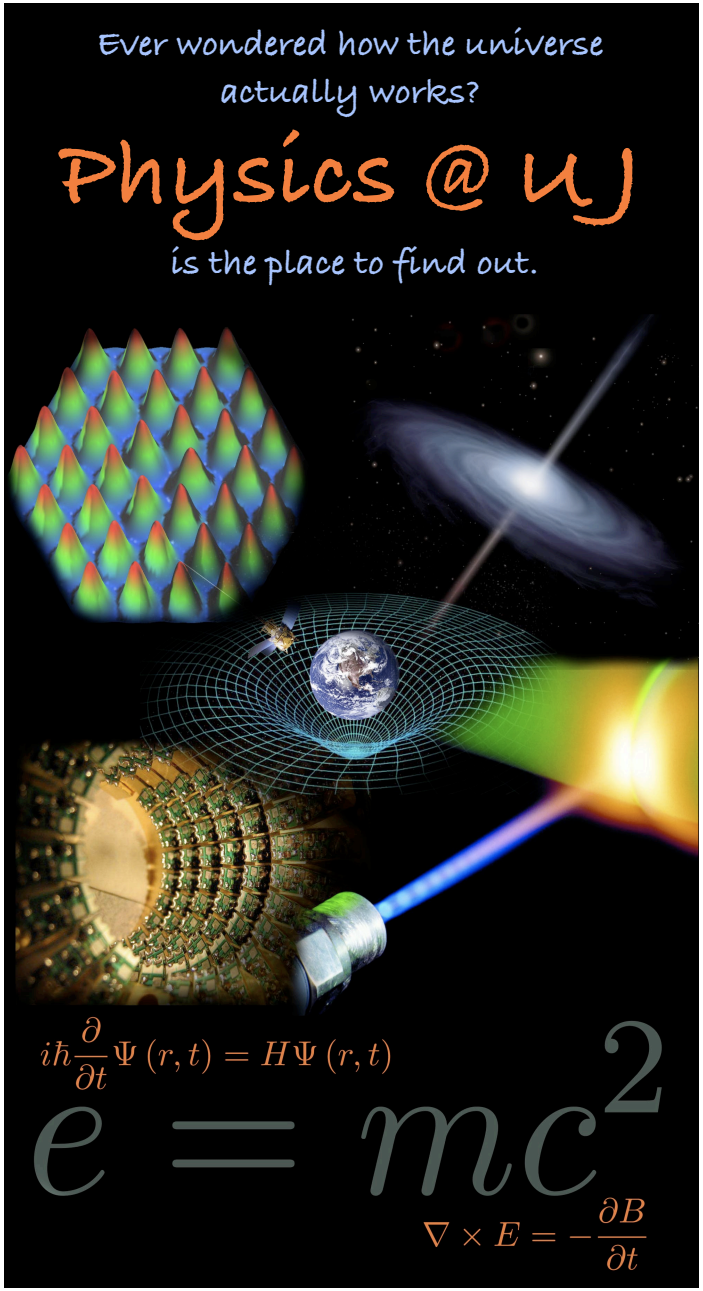
UNIVERSITEIT VAN JOHANNESBURG



Department of Physics

Physics is the subject that investigates all facets of the physical world – from galactic and stellar objects to the smallest elementary particle in the atom. It describes what we see in experiments in terms of fundamental laws, leading to theories to explain the unknown. This knowledge and understanding of nature leads to all the technological devices that enhance the quality of life of humanity: from micro-machines to rocket engines, electricity and electronics, telephones, radio, television, computers, lasers, medical radiation devices, and many more.

Undergraduate education

In your first year you'll learn more about a wide wide spectrum of topics in Physics: dynamics, waves, thermodynamics, electricity, magnetism, optics, atomic physics and nuclear physics. These topics are developed further in the second year on a higher level, while in the third year attention is given to more advanced topics like quantum mechanics, theory of relativity, statistical physics and elementary particles. In all courses experimental work is performed in well-equipped laboratories.

Post graduate training

In the honours course (4th year of study), students delve more deeply into advanced subjects. A student can compile a course from modules in quantum mechanics, electromagnetism, solid state physics, and statistical physics. For the discerning student wanting to have more options, up to two approved modules may be taken as electives from other Science Departments. Advanced experimental work is also performed for this degree.
On Master's and Doctoral level students conduct a research project and the degree is awarded on the submission of a Dissertation or Thesis on the research topic. Research results are are also published in international journals.

