ISLAMIC WORLD ACADEMY OF SCIENCES

Newsletter

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CONTENTS

CARBON TRADE

Abdullah Al-Musa
Director General, Islamic World Academy of Sciences

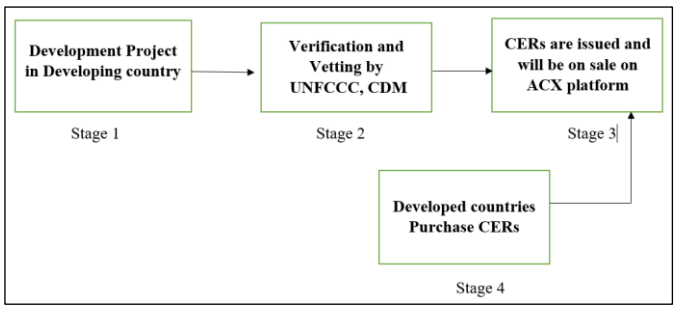
One of the COP26 achievements in carbon reduction is that it vitalizes article 6 of the Paris Agreement allowing the carbon credit mechanism to be operational.

Although the mechanism is not fully defined, however, based on the available information the procedure is as follows:
A developing country that embarks on a project that can reduce CO_2 emission (as part of its Sustainable Development Scheme) and is willing to benefit from the carbon credit market has to contact UNFCCC to vet and verify the reduction (There is a universal format to calculate the CO_2 reduction agreed upon in COP26).
Once the reduction is verified, the Clean Development Mechanism (CDM) of the UNFCCC will issue Certified Emission Reductions (CERs).

CERs are units tradable that are issued for GHG emission reduction. The CERs are put on sale through the digital platform of Air Carbon Exchange Company (ACX). As of today, there are clients who represent 30 different countries who are allowed to purchase the CERs.

Thus, the mechanism has 4 stages:

Stage 1. Developing country reduces GHG emission through projects in its drive for sustainable development.
Stage 2. UNFCCC has to verify the reduction. Once confirmed CDM will issue CERs.
Stage 3. CERs are put on ACX company platform for sale.
Stage 4. Developed countries can purchase the CERs.



To spearhead climate-responsive action, a digital infrastructure has to be built to track and calculate reductions in GHG emissions. The digital infrastructure should satisfy the monitoring, reporting and verification of GHG emissions requirements and is to be linked to national and international registries. Emissions emanating from transport, agriculture and industry could be tracked. Countries that embark on establishing this system would be able to participate effectively in international carbon trade.

[1] *Biologist, Professor and Chancellor of University of Petra, Amman Jordan.*

HIGHER EDUCATION IN THE ARAB WORLD: E-LEARNING AND DISTANCE EDUCATION

Adnan Badran[1], Elias Baydoun[2] and Joelle Mesmar[3]

Today's buzzwords: "Distance education" and "E-learning". Although their meanings are often interchanged, there are differences between the two. By definition, the first denotes a method of learning that involves the physical separation of the educator from the learner, characterized by non-contiguous communication. And the second refers to a style of learning that includes the use of technology and digital resources for instruction and assessment. Both are focused around the digital technology element.

Although distance education and e-learning have been gaining momentum in the past few decades, it is the recent COVID-19 pandemic that has emphasized its importance and driven the education sector online. Ever since, the nature of distance education and e-learning has been changing and evolving more rapidly, as higher education institutions, staff, educators, and learners are embracing a new level of digital maturity. In parallel, the online learning ecosystem has also been growing considerably. Today, more and more organizations are taking up e-learning and distance education, in addition to embracing the blended learning approach, which is becoming increasingly popular. This is a crunch time for higher education institutions that must not be squandered.

