UAE University/ Physics Department/ 2008-2009

A report on the research status of the Physics department for the academic year 2008-2009

Introduction

Research at the Physics department is characterized by its diversity. The department hosts faculty members with specialties in theoretical and experimental condensed-matter physics, high-energy and elementary particles physics, atomic and nuclear physics, material science and nanotechnology, laser physics, mathematical and computational physics, medical physics and astrophysics. Among these fields, condensed matter physics – including solid-state physics – is conducted by the largest number of faculty members. The department has also a strong high-energy and elementary particles team of three faculty members. Nanophysics and nanotechnology are strongly represented by the two newly appointed faculty members who are experts in the field. They have received recently a grant from UAEU to purchase systems for the synthesis of nanoparticles and carbon nanotubes. Computational physics is being conducted by many faculty members on various problems such as electronic structures and molecular dynamics simulations. This was recently boosted by the new high-speed cluster of computers.

A detailed account of the current research profile

I. Faculty and staff

II. Research fields

III. Faculty names with research interests

IV. Research Groups

V. Research laboratories

VI. Statistics of publications, conferences, and grants

VII. Publications

I. Faculty and staff statistics

Rank	Number
Full professors	3
Associate professors	13
Assistant professors	5
Instructors	3
Academic assistants and Lab specialists	11

II. Research fields

1. Particle and Nuclear Physics

(1)High Energy Particle Physics:

a) Electroweak Symmetry Breaking and Neutrino Physics,
b) LHC Physics,
c) Physics beyond the Standard Model,
d) Flavor Physics,
e) Dark Matter,
f) Quantum Chromodynamics,
g) Confinement.

(**2) Nuclear Physics:**

a) Hydrodynamics and radiation transport,
b) Physics and Applications of Dense Nonideal Plasmas,
c) Radiation and Particle Transport in Materials,
d) Advanced Mathematical and Numerical Methods.

2. Solid State Physics and Materials Sciences

(1)Theoretical:

a) Models of High Tc Superconductivity,
b) Electronic band structure and the density of states of Fe-based superconductors,
c) Vortex dynamics and phases in high-temperature superconductors,
d) Formation of Biexcitons in Molecular Crystals,
e) Band Structures of Polymers, Composites and Superlattices,
f) Atomic Collisions with Positrons and Antiprotons,
g) Positronic Compounds,
h) Resonance Phenomena in Physical and Chemical Reactions,
i) Auge Processes,
j) Particle and antiparticle interactions with small Nuclei,
k) Four-Body Systems and Exotic Molecules,
l) Magnetic properties of nanoparticles,
m) Silicon Nanoparticles for Solar-Energy Applications,

n) The II-VI and III-V semiconductor Alloys for Photonic and Telecommunication Applications,
o) Bose-Einstein condensation.

(2) Experimental:

a) Electrical and optical properties, I-V characteristics, and capacitance-voltage measurements and photoconductivity of Phase Change materials, amorphous semiconductors, and Chalcogenides.
b) Nanocluster/nanowire devices and applications as gas sensors.
c) Synthesis, characterization, and device applications of carbon nanotubes.
d) Vortex dynamics and phases in high-temperature superconductors.
e) Physical properties of superconducting nanomaterials.
f) Laser Physics

3. Atomic and Molecular Physics:

a) Few Body Problem,
b) Multi-Electron Processes in Atomic and Molecular Collisions

3. Astrophysics Physics and Astronomy:

a) Active Galactic Nuclei,
b) Lunar Crescent Visibility Problem,
c) History of Islamic Science,
d) Astronomy Education

4. Medical Physics:

a) Magnetic Resonance Imaging (MRI),
b) Medical Image Analysis and Texture analysis,
c) Applications of nanoparticles in medical physics,
d) Fluid transport through porous media, Bio-Electrostatics,
e) Air Pollution and Respiratory Diseases,
f) Biological Effect of Non-ionizing Electromagnetic Radiation,
g) Modeling the human immune system.

5. Physics Education:

a) Investigation of the level of comprehension of very basic physics concepts,
b) Investigation of the most appropriate teaching approach.

III. Faculty names with research interests

Name	Research interests
Prof. Mohamed Assad Abdel-Raouf	Models of High T_c Superconductivity; Formation of Biexcitons in Molecular Crystals; Band Structures of Polymers; Composites and Superlattices; Interface States; Atomic Collisions with Positrons and Antiprotons; Positronic Compounds; Resonance Phenomena in Physical and Chemical Reactions; Auge Processes; Particle-Antiparticle interactions ; Four-Body Systems and Exotic Molecules
Prof. Nacir Tit	Computational Semiconductor Physics and Electronic Structures; III-V and II-VI semiconductors, Superlattices; Alloys; Modeling of Photoluminescence data
Prof. Maamar Benkraouda	Superconductivity; Electronic properties of Materials
Dr. Adel Hashish	Bioelectroststics; Medical and Radiation Physics and Biological effects of EMFs
Dr. Saleh Thaker	Laser-Plasma Interactions; Plasma Instabilities and Particle Acceleration; Laser Interaction with Matter; Condensed Matter (Phase Change Materials)
Dr. Noureddine Amrane	Computational materials science; Condensed Matter Physics
Dr. Naser N. Qamhieh	Amorphous semiconductors; Chalcogenides; Photoconductivity; Electrical properties; Optical properties; Time of Flight; Density of states; Phase change materials; Impedance spectroscopy; I-V characteristics; Capacitance-voltage measurements.
Dr. Hassan Ghamlouche	Solid State Physics, Semiconductors, Superconductors, Phase change materials
Dr. Mofreh R. Zaghloul	Nuclear Science and Engineering; Plasma Physics; Nuclear Fusion
Dr. Ihab M. Obaidat	Superconductivity; Magnetism; Semiconductors
Dr. Fathalla Hamed	Physics of Materials
Dr. Ehab Malkawi	High Energy Physics; Elementary particle Physics; Phenomenology and Physics Beyond the Standard Model; Neutrino Physics
Dr. El Hadi Sadki	Experimental Solid State Physics and Materials Science. Synthesis, characterization, and device applications of carbon nanotubes. Physical properties of superconducting nanomaterials.
Dr. Doaa Mahmoud Ghoneim	Image Analysis; Image Processing; MRI; Texture Analysis
Dr. Bashar Issa	MRI; RF Pulse Design; Magnetic Nanoparticles Contrast Media

Dr. Amal Abdulla Al Ghaferi	Materials Science and Engineering
Dr. Ahmad Ibrahim Ayesh	Nanotechnology; nanodevices; nanoclusters; nanowires; electronic devices
Dr. Ilias Fernini	Astrophysics; Active galactic nuclei; Lunar crescent visibility; History of Islamic science
Dr. Abdessamad Abada	Theoretical Physics
Dr. Salah Nasri	Theoretical High Energy Physics
Dr. Ahmad Hasan	Experimental Atomic and Molecular Physics: Few Body Problem and Multi-Electron Processes in Atomic and Molecular Collisions
Dr. Usama Al Khawaja	Bose-Einstein Condensation, Solitons, and Mathematical Physics

IV. Research Groups:

	Group name	**Group memebers**
1	Experimental Semiconductors and Chalcogenide Materials (ESCM)	Dr. Hassan Ghamlouche, Dr. Naser Qamhieh, Dr. Saleh Thaker, Dr. Ahmad Ayesh
2	Nano Physics	Dr. El Hadi Sadki, Dr. Ahmad Ayesh , Dr. Naser Qamhieh, Dr. Hassan Ghamlouche, Dr. Saleh Thaker, Prof. Nacir Tit, Dr. Ihab Obaidat, Dr. Bashar Issa,
3	Superconductivity group I	Prof. Maamar Ben Krouda, Dr. Noureddine, Dr. Fathallah Hamed
4	Superconductivity group II	Dr. Ihab Obaidat and Dr. Hassan Ghamlouche
5	Computational Material Science	Prof. N. Tit and Dr. Noureddine Amrane
6	Theoretical High Energy Physics	Dr. Ehab Malkawi and Dr. Salah Naseri
7	Physics Education	Dr. Naser Qamhieh, Dr. Ehab malkawi, Dr. Ihab Obaidat
8	Medical Physics	Dr. Adel Hashish, Dr. Bashar Issa, Dr. Doaa Ghouneim
9	Astrophysics	Dr. Ilias Fernini
10	Nuclear Physics	Dr. Mofreh Zaghloul
11	Atomic and Molecular Physics	Dr. Ahmad Hasan
12	Bose-Einstein Condensation	Dr. Usama Al Khawaja
13	Theoretical Physics	Prof. Mohamed Assad Abdel-Raouf

1. Experimental Semiconductors and Chalcogenide Materials (ESCM) group

Group Members:

1. Dr. Hassan Ghamlouche
2. Dr. Naser Qamhieh
3. Dr. Saleh Thaker
4. Dr. Ahmad Ayesh

Chalcogenide amorphous semiconductors, utilizes the resistivity difference between crystalline and amorphous phases. It is noted that a typical resistivity ratio between amorphous and crystalline phase is more than 1000. This huge difference in the resistivity establishes the phase-change memory as a good candidate for the next generation nonvolatile memory. Chalcogenide-based Phase Change Memories are successfully employed in optical data storage and are becoming a promising candidate for future electronic storage applications. Despite the increasing technological interest, many fundamental properties of these materials remain poorly understood. Apart from the commercial importance of these materials, the rarely found combination of materials properties, a fast reversible phase transition from the crystalline to the amorphous phase accompanied by a profound change of electronic conductivity and optical reflectivity is also of great scientific interest.