Research

The Department has modern sophisticated research laboratories equipped with a large variety of processing and characterization equipment. Research degrees are offered in topics outlined on the following pages:

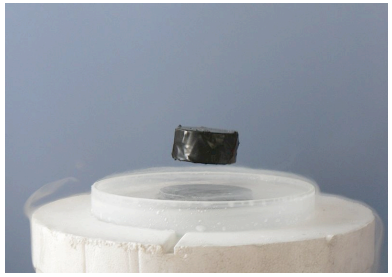
Astrophysics

The Department of Physics at the University of Johannesburg has seen a lot of vibrant research in astrophysics of late. In one project active galaxies are studied, specifically the class known as Seyfert galaxies. Another project focuses on pulsating stars, specifically the Beta Cephei-class of hot, young pulsating stars. Besides continuing observational programmes at Sutherland, this research is being expanded on two fronts: cutting-edge statistical methods, and theoretical modeling of stellar instabilities. In this project close collaboration exists with researchers at Wits and at the Hartebeesthoek Radio Astronomical Observatory. UJ is also nurturing joint projects with researchers at the University of Cape Town, Stellenbosch and Pretoria respectively. Researchers working on these projects are experienced users of the family of telescopes at the Sutherland station of the South African Astronomical Observatory (SAAO) in the Northern Cape. Innovative research has also been done on the use of astronomical observations to measure atmospheric pollution. The Stellar Astrophysics group uses the UJ computing cluster and the Open Science Grid.
Our astrophysics research programme involves work with the H-ATLAS consortium (www.hatlas.org), that is composed of over 150 astronomers worldwide and was awarded the largest observing time with the recently launched Hershel Space Observatory. We are also involved in various MeerKAT and South Africa Square Kilometer Array (SA SKA) related programmes.

Cr based research

Chromium and chromium alloys show interesting behaviour that has been investigated by scientists for decades – and yet they are still surprised every day by new findings. This group of metals is unique since the properties of chromium can be altered dramatically with the addition of even a small amount of impurities such as silicon, vanadium, etc. There is also renewed interest in acquiring knowledge of these alloys especially in the form of thin films, because of its applications in the field of data storage. In the Department there is an established group of Physicists further investigating the properties of bulk and thin film chromium alloys with the help of postgraduate students. Several collaboration agreements exist between this group, industries and universities in South Africa as well as overseas.

Correlations and ground states of matter



This research group performs experiments at extremely low temperatures (close to the absolute zero) and in very powerful magnetic fields (close to a million times the field strength of the earth) on metals and intermetallic compounds to study magnetism, superconductivity, and other fundamental interactions in matter. We are the only laboratory in Africa with advanced instrumental stations to study a variety of physical properties (specific heat, magnetic properties, thermal and electronic transport) at these extreme conditions. A key area of our research involves physical chemistry and metallurgy to synthesize and discover exciting new compounds and alloys.

Solar irradiation

A team in the department is quantifying the gound-level characteristics of solar radiation with the aim of determining its solar energy generation potential in the Gauteng urban environment, considering specific location altitude, land aspect, aerosol concentrations and weather patterns. This project aims to create an intenet-based provincial solar atlas that will be available as a resource to the solar power industry and the public for solar panel installation. The work is part of the regional Enerkey initiative, which is exploring Gauteng's energy consumption, management and future requirements.

High Energy Physics

The University of Johannesburg High Energy Physics group is a member of the SA-CERN Programme. They are working on the giant multi-purpose ATLAS detector, one of the experiments at the Large Hadron Collider (LHC) at CERN in Switzerland, as affiliates of Brookhaven National Laboratory. ATLAS will investigate a wide range of physics, including the search for the Higgs boson, extra dimensions, particles that could make up dark matter and the quark-gloun plasma. The UJ group works in close collaboration with Ketevi Assamagan, the co-leader of the ATLAS Higgs working group, and is therefore participating in the search for the Higgs. Future research may include the possible discovery of the charged Higgs and its relation to supersymmetry, which will develop new physics beyond our best current model of particles. The new high performance computing cluster at UJ, which also provides access to the Grid is a crucial component of the work. The Grid is the basis for access to data and the implementation of demanding computational physics simulations and analysis codes. The UJ Grid node has been developed in a collaboration with Jeremy Dodd and Mike Tutts of Columbia University and the Open Science Grid team, as well as Ben Clifford from the University of Chicago.