In its previous conference and as part of the theme of focusing on Arab universities, the Arab Academy of Sciences has delved into the challenges and lessons learned from the COVID-19 pandemic and addressed how higher education should look like in the post COVID-19 era. Generally, this had meant a move from traditional means of education to purely digital at the start of the pandemic. This year, the Academy will reflect on how higher education institutions in the Arab world have been adjusting to this new normal and look onward into the future of higher education. The conference will aim to bring together key

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[3] *Advisor, American University of Beirut, Lebanon.*

stakeholders including educators, experts, administrators, and students to share their experiences and ideas on distance education and e-learning. Participants will discuss challenges in shaping the future of education, drawing on the changing needs of students, educators, and staff in the wake of the COVID-19 pandemic. They will also be engaged to explore how to harness the full potential of distance education and e-learning in order to enhance and improve educational outcomes.

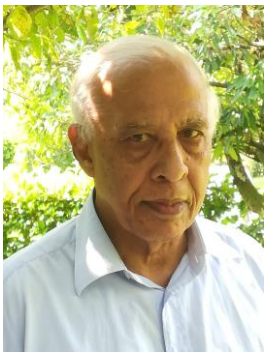
Particularly, Arab institutions need to rethink teaching and learning, redesign assessment, enhance student engagement, survey digital education tools and trends in tech-savvy education, address the digital disconnect and inclusive learning, and look into the future of research, among others. Largely, they need to adopt technology-enhanced learning as a central part of their strategic agenda, ensure the quality of education is guaranteed, and develop a vision for the future of higher education in the Arab world.

Blended learning is becoming the new trend of modern education, where the instructor becomes the facilitator rather than the disseminator. In this style of pedagogy, E-learning, distance education and face to face interactive learning, become blended toward building the minds of men and woman to a horizon of enquiry, problem solving and creative critical thinking, and release the potential of learners.

While it is one thing to embrace e-learning and distance education as an essential part of the future of higher education; it is quite another to implement them. If these are to be successful, critical success factors need to be identified and policy makers in the higher education institutions need to be well informed for the education process to be implemented effectively. We propose that this conference provides a platform to: discuss the benefits and advantages of e-learning and distance education; address best practices and success factors; and consider the hurdles and challenges in their implementation by drawing on experiences from developing and developed countries, all the while taking into consideration the needs of students, emphasizing on quality assurance, and addressing norms and standards of accreditation.

BLACK HOLES AND THEIR SPACETIME SINGULARITY

M. Asghar
Council Member, Islamic World Academy of Sciences



Abstract: Starting with the stellar evolution, this document discusses the physics of a very high gravitational field inside the black hole. The extremely high gravitational field leads to the presence of Roger Penrose's purposed closed spacelike trapped 2-surfaces from which both the inwards-pointing and outwards point null geodesics (light rays) converge in the future direction and are brought to focus through the gravitational lensing effect on the black hole spacetime singularity, where the mass density and the curvature become infinite leading to the breakdown of the laws of physics governing Einstein's General Gravitational Theory.

1. Stellar evolution

Beyond iron, due to the absence of nuclear fusion reactions, the stellar evolution process as a function of the mass of a star, is entirely controlled by gravity. Here, one forms neutron stars through the merging of the atomic electrons and nuclear protons into neutrons; when they become heavier in mass and overcome the neutron degeneracy pressure, they via the supernova explosion, go over to quark-gluon plasma stars. With the further increase in the mass of these stars, the quark-gluon plasma is reduced to a non-interacting Fermi gas of quarks and gluons. When the mass increases further and overcomes the quark degeneracy pressure, then again via the supernova explosion, the system goes over to black hole containing a Fermi gas of quarks **(1).**

In order to treat the physics of a black hole, one starts with the Schwarzschild metric solution to the Einstein field equations that describe the gravitational field outside a spherically symmetric mass leading to the relation:

$$c^2 = 2GM/r,$$

where M is the mass of the sphere; c, the velocity of light as the escape velocity from the gravitational field of mass M; and r, the radius of

the sphere under these conditions, called the Schwarzschild radius $r = r_s$.
A spherical object whose radius is smaller than the Schwarzschild radius is called a black hole., and the surface at the Schwarzschild radius is called the "event horizon" in a non-rotating body. For r less than r_s one is inside the black hole from where no light or particle can escape.