Our interests are in defining material properties and demonstrating the feasibility of finding a suitable phase change material (s) of very low switching voltages. This would have a great impact on data storage technology. We seek to investigate the electrical and optical properties of a variety of amorphous chalcogenide materials for optical and electrical memories. We use both electrical and optical techniques including impedance spectroscopy, I-V and C-V measurements, Hall Effect, electrical switching measurements and UV/VIS/NIR Spectroscopy.

Measurements on Ge-Sb-Te and Se-Sb-Te thin films have been performed. Initially, effects of contacts have been investigated using Impedance Spectroscopy technique. A new contact deposition method has been proposed in order to minimize the contact effects[1-3]. Capacitance-Voltage technique has been used to study the effect of temperature and applied voltage bias on the capacitance. Nonlinearity and negative capacitance effects have been observed and analyzed. The main reasons of these two effects are the nucleation and growth of crystalline islands during the heating process, especially at temperatures close to the transition from amorphous to crystalline states, T_c[4-6]. Using a UV/VIS/NIR Spectrophotometer, the energy gap and the refractive index in both amorphous and crystalline states have been determined[7]. Finally, the structure of the films has been investigated using XRD technique. The lattice constant has been determined in the crystalline state of each family of the films[7].

The key areas motivating our research in phase change data storage materials are:

- New materials which outperform current phase change materials upon scaling to smaller dimensions.
- Novel, high performance, materials for electrical phase change materials.
- Compositional effects on switching and threshold voltage.
- Full understanding of the phase change mechanism on an atomic scale.

References

1. **Saleh T. Mahmoud, H. Ghamlouche, N. Qamhieh, Hessa Al-Shamisi**

   "Novel preparation methods of electrical contacts in Ge-Sb-Te thin films", *Applied Surface Science* Vol. 253, (2007), p. 7242-7245.

2. **H. Ghamlouche, N. Qamhieh and S.T. Mahmoud**

   "Electrical properties of $In_{0.3}Ge_2Sb_2Te_5$ films using impedance spectroscopy", *J. Ovonic Research,* Vol.3, No.5, (2007) p. 103-110.

3. **N. Qamhieh, H. Ghamlouche, S. T. Mahmoud, H. Al-Shamisi and S. Ahmad**

   "Electrical conductivity measurements in $Ge_2Sb_2Te_5$ films", *J. Optoelectronics and Advanced Materials*, Vol. 9, October Issue (2007), p. 3157-3160.

4. **H. Ghamlouche, S. T. Mahmoud, N. Qamhieh, Sadiqa Ahmad and Hessa Al-Shamisi**

   "Capacitance–Voltage Measurements of Ge-Sb-Te Thin Films", *Physica Scripta, 77 (2008), 015701, p. 1-5.*

5. **S. T. Mahmoud, H. Ghamlouche, N. Qamhieh and Sadiqa Ahmed**

   "Capacitance-Voltage characteristics of $In_{0.3}Ge_2Sb_2Te_5$ thin films", *J. Non-Crystalline Solids* 354 (2008), p.1976-1980.

6. **H Ghamlouche, S T Mahmoud and N Qamhieh**

   “Electrical Properties of $Se_2Sb_2Te_6$ thin films”, *J. Phys. D: Appl. Phys.* 41 (2008) 215303. Published online at: www.stacks.iop.org/JPhysD/41

7. **N. Qamhieh, S. T. Mahmoud and H. Ghamlouche**

   “Comparative Structural and Optical Properties of $Ge_2Sb_2Te_5$, $In_{0.3}Ge_2Sb_2Te_5$ and $Se_2Sb_2Te_6$ thin Films”, accepted in *J. Optoelectronics and Advanced Materials,* July 2009.

2. Nano Physics group

2.1 Group 1: Nanocluster devices

Group members:

1. Dr. Ahmad Ayesh
2. Dr. Naser Qamhieh
3. Dr. Hassan Ghamlouche
4. Dr. Saleh Thaker

Nanophase materials represent an appealing class of materials and have properties which cover the entire range from metals to semiconductors and insulators. Those materials have properties which are different from the conventional materials with larger grain sizes. Various research studies demonstrated a remarkable improvement in the electrical, chemical, and mechanical properties of the nanophase materials. Furthermore, the large ratio of surface to volume atoms of the nanomaterials makes them more effective in detecting the molecular events than the bulk materials.

Gas and chemical sensors are devices allowing gaining chemical information about their surrounding atmosphere, i.e. information about the presence or absence of certain materials or/and their concentrations. The detection mechanism is based on the fact that changing the atmosphere alters the sensor's properties in a characteristic way. The sensors of our interest are the conductance based sensors and they operate with changes in their electrical resistance.

Gas sensors are required for a wide range of applications in various areas such as domestic safety, automotive applications, environmental monitoring, public security, air conditioning in airplanes and spacecraft, and sensor networks. This vast range of applications created a worldwide increasing demand for cheap, small, low power consuming, and reliable nanomaterial based gas sensors.

A main goal of our group is the fabrication and characterization of nanocluster/nanowire based devices for gas and chemical sensing applications. Our research focus on sensors that can be used for environmental applications such as sensors for carbon monoxide (CO), nitrogen dioxide (NO_2), hydrogen (H_2), and ethanol.

The research of our group is focused on the following goals:

1. The fabrication of the nanocluster/nanowire devices. The devices are fabricated using the self-assembly technique in order to make them easy to manufacture on a commercial scale.
2. Conduct systematic investigations of the sensitivity, selectivity, and stability (3S) of the sensor for different gases.
3. Study the effects on the 3S of the morphology, dimensions, and the physical and chemical treatment of the nanocluster device.

2.2 Group 2: a) Synthesis, Characterization, and Device Applications of Carbon Nanotubes

Dr. El Hadi Sadki

This research is about the synthesis, characterization, and device applications of carbon nanotubes. In particular, the main focus is on the synthesis mechanisms of carbon nanotubes by chemical vapor deposition (CVD), in order to control and accurately predict their post-synthesis structural and physical properties. This "holy grail" of the carbon nanotubes research field, will make it possible to have "custom-built" carbon nanotubes designed for each specific application, without relying on chance or post-synthesis selection and filtration as it is presently. One breakthrough in this area that it is actively pursued is the success in the CVD synthesis of ultra-long and highly aligned carbon nanotubes on a substrate, and hence opens the way for exciting possibilities for carbon nanotubes-based nanodevices, such as gas or biomolecular sensors.

2.3 Group 2: b) Physical Properties of Superconducting Nanomaterials

Dr. El Hadi Sadki

This project is about the study of the superconducting properties of materials at the nanoscale, in particular in superconducting nanowires. In addition to the expected and interesting new physics in these systems, such as the effect of the dimensional confinement on the superconducting critical temperatures and currents, the understanding of these properties will allow new technological advances for these nanomaterials, as miniature non-dissipative and fast electronic interconnects inside computers for example.

2.3 Group 3: Nanoparticles

Group members:

1. Dr. Ihab Obaidat
2. Dr. Bashar Issa
3. Dr. Nacir Tit

Collaborators:

1. Professor Yousef Haik, Dept. Mechanical Eng., UAE University, UAE.
2. Professor Richard W. Bowtell, Dept. of Physics, University of Nottingham, U.K.

Due to finite size effects, such as the high surface-to-volume atomic ratios and different crystal structures, magnetic nanoparticles are found to exhibit interesting and considerably different magnetic properties than those found in their corresponding bulk materials. These new properties prompted the application of this type of nanoparticles in diverse fields. But the science of magnetic nanoparticles is still evolving in three different directions. These are; the understanding of the physics of some of their properties, the synthesizing of nanoparticles in well-specified sizes and uniform distribution, and the expanding of the fields of their applications.

