonances which are produces in such a collision. Detector developments and testing are done at UT Austin for the ALICE pixel detector ITS (Inner Tracking System) and the STAR TOF (Time of Flight) and Muon detector (MTD).

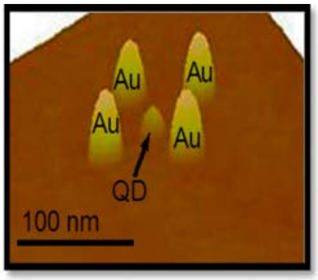
RLM 2nd Floor
Physics Department Open House

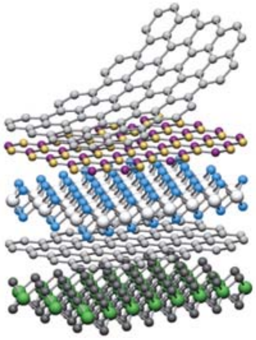
Texas Petawatt Laser Prof. Ditmire & Prof. Hegelich, RLM 2.200A

The Texas Petawatt Laser is housed in a large high bay in the basement of RLM, located under the plaza in front of the building. This laser produces peak powers of over 1 quadrillion watts, making it the highest power laser currently in operation in the United States. It can heat materials to 100 Million Kelvin and create pressures of 1 million atmospheres—conditions relevant to astrophysics. The laser is being used for proton beam heating of dense plasmas, shock physics, laser hole boring, and exotic ion acceleration (Prof. Todd Ditmire), accelerating electrons to very high energy, above 2 GeV (Prof. Mike Downer), and highly relativistic ion and neutron acceleration (Prof. Manual Hegelich). These experiments involve both very basic science and many technological application.

Dynamics at Surfaces Prof. Greg O. Sitz, RLM 2.420

This research group conducts experimental and computational studies of elementary processes occurring at or on a solid surface. These processes are important areas of scientific and technological interest ranging from thin film growth, to catalysis, to chemistry and physics in interstellar and atmospheric clouds. The experiments employ supersonic molecular beams coupled with nonlinear laser spectroscopy to study gas-surface interactions with complete quantum state specificity. For example, in a typical experiment one laser system prepares a beam of molecules incident on a surface in a selected rotational and vibrational state, and with a known kinetic energy. A second laser is used to measure the final state distribution of the molecules after they have scattered from the surface





Light-Matter Interaction on Nanoscale

Prof. Elaine Li, RLM 2.416

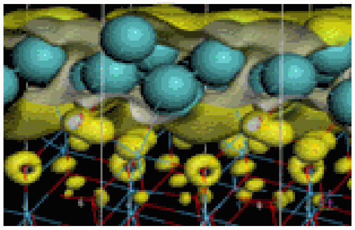
Our group investigates the interaction of light and matter at the nanometer length scale and femtosecond (10^{-15} second) time scale. Our goal is to understand and control how electrons behave in different materials, so that we can ultimately control materials properties. Here are just two examples of recent projects. The top picture shows a “quantum dot” that holds electrons. It emits one photon at a time. We can control how fast the photons are emitted or where the photons go by arranging gold nanoparticles around it. Another class of materials we are currently investigating is known as the Van der Waals materials. The atoms within a plane are bounded with strong covalent force while different layers are bound together with weak Van der Waals force. One can create a single atomic layer using a variety of method including using a scotch tape! Furthermore, one can stack different types of materials together to realize quantum materials with the smallest thickness possible.