Fig. 1, shows the image of a black hole obtained through the worldwide Event Horizon Telescope system. The dark spot in the image represents a black hole surrounded by its event horizon along with the brighter halo outside of it.

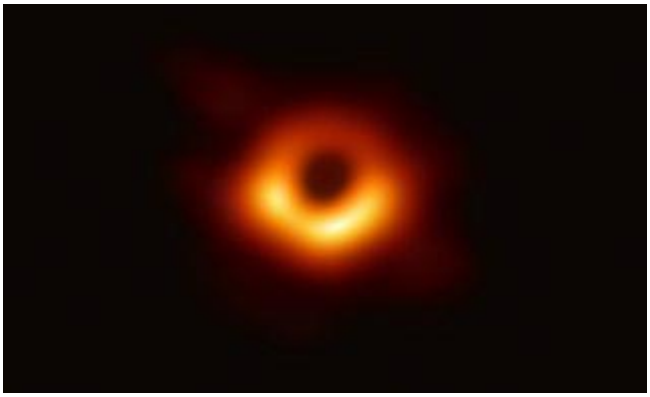


Figure 1. The Event Horizon Telescope, a planet-scale array of eight ground-based radio telescopes forged through international collaboration, captured this image of the supermassive black hole in the center of the galaxy M87 and its shadow. *(Image: © EHT Collaboration).*

2. Inside a black hole and its spacetime singularity

In order to discuss the physics inside a black hole, Fig.2, presents the light cones resulting from a collapsing star into a black hole compared to that for a flat spacetime without the gravitational field, shown in Fig.3. The strong gravitational field inside the black hole can very strongly distort the future paths of light in it and can even lead to closed curves. Following this idea, Roger Penrose proposed the concept of a closed spacelike "trapped 2-surface" **(2,3)** from which both the inwards-pointing and outwards pointing null geodesics (light rays) converge in the future direction. The term "trapped" implies that the gravitational field becomes so strong in some regions that the null geodesics are trapped inside a succession of 2-surfaces of smaller and smaller area in a contracting universe. However, the convergence of the null geodesics moving in a gravitational field happens only under the weak energy condition implying that their gravitational energy is greater than their kinetic energy **(4).** As these null geodesics move in the gravitational field, the gravitational lensing effect leads them to focus on what is called the black hole spacetime singularity, where the matter density and curvature becomes infinite. Moreover, due to the "geodesic incompleteness" condition, these null geodesics cannot move beyond this singularity representing the end of spacetime as shown as a vertical line in Fig. 2.

As these trapped surfaces are present inside the event horizon, hence, the black hole, there is no need for a symmetry such as spherical for a collapsing object to collapse to the singularity. Moreover, the boundary of all the trapped surfaces around a black hole is called "apparent horizon".

The General Theory of Relativity (GTR) predicts robustly **(5)** the existence of black holes which exist physically in the universe (Fig. 1.) Moreover, in the present context of trapped surfaces, the presence of a black hole imposes the existence of its spacetime singularity. However, the laws of physics governing the GTR break down at this spacetime singularity. Any eventual modified gravity theory has to be different from the present Einstein's GTR and without these spacetime singularities. Or could one suggest outrageously that these trapped surfaces are unphysical and these black hole singularities do not exist even in the Einstein's GTR?

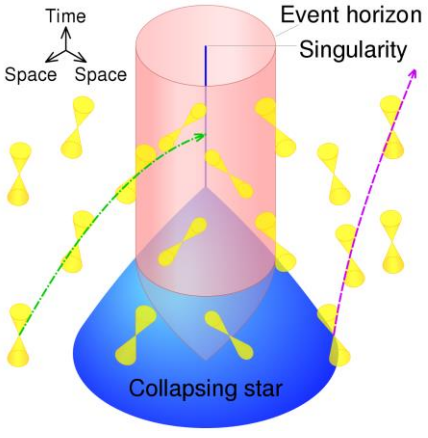


Figure 2. Light cones near a black hole resulting from a collapsing star. The purple (dashed) line shows the path of a photon emitted from the surface of a collapsing star. The green (dot-dash) line shows the path of another photon shining at the singularity (Wikipedia).