The surface atoms experience different environment than those in the core of the particle. There are several types of defects that exist on the surface such as atomic vacancies, changes in the atomic coordination, dangling bonds and lattice disorder. These surface defects result in uncompensated disordered spins at the surface of the nanoparticle leading to surface magnetization (ferromagnetism or antiferromagnetism). Several parameters are believed to determine the surface magnetization of the nanoparticle. Some of which are the size of the nanoparticle, the degree of surface disorder and the spin structure at the interface.

Our group studies the parameters which controls the magnetic properties (especially the Curie temperature) of these nanoparticles. We do this experimentally by synthesizing nanoparticles of various sizes with several synthesizing conditions and measuring there magnetic moments as function of applied magnetic field and temperature. We also do some computer simulations on the surface spin states.

Our group also studies the possible applications of these nanoparticles in the medical field where they can be used as contrast agents for MRI. Nanoparticles synthesized at the department of mechanical engineering are being tested for their MRI relaxation enhancement properties in different environments and different coatings. Characterization of these magnetic particles includes the measurement of magnetic moment, size and size distribution, composition, etc. MR longitudinal and transverse relaxation times are being measured locally at 1.5 T while collaboration with international groups has expanded measurements to higher magnetic fields. The magnetic field distortions created by magnetic material (or traditional contrast agents based on Gadolinium) can be modeled numerically and their effect on functional MRI signal studied. In particular the effect of diffusive motion in different regimes and environments is being investigated. These magnetic particles were originally developed for use as hyperthermia therapeutic agents in the treatment of cancer and other diseases.

3. Superconductivity group I

Group members:

1. Dr. Maamar BenKrouda
2. Dr. Noureddine Amrane
3. Dr. Fathallah Hamed

The group's activity at the moment centers on the study of the newly discovered Fe-based superconductors. Experimentally: we prepare Fe-based superconducting samples, and dope these samples with suitable chemical elements. Compositional and structural analyses on the prepared sample are carried out. We carry out complete transport and magnetic measurements on the prepared samples over the temperature range 2-400 K in the presence of applied magnetic fields (0-7 T). Theoretically: we calculate the electronic band structure and the density of states.

4. Superconductivity group II

Group members:

1. Dr. Ihab Obaidat
2. Dr.Hassan Ghamlouche

Collaborators:

1. Dr. Borhan Albiss, Jordan University of Science and Technology, Irbid, Jordan.

2. Dr. Mohamed-Khair Hasan (Qaseer), Jordan University of Science and Technology, Irbid, Jordan.

Our group studies the effects of disorder on the vortex pinning forces on the static and dynamic vortex phase transitions in high-temperature superconductors (HTSCs). It is known that disorder has clear effect on vortex pinning forces which determine the critical current density in these materials. Using magnetic and electric transport measurements, we study the role of different types and structures of defects on the magnitude and behavior of the critical current density.

The vortices in HTSC materials exhibit fascinating static and dynamic phase transitions. The Abrikosov lattice which is a regular array of vortices mainly formed in pure samples is known to be destroyed by disorder, inducing various vortex phases with surprising properties. These vortex phases include vortex lattice, vortex glass, and vortex melting phases depending on the disorder in these materials. We study the vortex phases in HTSCs experimentally using magnetic and electric transport measurements. We also employ molecular dynamics simulations in the London Langevin approximation using several realistic representations of the disorder combined with the role of temperature to investigate these vortex phases.

5. Simulations of Semiconductor Nanostructures & Devices group

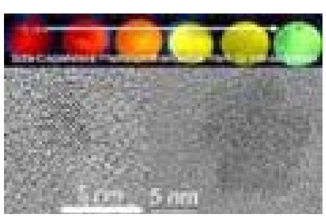
Group members:

1) Prof. Nacir Tit,
2) Dr. Noureddine Amrane
3) Dr. Ahmad Ayesh

Project#1: Silicon Nanoparticles for Solar-Energy Applications:

Integrating a high-quality film of silicon nano-particles (1 nanometer in size) directly onto silicon solar cells improves power performance by 60% in the ultraviolet range of the spectrum. A 10% improvement in the visible range can be achieved by using nano-particles of size 2.85nm.

Researchers at the University of Illinois, USA (led by Prof. Munir Nayfeh) worked with several institutions in Saudi Arabia to increase the efficiency and performance of the conventional solar panel, and found that by using nano-particles of the same material the solar panels were made out of, they could create a thin coating for the panel that would enable it to perform all its normal functions with greater speed and efficiency.



We propose to calculate the radiative efficiency and absorption of Si-nanoparticles of sizes varying from 1-5 nm and assess the effects of both structure relaxation and coating on the optical emissions of these particles. We plane to test two coatings: Hydrogen and oxygen.

Project#2 The II-VI semiconductor Alloys for Photonic Applications:

Novel epitaxial growth techniques have made it possible to grow compound semiconductor alloys with controllable compositions to a very high accuracy. Among the produced nano-structures, the II-VI alloys find a broad field of applications in optoelectronic industry (e.g., laser diodes emitting in the visible range, light detectors and emitters, and solar cells); while the III-V alloys extend their applications from microelectronics to telecommunication (e.g., long-wavelength lasers). Relying on this milestone advent, a new generation of devices with unique capabilities, ranging from solid-state photomultipliers to efficient solar cells to resonant tunneling transistors, is emerging from this approach. There are already many new device structures which are commercially available and many more at the advanced research stage.

On the computational side, we plan to pursue our collaboration with Dr. Hussain Alawadhi (University of Sharjah) to model their experimental photoluminescence (PL) data on the II-VI ternary and quaternary alloys. Namely, we plan to investigate the electronic properties of $Zn_{1-x}Mg_xSe_yTe_{1-y}$ ternary and quaternary alloys and search the range of compositions (x,y) to be suitable for photonic applications.

Project#3: The III-V semiconductor Alloys for Telecommunication Applications:

In the last decade, the nitride alloys (GaInNAs) attracted enormous interests as being very promising candidates to become wave-guides to sustain 1.3–1.6 μm wavelength in the telecommunication applications. More recently, in the last two years, new doping atoms are raising even greater interest to substitute nitrides while playing similar role. Namely, one mentions Boron and Bismuth doping GaAs.

In this investigation, we plan to model some PL experimental data obtained in University of Nottingham (UK) on $Ga_{1-x}B_xAs$ and $GaBi_xAs_{1-x}$ ternary alloys. We plan to investigate the electronic properties of these alloys in the dilute regime ($x<0.03$).

References:

[1] N. Tit and A. Al-Zarouni, *J. Phys.: Condens. Matter* **14** (2002) 7835.

[2] N. Tit and A. Murat, *Int. J. Mod. Phys. B* **22** (2008) 1997.

[3] N. Tit and I.M. Obaidat, *J. Phys.: Condens. Matter* **20** (2008) 165205.

[4] N. Tit, I.M. Obaidat and H. Alawadhi, *J. Phys.: Condens. Matter* **21** (2009) 075802.

[5] N. Tit, N. Amrane and A.H. Reshak, *J. Elect. Mat.* (2009) in press.

6. Theoretical High Energy Physics group

Group members:

1. Dr. Abdessamad Abada
2. Dr. Ehab Malkawi
3. Dr. Salah Naseri

Electroweak Symmetry Breaking:

One of the most important problems in particle physics is the mechanism by which fermions and gauge bosons get masses. In the standard model the SU(2)_L x U(1) breaking is triggered by the vacuum expectation value of order 100 GeV of an elementary scalar field. However this scale is sensitive to the ultraviolet physics, and requires a new physics at TeV scale to stabilize the weak scale. This energy scale will be probed by the Large Hadron Collider (LHC) at CERN in Geneva. We are interested in exploring the origin of the electroweak symmetry breaking and the possible candidates for new physics and their phenomenological implications.

Neutrino Physics:

Neutrino oscillation data from different experiments provide a strong evidence in favor of non-zero masses and mixings. One of the puzzling aspects of neutrino mixing is the near maximal value of the $\nu_\mu - \nu_\tau$. In contrast, the mixing angle in the quark sector is very small. This might be telling us that there is some new symmetry present in the lepton sector but not in the quark sector.

It has been observed that neutrino oscillation parameters are consistent with a tri-bi-maximal structure for the mixing mass matrix in which the atmospheric neutrino mixing angle is maximal and the solar neutrino mixing is tri-maximal (i.e $\sin^2(\theta_{12}) = 1/3$. A natural question is whether there is some fundamental symmetry behind this structure of the lepton mixing matrix. In Refs. [1, 2] we tried to adress this question and we showed [1] that a $Z_2 \times Z_2$ can lead to a tri-bimaximal mixing for the mixing in the neutrino mass matrix.