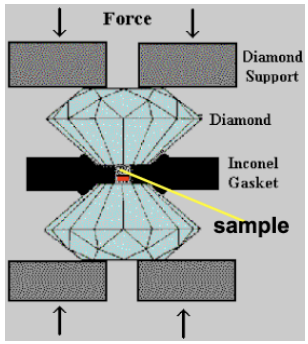
Nuclear Physics

UJ is launching a new Honours and Masters Course in the Science and Organisation of Nuclear Energy. The course material has been developed in close collaboration with iThemba LABS, NECSA and the PBMR. Topics include the physics and mathematics behind nuclear reactions, statistical risk analysis, environmental impact and safety. The Masters will involve a dissertation where research is carried out at UJ and in conjunction with scientists in the industry. The Nuclear Physics Group has an experimental program in light ion induced reactions at iThemba LABS together with collaborators from that laboratory as well as Milano University and Stellenbosch University. The group also pursues a program in high energy nuclear physics at Jefferson Labs in the USA. The quark structure of nucleons is studied by observing the production and decay of electro-produced baryonic resonances. A highlight in the Applied Nuclear Physics program has been the completion of the Technology Demonstrator diamond bearing rock sorter, in conjunction with Bateman. This machine is based on the combination of two nuclear-medical technologies : Gamma Radiation Therapy and the Diagnostic Imaging technique of Positron Emission Tomography. This technology is now being evaluated for the construction of the Mine Test Unit.

The group conducts research in Theoretical Nuclear Physics in both Nuclear Structure and Reactions. On the structure side, the structure of light exotic nuclei are studied, considering many-body descriptions of the novel features that exist towards the nucleon drip lines. That is related to the research in nuclear reactions, primarily nucleon-nucleus interactions and scattering, as that is one of the main ways that one gains knowledge of such structures. Related work in other reactions, as well as nuclear astrophysics (stellar evolution, nucleosynthesis - the creation of elements), also falls into this research sphere.

Diamond Physics

Diamond has extreme properties which suggest it in hitherto unimagined high technology roles, such as high performance radiation detectors, fast and high power electronic devices and as X-ray optical elements for high intensity synchrotrons. More recently, diamond is recognised as an ideal environment for storing coherent quantum states in an easily addressable manner, in the context of nanotechnology for quantum communication and computing. Several long standing collaborations exploit this potential. At iThemba LABS, the diamond group develops state of the art diamond scientific processing capacity. Diamond prepared here is used in experiments at ESRF-Grenoble on X-ray optical elements, in a collaboration with GSI-Darmstadt on radiation detectors, in a collaboration with Aarhus University on diamond's radiation emission properties, in a collaboration with Rutherford LAB-Oxford on the role of hydrogen in diamond and in a collaboration with the University of Kwa-Zulu Natal on quantum diamond.

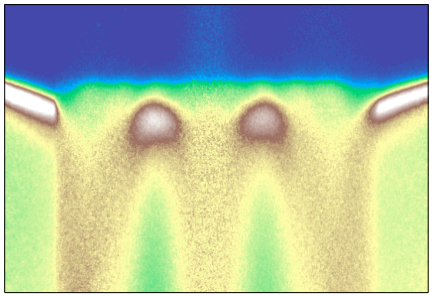


The Pressure is On

The focus is on studies of materials under extreme high pressure, routinely to 300 000 times the pressure of the atmosphere and up to higher pressures where necessary, over a wide range of temperature (-269°C to 2300 °C). These extreme conditions are attained in diamond-anvil high pressure cells, using lasers or electricity for high temperature work. Cutting edge equipment allows researchers to see how the system behaves with very small changes in pressure. Consequently quite unique and detailed investigations can be carried out. Research is in, but not limited to, the following areas :

- magnetic-electronic pressure studies of "hot topic" strongly correlated electron systems,
- studies of iron-based mineral assemblages under (high pressure-temperature) deep Earth conditions,
- pressure-response of nano-phase materials and search for new ultra-hard materials (as alternatives to diamond).

Electronic structure of correlated materials



We study complex materials where the interactions between electrons play an important or decisive role in the determining the, often unusual, properties of the system. Many of the most interesting materials studied today have such *electron correlations* at their heart. This results in properties such as high temperature superconductivity, giant magnetoresistance and orbital and charge orderings. Experimental measurements are carried out both within the Department using sophisticated low-temperature equipment available and at overseas synchrotron radiation laboratories in Paris and Berlin.

Enquiries:

Prof André Strydom, Physics Department
Tel: (011) 559 2320 **Fax:** (011) 559 2339
e-mail: amstrydom@uj.ac.za