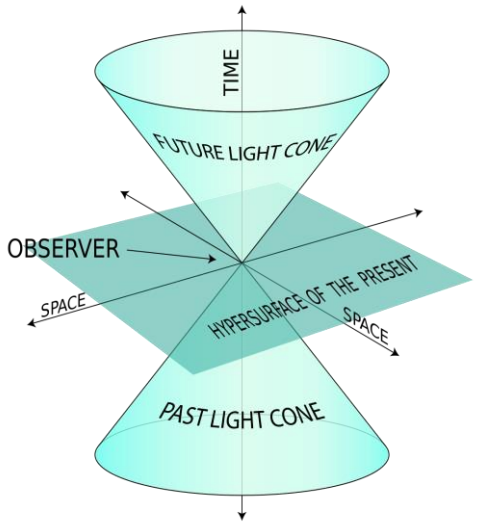


Figure 3. With space limited to two dimensions, the usual casual past and casual future light cones for a gravity frees flat spacetime relative to the present spacetime point (Wikipedia).

3. Conclusions: This document discusses the physics of very high gravitational field present in a black hole that leads to Roger Penrose's suggested closed spacelike trapped 2-surfaces from which both the inwards-pointing and outwards pointing null geodesics (light rays) converge in the future direction and are brought to focus through the gravitational lensing effect, on the black hole spacetime singularity, where the mass density and the curvature become infinite leading to the breakdown of laws of physics governing Einstein's General Theory Relativity.

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NOTE: LIFE-MACHINERY AND ITS OPERATION

M. Asghar FIAS

Life is an ensemble of elements optimized for a balanced life through the gradual but demanding evolutionary process. The life-machinery operates well with its physical and non-physical (spiritual) parts, if it is protected from the different external aggressions that disturb its chemical and physiological balance resulting in all sorts of malaises, diseases, and pathologies. Of course, sleep with its dreaming capacity is a powerful regulator and anti-dote against the pernicious and harm provoking external assaults resulting in various types of stress both physical and mental, on the working and dynamics of this life-machinery.
While living in a world as it is with its highly ferocious publicity-manipulated irrationality, one should learn to develop the capacity to be able to get out of one's "dailyness" through some personal para-activity such as poetry, music, painting, meditation, walks, sharing social moments or just being nowhere, as all of this helps to "reset" the life-machinery. Another important factor is to lead a simple personal life as much as possible away from the gluttonous over-consumption of all sorts and try to have healthy food that does have to be complicated in contents but rich in taste - a sort of spiritual nourishment. However, for genetic defects and their unavoidable unhealthy consequences leading to the different diseases and pathologies, one must develop appropriate cures and remedies.

"Life - what an uplifting passion
Of merry-go-round of seasons,
Caressed by its dangling desires
Amidst the rustling of dailyness!"
M. A.

HIERARCHY PROBLEM IN PHYSICS

M. Asghar FIAS

Abstract: This document analyses the hierarchy problem in physics and its continuous persistence in spite of a lot of effort for its solution.

Universe's structure and dynamics are controlled and regulated by its four fundamental forces: gravitational force, electromagnetic force, strong force and the weak force. The different characteristics of these forces are given in Table 1 **(1)** along with their respective strengths relative to the gravitational force. The table shows that the gravitational force is the weakest of all the forces. In the context of the particle Standard Model (SM), this factor of 10^{24} for the weak force relative to gravity has been called the "hierarchy problem".