References:

[1] The Z_2 x Z_2 Symmetry of the Tripartite Model. E. Lashin, E. Malkawi, S. Nasri and N. Chamoun. arXiv:0909.0828 [hep-ph]. Accepted for publication Phys. Rev. D.

[2] Form Invariance and Symmetry in the Neutrino Mass Matrix. E. Lashin, E. Malkawi, S. Nasri and N. Chamoun. To be submitted.

7. Physics Education group

Group members:
1. Dr. Naser Qamhieh
2. Dr. Ehab Malkawi
3. Dr. Ihab Obaidat

Teaching and learning introductory physics are both challenging tasks. Traditional methods of teaching have led to frequently disappointing results. Understanding and appreciation of basic physics concepts by students taking introductory physics courses are known to be major issues that have been and are currently attracting many physics educators. We believe that physics educators must convince the introductory physics audience that physics is beautiful, fun, rewarding. Failing in delivering this message, the students' perception and attitude of physics will not change.
Our research involves two main directions. The first direction is the investigation of the level of comprehension of very basic physics concepts among first year students at UAEU. This is being conducted using well-designed multiple-choice tests that focus on the basic concepts. From the results of the students, we are able to identify common naïve mental models among these students.

The second direction of our research is the investigation of the most appropriate teaching approach. We believe that reconstructing the lecture is one of the best approaches. We believe that discussing the basic concepts and how they are employed in some applications is absolutely indispensable tools for helping students to relate physical concepts to the real world. Students must be effectively involved in the discussion of these basic concepts and must be taught how to become active participants in the lecture. We have created an interesting teaching model which is composed of three components; the lecturing component, online self tests at the end of each chapter, and two well designed multiple-choice exams. The online multiple-choice based self tests at the end of each chapter enable students to practice solving problems besides the conceptual questions to measure their physics understanding. After the test students see their scores and were given the chance to improve them. The students' performance was found to be very encouraging. We are in the process of improving on this model and applying it to other physics courses.

8. Medical Physics group

Research is focused into two main areas of Bio-Electrostatics and Medical Imaging. In the former both theoretical and experimental work investigates the development and optimization of drug delivery systems targeting the lung. Medical imaging research is mainly related to magnetic resonance imaging (MRI) techniques and texture analysis of MRI and other imaging modalities. Analysis and processing of biological/medical images is also investigated in our group. New techniques of feature extraction, classification and pattern recognition are developed and applied.

Dr. Adel Hashish

Bio-Electrostatics

I am engaged in the research and design of a novel drug delivery system to replace currently used devices, which are based on injections. The new device (an Electrostatic Nebuliser) will be battery operated, compact and have the ability to deliver accurately the daily dose of drug to the body, via the lungs, using charged aerosol particles. Nuclear medicine and MRI are used to optimize drug delivery to the lung. Mathematical model of the human lung is used to predict the deposition of an aerosol pulse in healthy and diseased lung.

Other areas of research include i) Air Pollution and Respiratory Disease where the effects of particulate emissions from motor vehicles on health are investigated; and ii) Biological Effect of Non-ionizing Electromagnetic Radiation iii) Modeling the human immune system.

Dr. Bashar Issa

Magnetic Resonance Imaging (MRI)

Research areas cover the characterization and synthesis of nanoparticles contrast agents, and susceptibility imaging. Nanoparticles synthesized at the department of mechanical engineering are being tested for their MRI relaxation enhancement properties in different environments and different coatings. Characterization of these magnetic particles includes magnetic moment, size and size distribution, and composition. The magnetic field distortions created by magnetic material are also modeled numerically and their effect on functional MRI signal studied.

Other interests include the design of radio frequency pulses using optimization techniques and numerical modeling of fluid transport through porous media.

Dr. Doaa Mahmoud Ghoneim

Medical Image Analysis

The value of biomedical image analysis and processing is progressively increasing in literature and clinical applications. On one hand due to the importance of the salient information these images carry, and on the other hand as a result of the recent evolution in information systems that allows quick storage as well as easy handling and manipulation of digital images. New techniques to enhance biomedical image details and feature extraction are approached. The objective of those techniques is to improve detail representation and to maximize image usability even at low contrast and resolution conditions. Texture analysis is applied on the enhanced images and its results are used for nondestructive objective assessment of the underlying sample. Several interdisciplinary projects between the Physics Department and partners are aiming towards the noninvasive evaluation of tissue condition based on its image texture results. The images under investigation are mainly: MRI, CT, Ultrasound and microscopic ones, obtained either *ex vivo* on excised organs or *in vivo* from living subjects. The tissues and organs which have been investigated so far are: brain (tumors), liver (fibrosis), and muscle (atrophy). Computer programming is a major part in this research as the manipulation of images is entirely automated. A solid mathematical background is also essential for method developing, structure modeling, and optimization.

References:

1) A.S.Hegazi, A.H. Hashish and E.Ahmed (2009), On managing complex adaptive systems motivated by biosystems application to infections, *Nonlinear Biomedical Physics*, **3:**11.

2) A.H. Hashish (2009), Optimizing deposition of aerosolized drug in the lung: effect of electrostatic charge on aerosols**,** J.Aerosol Medicine and Pulmonary Drug Delivery, **22 (2)**: p 174 , Proceeding of The Seventeenth International Congress of Aerosol in Medicine (17th ISAM-2009), (ABSTRACT),May 10-14, 2009 – Monterey, California.

3) A.H. Hashish (2009), On modelling of particle deposition and clearance in the human lung**,** J.Aerosol Medicine and Pulmonary Drug Delivery, **22 (**2): p 111**,** Proceeding of The Seventeenth International Congress of Aerosol in Medicine (17th ISAM-2009), (ABSTRACT),May 10-14, 2009 – Monterey, California.

4) A.H. Hashish, M.A. El-Missiry, H. I. Abdelkader and R.H. Abou-Saleh (2008**),** Assessment of Biological changes of continuous whole body exposure to static magnetic field and extremely low frequency electromagnetic fields in mice. , Ecotoxicology and Environmental Safety, **71**: pp 895-902.

5) B. Issa. Medical Physics Education and Training: Regional and International Challenges. International federation for Medical and Biological Engineering (IFMBE) Proceedings 25/XII, pp. 204–207 (2009).

6) B. Issa. Design of Self-Refocused Pulses under Short Relaxation Times. Journal of Magnetic Resonance **191,** No. 2, 151-159 (2009).

9. Astrophysics group

Dr. Ilias Fernini

Interest 1: Active Galactic Nuclei (AGN)

My research interest in AGN is to check if radio galaxies and quasars are just the same type of radio sources but viewed at different angles to the line of sight. A large number of radio galaxies and quasars have been observed with the Very Large Array (VLA) at different frequencies using the highest possible resolution. I have analyzed the jet/counterjet ratio, the depolarization asymmetry, and the hot spot location for these radio sources to check if the unified scheme is a good model that can explain the differences we see in these two types of objects. I am now concentrating on the spectral indices of these sources.

References:

- "Multi-Wavelength Observations of FR II Radio Galaxies and Quasars", **Fernini, I.**, Proceedings of the Extragalactic Jets Conference: From Radio to Gamma Rays (Girdwood, Alaska, USA), eds. T.A. Rector & D. S. de Young, ASP Conf. Series Vol. 386, 120, 2008.
- "8.4 GHz High-Resolution Observations of Fanaroff-Riley II 3CR Radio Sources with $0.3 < z < 2.0$. II. Ten New Images, **Fernini, I.,** Astronomical Journal, Vol. 134, No. 1, 158, 2007.

Interest 2: Lunar Crescent Visibility Problem

The start of any Islamic month is solely determined by the first appearance of the crescent after the new Moon. This practice is based upon the teachings of the Prophet Muhammad (PBUH) which has to be strictly followed by Muslims. The question that we are facing today is as follows: can our present astronomical knowledge be useful in determining the first appearance of the crescent and hence be a help in deciding when to start months like Ramadhan (ninth month) and Dhu'l Hijjah (twelfth month), which are the two important months that Muslims look for the most in comparison to the other months of the Islamic calendar? This matter is further complicated since the problem is not just a pure astronomical problem. Besides astronomy, optics, meteorology, geography, and physiology of the human eye are all parts of this science quest to determine the earliest visibility of the crescent. Thus, the crescent visibility problem is a non-trivial problem. It involves so many disciplines and cannot be solved by just one.