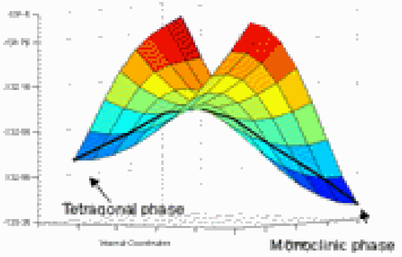
RLM 3rd Floor

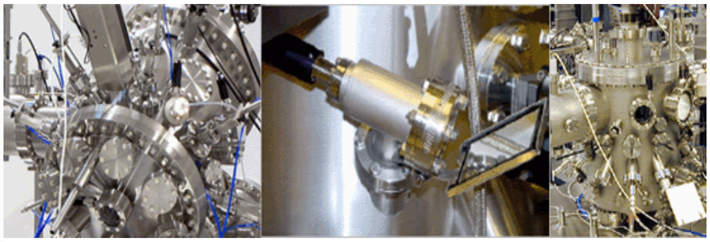
Physics Department Open House

Material Physics: Molecular Beam Epitaxial Growth and Advanced Atomic Design

Prof. Alex Demkov, RLM 3.110





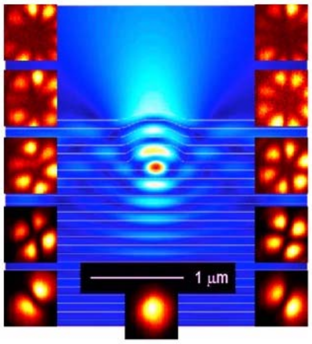


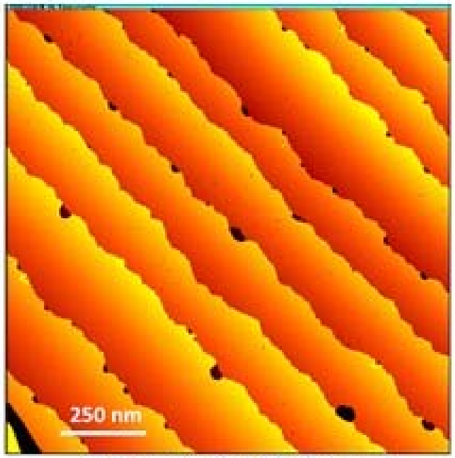
We work on the quantum theory of real materials. Owing to the complexity of these problems, our research requires state-of-the-art molecular beam epitaxy (MBE) and high performance computing; most of the computing is done at the Texas Advanced Computing Center (TACC). We do both theoretical and experimental research. We aim to advance the fundamental understanding of new materials, particularly complex oxides. Oxides are moving to the forefront of materials research, with potential applications in electronics, spintronics, optics, sensors, and energy.

Nanoelectronic Materials Research

Prof. Ken Shih, RLM 3.110

Examples of research areas in Shih's group are quantum optical control of semiconductor nanostructures, quantum engineering of metallic thin films, and atomically smooth epitaxial films on silicon. When an electronic system is confined in one or more dimensions to a length scale comparable to the de Broglie length, quantum confinement occurs. Such confinements play a central role in artificially engineered electronic systems such as quantum wells, quantum wires, dots and related superlattices.

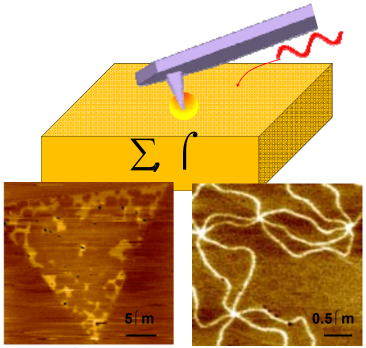




2ML crystalline Pb film on Si

Nanoscale Electromagnetic Imaging

Prof. Keji Lai, RLM 3.108



In_2Se_3 $YMnO_3$

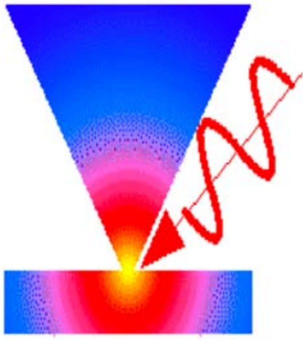
We visualize and manipulate nanoscale electronic phases in novel materials by guiding microwaves and DC voltages to a nanometer-sized probe tip. Knowledge down to the mesoscopic length scale (nanometer to micrometer) fills an important gap between the single atomic response and macroscopic device performance. The spatially resolved information is critical for us to understand many complex systems in the frontier of condensed matter physics, including low-dimensional materials, multiferroics, and topological insulators.

RLM 12th and 13th Floors

Physics Department Open House

Spintronics (spin-based electronics)

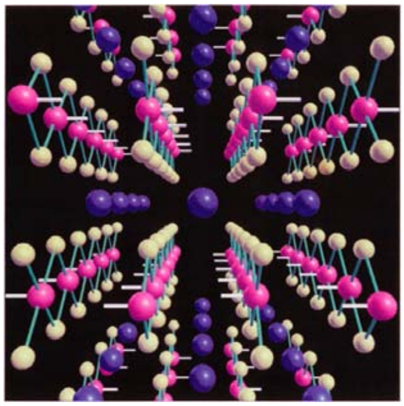
Professor Maxim Tsoi, RLM 12.322



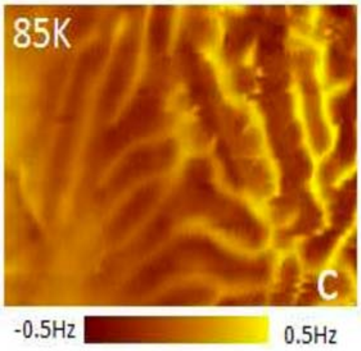
SPINTRONICS is a promising nanoscale technology that may offer signal-processing devices with higher speed, lower power consumption, and other advantages over conventional microchips by controlling and manipulating spins. The Giant Magnetoresistance (GMR) effect (2007 Physics Nobel Prize), now used in computer read heads and magnetic random access memories, has proven technological importance and potential. GMR refers to a large change in resistance of a ferromagnetic system when the relative orientation of magnetic moments is altered by an applied magnetic field.

