DEPARTMENT OF PHYSICS

2012 UNIVERSITY OF NAIROBI ANNUAL REPORT

1. Introduction

The Department of Physics, University of Nairobi is as old as the University itself. It has 31 academic, 21 technical and support staff members and is the most active Physics Department in the Eastern and Central Africa region. The Department conducts training and research (at undergraduate and postgraduate levels) in fairly interactive areas, with emphasis on Applied Electronics, Applied Nuclear and Radiation Physics, Laser Physics & Spectroscopy, Condensed Matter Physics, Geophysics and Theoretical Physics. The department has embarked on continual upgrading of its facilities; all these are in line with our desire to train holistic physics graduates that make positive contribution not only to our nation but also to the whole of mankind.

2. Courses Offered

Undergraduate

- B.Sc. (Physics)
- B.Sc. (Microprocessor Technology & Instrumentation)
- B.Sc. (Astronomy & Astrophysics)

Postgraduate

- M.Sc (Physics)
- Ph.D. (Physics)

3. Enrolled Students

- B.Sc.: 274
- M.Sc.: 20
- Ph.D.: 13

4. International Student Component

- 1 international student enrolled for M.Sc.

5. Research Activities Undertaken

APPLIED ELECTRONICS: Distributed embedded systems platform; Optimized DC power controller; Environmental monitoring and management system; Field Programmable Gate Array (FPGA) based instrumentation; Step numerical control based intelligent Computer Numerical Control (CNC) controller.

APPLIED NUCLEAR & RADIATION PHYSICS: Medical elementology and spectral diagnosis of disease; Radiometric geothermics; Spectroanalytical environmentrics; Material analysis by chemometric spectroscopy; Radiometric beam quality characterization; Gamma ray spectrometry and detector efficiency modelling.

LASER PHYSICS, SPECTROSCOPY & IMAGING: Laser and spark produced dense plasmas diagnostics and modelling; Tuneable diode laser spectroscopy applied to trace gas monitoring; Application of LED multispectral imaging microscopy to malaria diagnosis; Development of efficient image recognition algorithms with application to malaria diagnosis; Radiative characterization of atmospheric aerosols using Sun Photometry; Quantitative analysis of trace atomic and molecular signatures of HBRA geothermal matrices by chemometrics assisted LIBS; Monitoring aquatic plants proliferation in Lake Victoria using satellite data.

CONDENSED MATTER PHYSICS: PHOTOVOLTAICS: Dye sensitized solar cells (DSSCs); Microcrystalline silicon solar cells; Quantum dot solar cells; Computer simulation and modeling using LABVIEW^{TM} software application; PV systems sizing. SENSORS: Semiconductor sensors and light emitting diodes. THIN FILMS: Electrophoretic deposition (EPD) of TiO_2 thin films for photocatalysis, and other uses. THERMOPHYSICAL PROPERTIES: Nondestructive evaluation and characterization of materials; Thermophysical properties of solids, in particular, ceramics and granular thermal insulators. NANOTECHNOLOGIES for sustainable development.

GEOPHYSICS: Geophysical monitoring of groundwater for earthquake prediction in seismically active areas of Kenya; Integrated geophysical research investigation of greater Magadi area, Kenya; Investigation of nuclear elements and their radiation exposure in carbonatite rocks in South Nyanza and the coastal regions; Elemental analysis of rocks from gold mines in Migori-Transmara complex of South Western Kenya; Assessment of heavy metal fluxes and radiation exposure in extractions and processing of coltan ores in Rwanda; Paleomagnetic and rock

magnetic studies of the Proterozoic granites from Western Kenya; Radiation hazards due to tunsstun mining in Rwanda.

THEORETICAL PHYSICS: Studies on neutrino mass at finite temperature; Inflationary Cosmology; Baryogenesis and the Big bang Nucleosynthesis; Cosmic Microware Background Radiation; Hubble's Law and the Expansion of Space; FLRW Metric; Friedman – Lemaitre, Robertson-Waker Metrix; Galaxy Formation in the BB Theory; Physics at the Earliest Instant of time; Extrapolation of the Universe Backward in Time; Dark Matter and Dark Energy; Cosmological Horizon (past and future); Galactic evolution and distribution – Large Scale Structures of the Cosmos; Flatness/Oldness Problem; Science and Religion (Creation vs. Evolution); Prediction of the characteristic features of alpha decay using quantum mechanical tunneling; Emission of Electrons from cold metallic surfaces by the quantum mechanical tunneling: application to the scanning tunneling microscope; Modes of production, propagation and detection of AM radio waves; Minimization of Atmospheric water vapor and surface Emittance Effects on Remotely Sensed Sea surface temperatures; Remote sensing of precipitable water by a Thermal Infrared Multichannel Approach; The Cosmic rays and neutron decay; Singular integral equations for Decay processes; The Big-bang Cosmology; Detection of gravity waves in Africa using 3 GPS receivers that are separated by 20-30 kms; Characterization of the F-Region current using satellite data and data from ground based magnetometers during geomagnetic storms and their impact on power grid; Geomagnetic field variations using magnetometer data and GPD data; Spinor Theory of Gravity; Characterization of Plasma Equatorial Anomaly during Equinoxes and Solstices; Variations of the Horizontal component of the magnetic field during storm time from MAGDAS data.