References:

- “Yallop’s Criterion as a Test for the Earliest Crescent Visibility”, **Fernini, I.**, The Eighth Annual U.A.E. University Research Conference, 328-344, 2007.
- “Astronomical Crescent Visibility Criteria”, **Fernini, I.**, Proceedings of the First Emirates Astronomical Conference, Applications of Astronomical Calculations, Eds. Guessoum, N. & Odeh, M., Center for Documentation and Research, Abu-Dhabi (UAE), 29, 2007.

Interest 3: History of Islamic Science

No one can deny that there was an Islamic era where science, in all of its branches, flourished for more than ten centuries. The odd thing is that very few appreciate the extent and the impact of such an Islamic science that paved the way to the European renaissance. I wrote a book on the subject where I showed the important contribution of Muslim scientists in physics, astronomy, mathematics, and many other fields. I am still searching and looking for old manuscripts that hide within them the contribution of the Islamic era in all fields. It should be noted that the impact of the Islamic era on our modern civilization is not fully appreciated yet. Further work and devotion to this field are also needed to show that this contribution was not only from Muslim scholars, but also from Jewish and Christian scholars that worked under one roof: science.

References:

- "A Bibliography of Scholars in Medieval Islam*", **Fernini, I.,** Publisher: Cultural Foundation of Abu Dhabi (UAE), 611 pages, 1998.*

Interest 4: Astronomy Education / Public Outreach

Astronomy education is a broad subject, but I am emphasizing on two main themes: how to design a good astronomy course curriculum, and how to convey the message of astronomy to the public in general. In terms of the first theme, it is important to know that an introductory astronomy course designed for non-science majors can do two things well. It can teach students about their place in the universe, and it can show students how science works. It is not meant to train students to be astronomer, but to enrich their lives. This is why it is important to define what an introductory astronomy course designed for non-science majors should do, i.e., defining its goals. Some of the old traditional goals just do not work, like to use astronomy to teach math or to teach physics. The goals must be purely astronomical: (1) to let the students know about their place in the evolution of the universe, and (2) to let the students build their scientific arguments.

For the second theme, we should note that astronomy is a science of wonder and admiration that suits all ages and all genders. It is a science that can help the citizens of the world to rediscover their place in the universe. All humans should realize the impact of astronomy and basic sciences on their daily lives, and understand better how scientific knowledge can contribute to a more equitable and peaceful society. To convey this message, I publish every year, with the help of the Emirates Heritage Club, an almanac that facilitates the understanding of the universe through short articles explaining the most important astronomical events of the whole year with simple drawings. I also visit schools to give general lectures in astronomy as well as to conduct night astronomical observations to show to kids the beauty of the night sky.

References:

- "Astronomy at the Service of the Islamic Society", **Fernini, I.**, Proceedings of the International Astronomical Union – UNESCO Symposium 260, Paris (France), 2009, under press.
- "Teaching Astronomy to Non-Science Majors", **Fernini, I.**, Proceedings of the Third Annual Conference for Middle East Teachers of Science, Mathematics and Computing, Eds. Stewart, S. M. & et. al ., Abu-Dhabi (UAE), 153, 2007.

10. Nuclear Physics group

Group Members

1) Mofreh Zaghloul (PI)

2) Meyara Al-Noaimy (undergraduate student -graduated)

3) Ahmed Nihad Ali (undergraduate student -current)

The research interests of this group, in the broad sense, are focused on the physics of nonideal plasma with applications to energy production and propulsion systems. In a brief summary, these interests include the following areas:

Computational Physics and Hydrodynamics Simulation: The group theoretically investigates many physical and practical problems including hydrodynamics and radiation transport and has developed comprehensive computer codes to numerically simulate phenomena and devices of interest to energy production and propulsion systems. Results of research in this area are published in international journals like *J Physics D: Applied Physics* and *Fusion Science and Technology*.

Physics and Applications of Dense Nonideal Plasmas: The group intensively investigates the physics and develops unique computer codes and new measurement techniques to predict and measure the thermodynamic, radiative and transport properties of such nonideal plasma systems with emphasis devoted to the general case of multi-component plasma mixtures as it applies to many applications. Research results in this field have been published in well-known international journals such as *Phys. Rev. E*, *Physics of Plasmas*, *Plasma Physics & Controlled Fusion*, *J Physics D: Applied Physics*, *J. Applied Physics*, *Plasma Physics*, *IEEE Trans. Plasma Sci.*, *Fusion Science and Technology*, and *Fusion Engineering and Design*.

Radiation and Particle Transport in Materials: Interaction of after-glow X-ray and debris with the chamber gas and first wall material (liquid or solid) is an important phenomenon. The group is interested in understanding and quantification of the energy deposition and the resulting effects for its importance in the design of the first wall of an IFE chamber on top of the choice of the buffer gas. Preliminary research results in that topic have been published in *Fusion Science and Technology*.

Advanced Mathematical and Numerical Methods: Many well-known problems are of common interdisciplinary interest in general and to the hydrodynamic simulation in particular. The solution of the coupled nonlinear and nonideal Saha equations including quantum effects and the calculation of the Faddeyeva and Voigt functions are examples of these common problems that require highly accurate and efficient algorithms. One of the interests of the group is to develop highly accurate and efficient mathematical and computational algorithms for the solution of this kind of problems to be implemented in the groups own library and codes and to be publicized and shared with the scientific community as well. Research results related to such a kind of problems are published in *J Physics D: Applied Physics*, *Phys. Rev. E*., *IEEE Trans. Plasma Sci*., and *Monthly Notices of the Royal Astronomical Society*.

Formulation and Solution of the Inverse Problem: In many cases it is more convenient and more practical to solve the inverse problem. The group is interested in developing methodologies and related computational algorithms to solve the inverse problem of evaluating and predicting the equation-of-state of dense nonideal plasmas. Preliminary results from my research in this topic have been published in *Phys. Rev. E.* and *the Astrophysical Journal.*

11. Atomic Physics Group

Dr. Ahmad Hasan

i) Electron capture and excitation:

These processes are the dominant processes in collisions of highly charged ions with many-electron targets. They produce highly and multiply excited atomic states which eventually decay through many-electron transitions that involve emitting photons and Auger electrons. These many-electron transitions, as well as the properties (binding energies, lifetimes, relaxation pathways and branching ratios) of highly excited many-electron systems have fundamental scientific interest, being just at the border of what can be explored experimentally and theoretically. In addition, they have strong practical impact on various applications such as solar wind interaction with comets and the characterization of fusion and astrophysical plasmas. My Ph.D. work focused on this area of atomic and molecular physics and the following research articles are few relevant publications out of our work in this field:

[1] M. Zapukhlyak, T. Kirchner, A. Hasan, B. Tooke, and M. Schulz "Projectile angular-differential cross sections for transfer and transfer excitation in proton collisions with helium" Phys. Rev. A 77 012720 (2008).

[2] A. Hasan, B. Tooke, M. Zapukhlyak, T. Kirchner, and M. Schulz, "Kinematically complete experiment on transfer excitation in intermediate-energy p+He collisions" Phys. Rev. A 74, 032703 (2006).

[3]

ii) Ionization processes:

Ionization processes are important in collisions of energetic electrons, fast ions, and photons with many-electron targets (atoms and molecules). These processes produce at least three free particles a many-body system. The dynamics of many-body systems, i.e. the time development of such systems under the influence of the mutual interactions between the involved particles, must be considered as one of the unsolved, fundamental problem in physics and it is relevant in almost all research areas in modern physics. Furthermore, one can precisely select systems with particle numbers ranging from 3 to 10. Such systems can provide an important link between the well understood two-body problem and systems with very large particle numbers where thermodynamics and statistical mechanics provide a good description. Frequently, many-body systems in atomic collisions include two or more electrons that enable one to study dynamical electron correlation. Such correlation is a rich puzzle in quantum physics and it is far from being understood completely. Not only electron correlation is needed to understand interactions that involve many-body systems, but also has many applications in science and technology. The correlated motion of electrons determines the structure and evolution of many complex materials of our everyday world. Superconductivity and chemical reactions are few of many examples.