Force	Range (cm)	Interaction particles	Exchange particles	Strength
Gravity	∞	all mass/energy	graviton (m = 0)	1
Weak	10−15	All elementary particles except photons & gluons	weak bosons (m ~ 100 × m-proton)	10^{24}
EM	∞	All charges	photon (m = 0)	10^{35}
Strong	10−13	Quarks and gluons	gluons (m = 0)	10^{37}

Table 1. The Four Fundamental Forces of Nature

The coupling constant for gravity is the Newtonian gravitational constant G and for the weak force, it is the Fermi interaction constant G^0_F. Both the G and the G^0_F are *constants of Nature*. Moreover, the G^0_F through the relation:

$$\mathbf{G^0_F = (2)^{1/2}/8 \cdot (g)^2 / M^2_W c^4,} \qquad \mathbf{(1)}$$

depends on the coupling constant g of the weak interaction and mass M_W of the W boson that mediates the weak interaction.

In the SM, the mass of a particle is generated through its coupling to the Higgs field whose mediating particle is the 125 GeV Higgs boson. Also, in the context of this Model, one expects that the quantum corrections (called the renormalization process) to the Higgs boson should have pushed its mass to a much higher value towards the Planck mass $M_{Planck} = 1.22\ 10^{19}$ GeV, leading to a much higher value of M_W. According to relation (1), this should have resulted in a lower value of the Fermi constant and, hence, a lower value of the weak force leading towards the annulation of the "hierarchy problem".

This suppression of the quantum corrections to the Higgs boson's bare mass is explained through the Supersymmetry formalism **(2)**, where each type of pair of fermion and bosons contributes equal but of opposite-sign quantum corrections. However, at present, the work done at the 14 TeV LHC at CERN, Geneva, has not shown any sign for the existence of supersymmetry particles. Moreover, it is interesting to note in Table 1, that the mediating particles for gravity, EM and strong force have zero rest masses and they are not subject to these quantum corrections, because their mass must remain zero.

One often justifies the weakness of gravity in the normal three-dimensional space due to sharing its strength with the so-called extra dimensions assumed to be compactified **(3)**. However, the recent experimental work shows that the Newtonian gravity of inverse square-law holds down to a separation of 0.52mm **(4)**. This value tightens the upper limit on the radius of the hypothesized extra dimension to 30 μm.
Finally, it seems that in the present situation, the "hierarchy problem" continues to persist and it may continue to persist, if it results from fine-tuning in Nature of gravity and the weak force like the other forces.

Conclusions: This write-up treats the hierarchy problem in physics and its continuous persistence in spite of a lot of effort for its solution.

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MISCELLANEOUS NEWS

WORKSHOP ON GOVERNMENT, RESEARCH AND INDUSTRY FOR SUSTAINABLE DEVELOPMENT

The Islamic World Academy of Sciences (IAS) in collaboration with the Industrial Research and Development Fund (IRDF)/HCST, Jordan and the Royal Academy of Engineering, UK, organized a workshop on **Government, Research and Industry for Sustainable Development**. Session 1 was entitled "**Innovation as an Outcome of Research".**

The session was moderated by **Prof. Fouad Mrad,** *Science Advisor and Lead Judge, Stars of Science – Qatar Foundation. Dr. Mrad gave a background on the session topic and on* **Arab Countries' Scientific Research Existing Capacity and Impact.**

Ms. Bahia Al Yafi, *Director of Innovation, Alyafi IP Group (MENA), Lebanon, talked about* **Policies for Opening Local Knowledge Gates of Universities & Research Centers.**

Dr. Lotfi Belkhir, *Associate Professor for Entrepreneurial Transformation, Qatar University, presented the* **Action Plan 2022 for Harnessing Local Scientific Research Towards Innovation.**

Prof. Dame Helen Atkinson DBE, FREng, *Pro-Vice-Chancellor of Cranfield University's School of Aerospace, Transport Systems and Manufacturing, UK, talked about* **Impactful Research Policies and Measurements in the UK**

Watch the workshop:

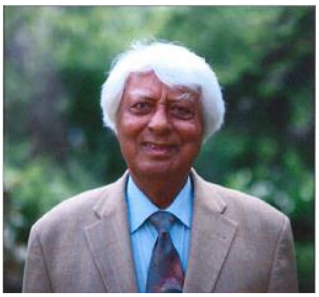
https://www.youtube.com/user/TheIASworld/videos

IAS AND IOFS SIGN A MEMORANDUM OF UNDERSTANDING

The Islamic World Academy of Sciences (**IAS**) and Islamic Organization for Food Security (**IOFS**), Kazakhstan signed a Memorandum of Understanding that helps to identify and explore the key opportunity and growth areas to provide a platform for knowledge and experience exchange between OIC researchers.