6. International Links and Collaboration

- Uppsala University, Sweden
- Lund University, Sweden
- Air Force Research Laboratory/Institute for Scientific Research (Boston College), USA
- Stanford University Solar Center, USA
- University of Rome (La Sapienza), Italy
- Space Environment Research Centre, Kyushu University, Japan

7. **Publications for 2012**

- Kaniu IM, Angeyo KH, Mwala AK and Mangala MJ (2012), "Direct rapid analysis of trace bioavailable soil macronutrients by chemometrics-assisted energy dispersive X-ray fluorescence and scattering spectrometry", Anal Chim Acta, 729 (2012), 21–25

- Mito CO, Boiyo RK, and Laneve G (2012), "A simple algorithm to estimate sensible heat flux from remotely sensed MODIS data", International journal of Remote Sensing, 33(19) (2012), 6019-6121

- Otakwa RVM, Simiyu J, Waita SM and Mwabora JM (2012), "Application of Dye-sensitized solar cell technology in the tropics: effects of radiation intensity and temperature on DSSC performance", International Journal of Advanced Renewable Energy Research, 1(2)(2012), 17-15

- Achola SO, Patel JP, Mustapha AO and Angeyo HK (2012), "Natural radioactivity and external dose in the high background radiation area of Lambwe east southwestern Kenya", Radiation Protection Dosimetry(2012), 1-6

- Olwendo JO, Cilliers PJ, Baki P and Mito C (2012), "Using GPS-SCINDA observations to study the correlation between scintillation, total electron content enhancement and depletions over the Kenyan region", Advances in Space Research, 49(2012), 1363-1372

- Olwendo JO, Baki P Cilliers PJ, Mito C and Doherty P (2012), "Comparison of GPS TEC measurements with IRI-2007 TEC prediction over the Kenyan region during the descending phase of solar cycle 23", Advances in Space Research, 49(2012), 914-912

- Ayieko CO, Musembi RJ, Waita SM, Aduda BO and Jain PK (2012), "Structural and Optical Characterization of Nitrogen-doped TiO_2 Thin Films Deposited by Spray Pyrolysis on Fluorine Doped Tin Oxide (FTO) Coated Glass Slides", International Journal of Energy Engineering (2012), 2(3), 67-72

- Otakwa RVM, Simiyu J, Waita SM and Mwabora JM (2012), "Application of dye-sensitised solar cell technology in the tropics: effects of air mass on device performance", International Journal of Renewable Energy Research, 2(3)(2012)

- Otakwa RVM, Simiyu J, Waita SM and Mwabora JM (2012), "Application of dye-sensitised solar cell technology in the tropics: effects of radiation intensity and temperature on DSSC performance", International Journal of Advanced Renewable Energy Research, 1(2)(2012), 109-116

- Kaniu MI, Angeyo KH, Mwala AK and Mwangi FK (2012), "Energy dispersive X-ray fluorescence and scattering assessment of soil quality via partial least squares and artificial neural networks analytical modeling approaches", Talanta 98(2012), 236-240

- Angeyo KH, Gari S, Mustapha AO and Mangala JM (2012), "Feasibility for direct rapid energy dispersive X-ray fluorescence (EDXRF) and scattering analysis of complex matrix liquids by partial least squares", Applied Radiation and Isot.opes , (2012) 70(11), 2596-601

8. Consultancies Undertaken

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9. Number of graduands

- B.Sc.: 21
- M.Sc.: 7
- Ph.D.: 0

10 Papers Presented at Conferences

- Muiva CM, Sathiaraj TS and Mwabora J (2012), "Chemical bond approach to crystallisation kinetics and thermal stabillity in some $Se_{90x}In_{10}Sb_x$ chalcogenide glassy alloys", 2nd African Materials Science and Engineering Network (AMSEN) Workshop, 21-23 March 2012, Nairobi, Kenya

- Angeyo HK (2012), "Coupling energy dispersive X-ray fluorescence and scattering (EDXRFS) and chemometrics for rapid non-invasive quality assurance analysis and characterisation of complex matrix materials", 2nd African-European conference on chemometrics, November 19-23, 2012, Stellenbosch, South Africa

- Omucheni DL (2012), "Utility of multivariate chemometric techniques in multispectral image analysis: an application to malaria diagnostics", 2nd African-European conference on chemometrics, November 19-23, 2012, Stellenbosch, South Africa

- Musembi RJ (2012), "Solar PV training kit, a novel community outreach program in Kenya", 1st international conference on physics for the development, 10-14 October 2012, Belgium

- Nyang'onda T (2012), "Analysis of Root Mean square roughness of Microcrystalline silicon thin films using scanning probe image processor software", International Conference on Nanoscience+Technology, July 23- 27, 2012, Paris, France.

- Omucheni DL (2012), "A joint Kenyan-Ivory Coast Malaria Measurement campaign", International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya.

- Omucheni DL, Kaduki KA and Angeyo HK (2012), "Application of Principal Component Analysis (PCA) to Multispectral Imaging Microscopy for Malaria Diagnostics", International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya.

- Mukhono P (2012), "Chemometrics -Assisted Laser Induced Breakdown Spectroscopy of High Background Radiation Areas Geothermal Field Matrices", International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya

- Mukhono PM, Angeyo HK, Massop D and Kaduki KA (2012), "Laser induced breakdown spectroanalysis and characterization of environmental matrices utilizing multivariate chemometrics ",International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya

- Cheruiyot EK, Mito CO and Kaduki KA (2012), "Application of Multi-spectral Satellite Imagery in Monitoring of Aquatic Vegetation and Water Quality Parameters in Large Inland Waters", International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya

- Memeu, DM, Kaduki KA and Mjomba CK (2012), "Automatic classification of plasmodium parasites using stained RGB images", International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya

- Gathoni R (2012), "Gas in scattering media absorption spectroscopy", International workshop on Spectral Imaging in remote sensing, 17-28th September 2012, Nairobi, Kenya

- Aduda B(2012), "Opportunities for and challenges to energy sufficiency and sustainability in the Kenya energy sector", Building a future energy system in Africa How can science academies contribute? Workshop, 10th September 2012, Stockholm, Sweden