[1] A. C. Laforge, K. N. Egodapitiya, J. S. Alexander, A. Hasan, M. F. Ciappina, M. A. Khakoo, and M. Schulz “Three-Body Dynamics in Single Ionization of Atomic Hydrogen by 75 keV Proton Impact” Phys. Rev. Lett. 103, 053201 (2009)

[2] J. S. Alexander, A. C. Laforge, A. Hasan, Z. S. Machavariani, M. F. Ciappina, R. D. Rivarola, D. H. Madison, and M. Schulz “Interference Effects due to Projectile Target Nucleus Scattering in Single Ionization of H2 by 75-keV Proton Impact ” Phys. Rev. A 78 060701 (2008)

12. Bose-Einstein condensation group

Dr. Usama Al Khawaja

My current research interests are:

1. Solitons dynamics and collisions in Bose-Einstein condensates and optical fibers: This includes:

i) Studying the effect of the nonlinear interaction and external potential on the soliton molecule formation

ii) Soliton tunneling

iii) Controlling the dynamics of solitons

iv) Effect of noise on soliton dynamics and collisions

2. Inverse scattering method and the Darboux transformation:

i) Obtaining new exact soliton solutions of nonlinear Schrödinger equations

ii) Investigating the integrability of nonlinear Schrödinger equations

3. J-matrix method (*collaboration with the theoretical physics group at King Fahd University for petroleum and Minerals*):

i) Obtaining resonance and bound states for certain potentials.

Refernces:

[1] *Lax Pairs of Time-Dependent Gross-Pitaevskii Equation*,
U. Al Khawaja,J. Phys. A: Math. Theo. **39**, 9679 (2006).

[2] *Exact solitonic solutions of the Gross-Pitaevskii equation with a linear potential,*
U. Al Khawaja,Phys. Rev. E **75**, 066607 (2007).

[3] *Soliton localization in Bose–Einstein condensates with time-dependent harmonic potential and scattering length*
U. Al Khawaja, J. Phys. A: Math. Theor. **42**, 265206 (2009).

[4] *Integrability of a general Gross–Pitaevskii equation and exact solitonic solutions of a Bose–Einstein condensate in a periodic potential,*
U. Al Khawaja, Physics Letters A **373**, 2710 (2009).

[5] *Singular short range potentials in the J-matrix approach,*
M.S. Abdelmonem, I. Nasser, H. Bahlouli, U. Al Khawajab, A.D. Alhaidari,

Physics Letters A **373**, 2408 (2009).

13. Prof. Mohamed Assad Abdel-Raouf group

Because of the fact that I have been working at different Universities, my group and the groups with which I collaborated are also scattered at different Universities. The research topics of my interest cover different areas of Theoretical Physics, namely atomic and molecular physics, particle and nuclear physics, solid state physics, mathematical physics as well as theoretical chemistry.

Research Topics:
(I) Atomic and Molecular Physics
My work in this topic is concentrated on the investigation of atomic and molecular reactions involving exotic particles and the calculation of Auger transitions

(A) Atomic and Molecular Collisions with Exotic Particles
Positrons (as well as electrons) are used in my group for studying different physical phenomena in atomic and molecular physics, e.g. excitation, ionization, charge exchange, recombination, resonances, etc. Collisions with positrons, however, are distinguished by the possible formation of the exotic positroniums. On the other hand, we are interested in collision processes involving other exotic particles (in particular, antiprotons). Our main goal in this field is to calculate the scattering parameters (e.g. scattering lengths and elements of the reactance matrix) in order to determine the differential, partial and total cross sections which contain all required information about the reactions considered. Our tools for these calculations are different methods of approximation, e.g. **Variational Methods (VM)**, **Coupled-static Greens function formalism**, **Glauber approximations** and **Complex Coordinate Variational Method**

(B) Auger Transitions
My work in this field is focused on the development of a least-square variational technique for calculating very accurate wavefunctions for the emitted Auger electrons. Also, I am interested in investigating Auger processes induced by inner-shell positron annihilations. **(1) M. A. Abdel-Raouf** and S. A. Elkilany: *Elastic Scattering of Positrons by Helium, Neon, Argon and Krypton*, XXVI International Conference on Photonic, Electronic and Atomic Collisions, Kalamazoo, Michigan (USA), 2009. **(2) M. A. Abdel-Raouf:** *Antiproton-Atom Scattering*, Proceedings of the 8^{th} Annual UAE University Research Conference, SCI, 359-370, (2007). **(3)** M. A. El-Aasar and **M. A. Abdel-Raouf:** Least-squares Variational Treatment of Positrons (Electrons)-Diatomic Molecules Scattering, J. Phys. **B 40**, Atomic and Molecular Physics, 1801-1819 (2007). **(4) M. A. Abdel-Raouf,** M. M. Abdel-Mageed and S. Y. El-Bakry: Inner-shell Annihilation of Positrons in Argon, Iron and Copper Atoms, arXiv: 0711.0453 (2007).

(II) Low Energy Particle and Nuclear Physics.
My interest in this field is established on the basis of earlier publications entitled: "On the Existence of Arbitrary Four-Body (or Quasi-Four-Body) Molecules", "Are Particles and Antiparticles able to form (Quasi) Molecular Structures?", "Possibility of producing intensive beams of Antihydrogen and its

consequences", "Positronium Molecules: Their existence, Formation and Annihilation". Since the restriction on the relative masses of the four bodies involved in the Four-Body Theorem was relaxed, we proved **the possible "Existence Antihydrogen-Deuterium and Antihydrogen-Tritium Bound-States". The numerical confirmation of the theorem was the subject of** two works, the first on the "Existence on Four-Body Molecules". The second work contains very accurate calculations of the "Binding Energy of the Positronium Molecule". (The Ps_2 was formed in Laboratory in 2007 by Mills' group at **UC Riverside**). On the other hand, the successful production of cold Antiprotons using "LEAR" experiment at CERN, the formation of Antihydrogens by the "ATHEN' experiment, the trapping of large number of Antihydrogens via "ATRAP" and "ALPHA" Experiments, as well as the recent production of "Protoniums", true "Muonium" and "Pionium" encouraged us to carry out different numerical investigations, the results of which are accumulated in the following publications: **(1) M. A. Abdel-Raouf**: *Pionium Exotic Molecules*, 19th International IUPAP Conference on Few-Body Problems in Physics, University of Bonn (Germany)-(2009). **(2) M. A. Abdel-Raouf:** *Matter-Antimatter Interaction at Low Energies: Formation of Exotic Heteromolecules,* 2009-Meeting of the Division of Particles and Fields of the American Physical Society, Wayne State University, Detroit, Michigan (USA). **(3) M. A. Abdel-Raouf**: *Binding Energies of Protonium Ions,* XXVI International Conference on Photonic, Electronic and Atomic Collisions, Kalamazoo, Michigan (USA)-(2009). **(4) M. A. Abdel-Raouf**: *Existence and Nonexistence of Protonium Entities*, Proceedings of the 9th Annual UAE University Research Conference, April 2008**,** SCI, pp 6. **(5) M. A. Abdel-Raouf:** *Possible Coexistence of Antihydrogen with Hydrogen, Deuterium and Tritium Atoms*, arXiv-0711-2284 (2008). My interest in low energy nuclear physics is focused on the cluster model of nuclear reactions.

(III) Solid State and Material Science

My interest in this field is threefold: (1) Employment of Positron Annihilation Technique for studying structures and defects of Polymers and Solids. (2) Searching for models for explaining the mechanism of coupling between charge carriers responsible for the appearance of high T_c superconductivity (particularly Hubbard model, spin-polaron, excitonic, charge transfer and polarization models (2) Studying the formation of unexcited and excited Biexcitons in molecular crystals.

(1) M. A. Abdel-Raouf: *Existence and Nonexistence of Biexcitons in Molecular Crystals*, arXiv0709.2786A, (2007). **(2) M. A. Abdel-Raouf** and E.H. Lilo: *Evidence for a Charge Transfer Mechanism of High T_c Superconductivity Based on Positron Annihilation Measurements*, Proceedings of the 7th Annual UAE University Research Conference, SCI, 205-216, (2006). **(3) M. A. Abdel-Raouf :** *Possible Realization of a Polarization Model for High Tc Superconductivity*, Proceedings of the 5th Annual U.A.E. University Research Conference, SCI, 56-60, (2004).

(IV) Mathematical Physics

My first goal in this field is to develop unified variational formalism for the treatment of bound-state and scattering problems. My publications are considered as basic references in Applied Mathematics and Mathematical Physics *(see Все ресурсы :: Электронная библиотека попечительского совета**...** , Methods of applied mathematics (Arbogast T., Bona J., 2004) , http://www.dleex.com/details/?6405) and http://mathnews.blogfa.com/cat-18.aspx)*. My second goals is to derive rigorous upper and lower bounds for binding energies (eigenvalues), wavefunctions (eigenvectors), scattering parameters (scattering lengths, eigenphases and elements of the reactance matrix) as well as the expectation values of arbitrary physical operators **(see M. A. Abdel-Raouf**: *Schwinger-like Variational Methods for Bound and Scattered Systems*, 10th Annual Research Conference of UAEU- (2009) - ARC-013).