Prof. Abdullah Al Musa, Director General, IAS and Mr. Yerlan A.Baidaulet (IOFS), agreed to jointly organize IOFS-IAS high-level conference in 2023 in Kazakhstan.

ACTIVITIES OF PROF. SYED QAIM IN THE SERVICE OF THE UMMAH



Prof. Syed Qaim wrote:

"After my official retirement in 2006 as Vice-Director of the Institute of Nuclear Chemistry of the Forschungszentrum Jülich (FZJ) and as Professor of Nuclear Chemistry of the University of Cologne, Germany, the FZJ requested me to continue in an advisory capacity, which I did and am still doing with pleasure. Since then I have been striving hard to transfer knowledge to developing countries in general, and Islamic countries in particular. As a result, three leading groups have been established:

The Cyclotron Group of the Egyptian Atomic Energy Authority in Cairo, Egypt. Six persons did Ph. D. under my direction; some technical and material help was provided by the German Government.

Nuclear Data Analysis Group of the Government College University Lahore, Pakistan. Three persons did Ph. D. under my supervision. Financial support was provided by UNESCO-ICTP, National Talent Pool and Higher Education Commission of Pakistan.

Nuclear Reaction Cross Section Measurement Group at Rajshahi University and Institute of Nuclear Science and Technology of the Bangladesh Atomic Energy Commission in Dhaka. Two persons did Ph. D. under my guidance and several visiting scientists spent some time at Jülich. Financial support was provided by DAAD, Alexander von Humboldt Foundation and through the Research Professorship of TWAS.

All the three groups have reached international fame, participating now in multinational cooperations and experiments.

A pleasant side effect for me was that a large number of publications kept on coming. I had 314 publications till retirement. Now the 100th publication after retirement has appeared in the journal „Molecules". I have pleasure in attaching it to this E-Mail. The list of those publications is also attached. The authors involved in those publications were: 13 from Egypt, 13 from Bangladesh and 11 from Pakistan."

PROF. JACKIE YING FIAS ELECTED TO THE PRINCETON BOARD OF TRUSTEES

Princeton University has named seven members to its Board of Trustees, effective July 1, 2022. One of them is IAS Fellow Jackie Yi-Ru Ying from Singapore.

Prof. Ying earned a Ph.D. in chemical engineering from Princeton in 1991 as an AT&T Bell Laboratories Ph.D. Scholar. She received a bachelor's degree in engineering from Cooper Union in 1987, where she graduated summa cum laude.

Ying is the founder and director of the NanoBio Lab, an incubator that translates and commercializes research in nanomedicine and diagnostic assays. She also established the Institute of Bioengineering and Nanotechnology in Singapore in 2003. Ying began her career at the Massachusetts Institute of Technology, where she became the youngest full professor in the history of the Department of Chemical Engineering. Her inventions have led to more than 190 primary patents, 42 of which have been licensed to multinational and startup companies.

Ying has received numerous awards for her research in bio-nanotechnology. She was elected to the German National Academy of Sciences Leopoldina, is a fellow of the U.S. National Academy of Inventors and the American Association for the Advancement of Science, and was recently inducted into the U.S. National Academy of Engineering. Ying also serves as an interviewer for Princeton in southeast Asia and is a member of the Princeton Alumni Association of Singapore's executive committee.

The Board of Trustees has fiduciary responsibility to ensure that the University carries out in perpetuity its educational and research mission.