Magnetism and Superconductivity

Professor John Markert, RLM 13.306C



This research synthesizes and address the basic physics of magnetic, superconducting, and other materials. We have developed high-Q mechanical oscillators as sensitive detectors of very small forces and dissipations. Experiments include micromagnetometry of nano-magnets and applications of high-Q oscillators to NMR force microscopy. Our ^{3}He-temperature (0.25 K) probe demonstrates the feasibility of the goal of single-proton-spin detection, with applications to molecular imaging and quantum computation.



Cool atomic microscopes

Professor Alex de Lozanne, RLM 13.302

We build novel microscopes to study new materials, usually at low temperatures. How cool is that? The images display the dramatic change with temperature in the magnetic properties of a crystal of a manganese compound. The surface is very flat, but the right atomic microscope (see picture) reveals rich magnetic structure. We measure how the surface changes when you apply a magnetic field or change temperature.

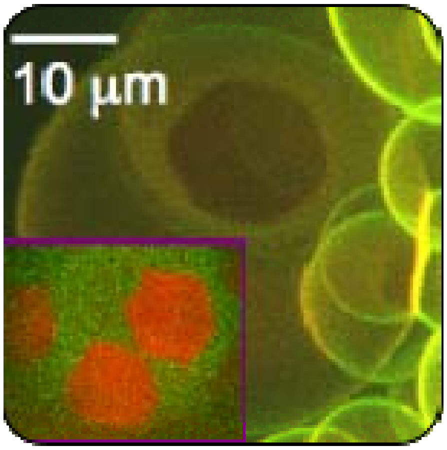
RLM 14th floor: *BIOPHYSICS* and *NONLINEAR DYNAMICS*

Physics Department Open House

Functional membranes

Professor Vernita Gordon, RLM 14.216

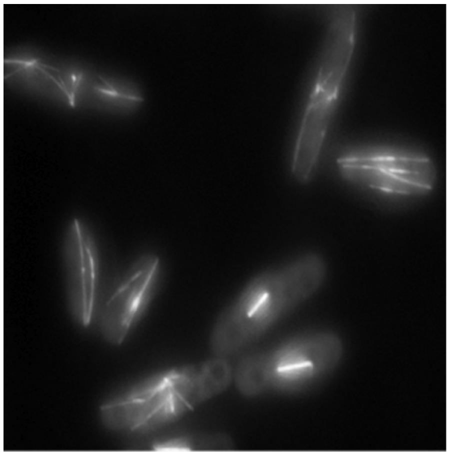
The cell membrane is much more than a passive container that holds the insides of a cell the way a plastic bag holds groceries. It is an active, dynamic interface, where lipids, proteins, and other components cooperate and interact with each other and with external and internal signals. We are working to understand some of that cooperativity by developing an experimental model system to study the formation of heterogeneities in lipid composition and phase when proteins adhere the membrane to a surface. This is analogous to what happens when cells stick to a surface or each other.



Mechanical properties of biological materials

Prof. E.L. Florin, RLM 14.304W

Biological matter has to deal with the presence of thermal forces and the fluctuations they cause. But instead of being hampered by them, many biological processes actually use thermal fluctuations to achieve functionality. For instance, Brownian motion is used to drive transport of molecules and thus is responsible for a huge number of reactions essential to maintain life. Thermal fluctuations are also responsible for material properties such as the stiffness of cellular biopolymer filaments. We built a series of new instruments, that exploit thermal fluctuations to quantify the mechanical properties of biological materials.



Ocean wave dynamics and swimming bacteria

Prof. H. Swinney & Drs. M. Allshouse & L. Zhang, RLM 14.304E

We are examining the fundamental physics of energy and mass transfer inside the oceans. In the deep ocean energy in the tidal flow is converted to waves that can travel thousands of miles, but it is not known how much energy is involved in this conversion, and how this energy affects the earth's climate. We conduct laboratory experiments on laboratory models of the oceans. One experiment uses a 4 meter long tank to examining how ocean flow toward a shore can trap nutrients and bio-matter and carry it long distances.

Another experiment examines swimming of a thumb-sized model of a bacterium. Bacteria, unlike people or birds, cannot coast or glide, that is, the inertia of a bacterium is effectively zero. Our experiments reveal that the standard model for bacterial swimming is badly wrong.