(V) Theoretical Chemistry

My interest in this field is focused on three directions: (1) Employment of elaborate quantum chemical approaches for studying band structures of polymers, composites and superlattices. My main goal in this direction is to investigate the physical and optical properties of the systems considered and search for systems with minimal band gaps adequate for doping. (2) Employment of ab initio Hartree-Fock techniques for studying the electronic structures of doped and undoped superconducting layers of ceramic materials. (3) Developing a quantum mechanical formalism for the treatment of the interface problems between one (and two) dimensional chains. Furthermore, I am interested in using **commercial Computer Codes** available for investigating the electronic and optical properties of macromolecules and superlattices. Finally, it is interesting to mention my recent contribution in the field of positron and positronium chemistry. **(1) M. A. Abdel-Raouf: Ab initio Calculations of the Interface States between Polyacetylene-Polyvinylfluoride and Polyethylene-Polyvinylfluoride Quasi-One-Dimensional Chains, arXiv: 0711-2425, (2007)**. **(2) M. A. Abdel-Raouf:** *Localization of Interface States Using Green\s Matrix Formalism*, Proceedings of the 8h Annual UAE University Research Conference, SCI, 353-358, (2007). **(3) Alneame, N. Amerane and M. A. Abdel-Raouf:** *Band Structure and Optical Properties of AlN/GaN and InN/GaN Superlattices* Proceedings of the 7th Annual UAE University Research Conference, STD, 98-107, (2006)- (2007). **(5) M. A. Abdel-Raouf:** *Bound States Composed of Positroniums and One-valence-electron Atoms*, 38th EGAS (European Group on Atomic Systems), Naples (Italy) - (2006). **(6) M. A. Abdel-Raouf:** *Existence of PS*Atom Molecules*, 8th EUROPEAN Conference on Atomic and Molecular Physics, Rennes (France) - (2004).

(VI) Teaching Physics Courses

My recent interest in teaching theory is documented in the works: **(1)** N. Qamhieh, **M. A. Abdel-Raouf**, E. Malkawi and I. M. Obaidat: *An Effective Model to Enhance Physics Learning at United Arab Emirates University*, in the 10th Annual Research Conference of the UAEU - (2009), ARC-057. **(2)** N. Qamhieh, **M. A. Abdel-Raouf**, E. Malkawi and I. M. Obaidat: *How to Challenge Learning of Introductory Course in Physics: A Suggested Model with Practical Application,* (Submitted) – (2009).

V. Research laboratories

The following equipments are available at the research labs*

1. Ultra High Vacuum Chamber for Nanoparticle Production (Mantis): The system can be used to produce most types of metallic and semiconducting nanoparticles using the sputtering method.

2. Chemical Vapor Deposition (CVD) System for Carbon Nanotubes Synthesis (MTI Corporation): The system is used for the synthesis of carbon nanotubes under different conditions of temperature, pressure, and gas flow rate.

3. Physical Property Measurement System (PPMS) (Quantum Design): The PPMS system is used to measure the electrical and magnetic properties of materials in large range of temperatures (as low as 2 K) and magnetic fields (as high as 7 Tesla) in a very accurate manner.

4. Coating Unit (Leybold): This system is used for thermal evaporation of solid materials such as metals and semiconductors, elements and compounds.

5. Thermal and Sputtering Unit (Torr): This system is used for thermal and sputtering deposition of metals (DC Sputtering) and semiconductors and Insulators (RF Sputtering.

6. Capacitance-Voltage System (Keithley): This system is used for measurements of Capacitance as function of applied bias voltage as well as function of time. There are two possibilities in this system, measurements at 100 kHz and 1 MHz and quasistatic measurements. It is mostly used for electronic devices such as diodes and transistors where there are junctions.

7. Current-Voltage Systems (Keithley): There are two types of this system Keithley 236 (Imax = 0.1 A) and Keithley 238 (Imax = 1 A). The only difference between the two systems is the current limit. This system is used to measure the variation of current with voltage and vice-versa .

8. Impedance Spectroscopy (Solartron): This system is used to measure the dielectric properties of materials. Real and Imaginary parts of the impedance and the related physical quantities such as the dielectric constant and the AC conductivity of the devices can be obtained.

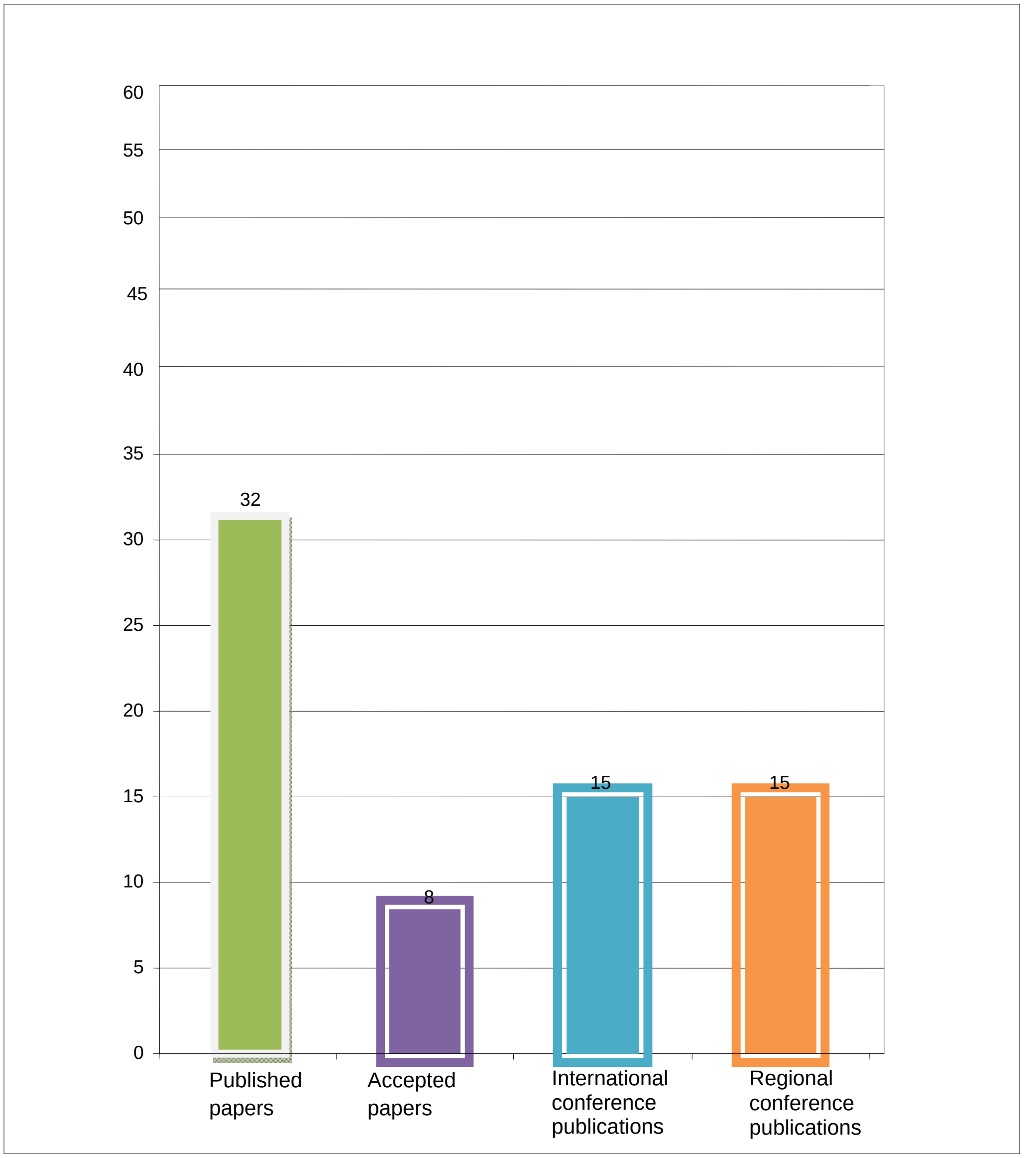
9. UV/VIS/NIR Spectrophotometer (Jasco): This system is used to measure the optical properties of materials (films, liquids and powders).

VI. Statistics for publications, conferences and grants*

Journal publications	
Published	32 papers in international peer reviewed journals
Accepted	8 papers accepted for publication in international journals
Conference publications	
Asia	1
Australia	None
Europe	4
Middle East	15
North America	8
Others	2
Research Funding in AED	
Grant	Amount in AED
UAEU grants	105700
4 Interdisciplinary UAEU grants	300000(Dr. Doaa)+200000(Dr. Doaa)+160200(Dr. Saleh)+180000 (Dr. Ahmad A.)
External grants: two Emirates Foundation and two British Council	200000(Dr. Bashar)+200000(Dr. Doaa) + 32,600 GBP (Dr. Bashar) +32,603 GBP (Dr. Amal & Dr. Ahmad A.)
Others	---

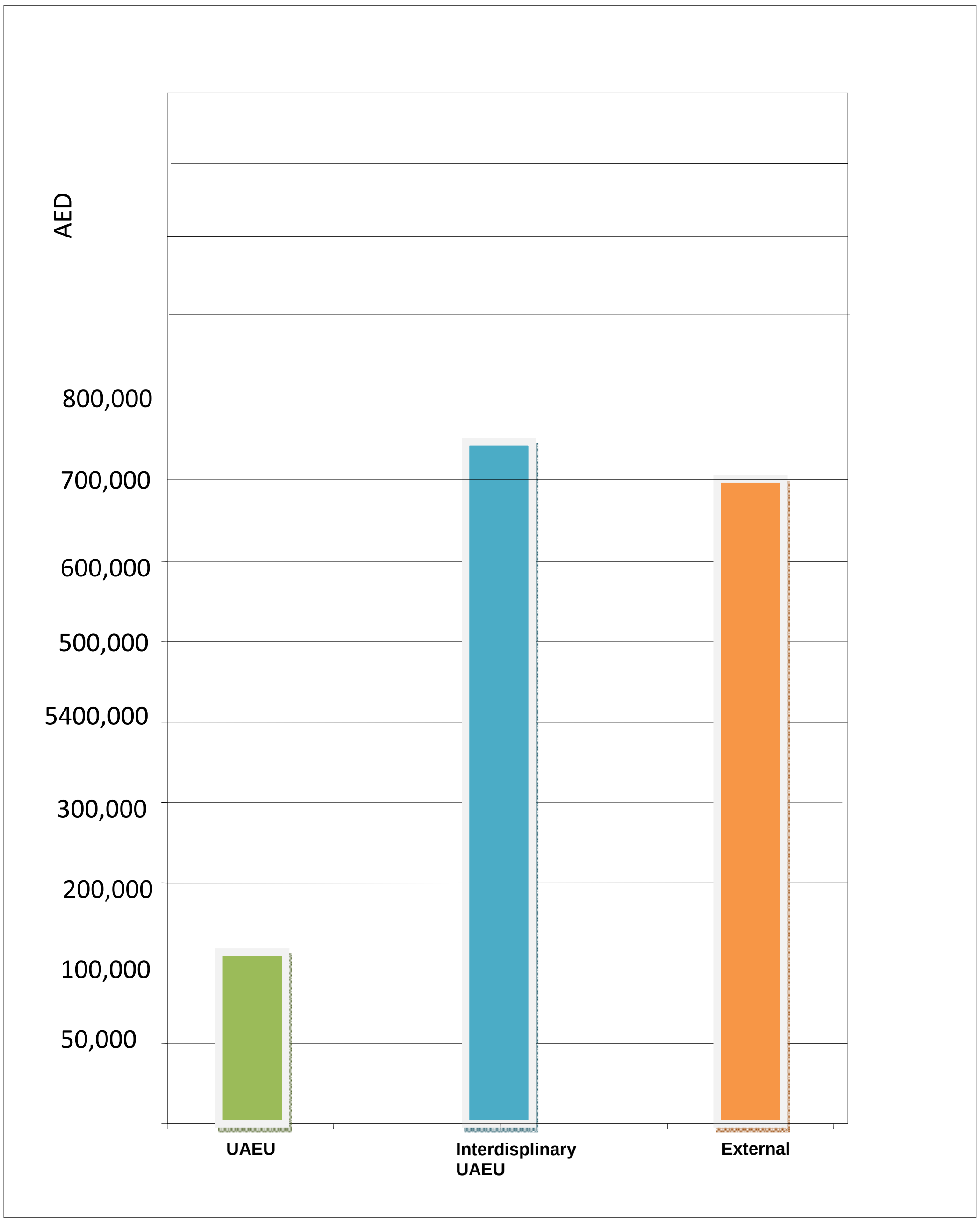
*** Source: Department's annual report 2008-2009.**

Publications 2008



Grants

2008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800,000
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External

VII. Publications**

1. A.H. Hashish, "Optimizing deposition of aerosolized drug in the lung: effect of electrostatic charge on aerosols". J.Aerosol Medicine and Pulmonary Drug Delivery, Proceeding of The Seventeenth International Congress of Aerosol in Medicine (17th ISAM-2009)

2. A.H. Hashish, "On modelling of particle deposition and clearance in the human lung". J.Aerosol Medicine and Pulmonary Drug Delivery, Proceeding of The Seventeenth International Congress of Aerosol in Medicine (17th ISAM-2009), (ABSTRACT),May 10-14, Vol.

3. I. M. Obaidat and Ehab Malkawi, "The Grasp of Physics Concepts of Motion: Identifying Particular Patterns in the Students' Thinking at UAEU". International Journal for the Scholarship of Teaching and Learning, Vol. 3, Issue No. 1, Jan., 2009.

4. I. M. Obaidat, U. Al Khawaja, and M. Benkraouda, "Investigating Dynamic Vortex Transitions in 2D Superconductors". Modern Physics Letters B, Vol. 23, 2009, pp. 2399 - 2408.

5. M.S. Abdelmonem, I. Nasser, H. Bahlouli, U. Al Khawajab, A.D. Alhaidari, "Singular short range potentials in the J-matrix approach". Physics Letters A , Vol. 373, 2009, pp. 2408 - 2412.

6. Mofreh R. Zaghloul, "Integrability Criterion for Lowering of Ionization Potentials and Formulation of the Solution of the Inverse Problem of Constructing Consistent Thermodynamic Functions of Nonideal Plasmas ". Phys. Rev. E, Vol. 79, Issue No. 1, 2009.

7. Mofreh R. Zaghloul, "Realization of electron degeneracy effects as up-shifting in the ionization energies in the classical Saha equation". Phys. Rev. E, Vol. 79, Issue No. 3, 2009.

8. Mofreh R. Zaghloul, "Thermodynamic Depression of Ionization Potentials in Nonideal Plasmas: Generalized Self-Consistency and a Backward Scheme for Deriving the Excess Free Energy". The Astrophysical Journal, Vol. 699, 2009, pp. 885 - 891.

9. N. Qamhieh, I. M. Obaidat, and F. Hamed, "On the Anomalous Steady-State Dark Conductivity in a-Se Films". International Journal of Modern Physics B, 2009.

10. N.Amrane, "Theoretical studies of positron annihilation in YN and ScN.". Materials Chem. Phys., Vol. 114, Issue No. 1, 2009, pp. 283 - 289.

11. U. Al Khawaja, "Soliton localization in Bose–Einstein condensates with time-dependent harmonic potential and scattering length ". J. Phys. A: Math. Theor. , Vol. 42, Issue No. 26, 2009, pp. 1 - 19.

12. U. Al Khawaja, "Integrability of a general Gross–Pitaevskii equation and exact solitonic solutions of a Bose–Einstein condensate in a periodic potential". Physics Letters A, Vol. 373, 2009, pp. 2710 - 2716.

13. A. Ayesh, "Experimental and simulational study of the operation conditions for a high transmission mass filter ". ARC10-2009, UAEU, 2009.

14. A. Ayesh, "Bi nanocluster device fabrication using V-grooves as a template ". ICN08: International Conference on Nanotechnology, 16-20 Nov. 2008, Abu Dhabi, United Arab Emirates.

15. A.H. Hashish, "Optimizing deposition of aerosolized drug in the lung: effect of electrostatic charge on aerosols". Proceeding of The 10th Annual Research Conference at The UAE University, April 13-16, 2009, Al-Ain, UAE (Oral presentation)., 2009, pp. 62 -

16. Ehab Malkawi, N. Qamhieh, and I. M. Obaidat, "Students' Understanding of Basic Physics Concepts of Newton's Laws of Motion at the UAE University". Proceeding of the Frontiers in Science Education Research Conference, Mar., 2009, pp. 153 - 157.

17. Ehab Malkawi, Naser Qamhieh, and I. M. Obaidat, "Students' Understanding of Basic Physics Concepts of Newton's Laws of Motion at the UAE University". The Frontiers in Science Education Research Conference, Mar., 2009.

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