Source: https://www.princeton.edu/news/2022/06/27/seven-elected-princeton-board-trustees

The Islamic World Academy of Sciences (IAS) heartily congratulates IAS Fellows

Professor Emerita Datuk Dr. Asma Ismail (USM) and

Academician Professor Datin Paduka Dr. Khatijah Mohamad Yusoff (UPM)

for being awarded the National Academic Award for the Year 2022.

This award is in conjunction with the 14th National Academic Awards which took place on March 24, 2022.

The National Academic Figure Award this year (2022) went to Professor Emerita Datuk Dr Asma Ismail of Universiti Sains Malaysia (USM) and Professor Datin Paduka Dr Khatijah Mohamad Yusoff of Universiti Putra Malaysia (UPM).

The National Academic Awards (AAN) is held to give the highest recognition to top scholars at local institutions of higher learning (IPT) and is awarded in appreciation of the best contributions of academicians in teaching and learning, discovery of new knowledge, academic publications and sharing in social media, creative inventions as well as knowledge transfer and development for communities and societies across continents.

AAN is a prestigious award to prove the commitment of the Higher Education Ministry (KPT) to continue developing excellent lecturers and teaching staff.

FELLOWS NO LONGER WITH US

THE LATE PROF. MUHAMMAD SAJJAD ALAM (USA)

It is with a sense of sadness and sorrow that the President and the Director General of the Islamic World Academy of Sciences (IAS) in Amman, Jordan, announce the passing away of the eminent scientist Prof. Sajjad Alam FIAS.

Prof. Alam was born on 5 January 1947 in Dhaka, Bangladesh. He was married with two children.

He obtained a BSc with Honors in Physics (1968), and an MSc in Theoretical Nuclear Physics from Dhaka University (1970). He obtained his PhD in Experimental Particle Physics from the University of Indiana, USA (1975).

He worked as a Teaching Assistant at the University of Indiana (1971-1974), Senior Research Assistant at Vanderbilt University, USA (1974-1975), Research Associate at Standford Linear Accelerator Center (SLAC), USA (1975-1979), Senior Research Associate (1979-1981) and then Assistant Professor (1981-1984) at Vanderbilt University, and Assistant Professor (1984-1988), Associate Professor (1988-1995) and Professor of Physics (1995-present) at Albany State University, USA. He was also Director of the Albany High Energy Physics Laboratory.

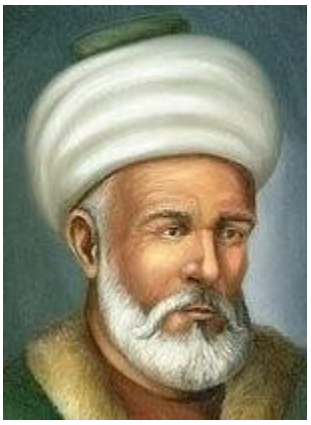
During his career, Prof. Alam had been involved with the SLAC-E82 (1971–75) and MARK II (1976–79) experiments at SLAC, and been part of the CLEO collaboration at Cornell Electron Storage Ring (CESR) at Cornell University, USA (1979-present). Since 1995, he had also been part of the ATLAS collaboration at the Center European Research Nucleare (CERN), Geneva Switzerland

He contributed to over 400 research papers in journals such as Physical Review, Physical Review Letters, Physics Letters and Nuclear Instruments and Methods. He and his fellow researchers had been responsible for a number of new discoveries in the field of high-energy nuclear particle collisions and decay. After his primary research interest (experimental particle physics), secondary interests include all aspects of computer science and engineering, semiconductor-based particle detectors, and exploring new technologies for teaching.

He had received the following prizes and awards: the P.N. Wang Doctoral Dissertation Award (1992) and the M.M. Zoeller Doctoral Dissertation Award (1993), Discovery of New Particles (1989), Excellence in Research Award (1993), the Abdus Salaam Award for Achievement in Science from the League of America (2000) and the Basit Athar Doctoral Dissertation Award (2001), also from Albany State University.

Prof. Alam was elected as a Fellow of the Islamic World Academy of Sciences in 2002.

ABUL AL-NASR AL-FARABI (870-950 AD)

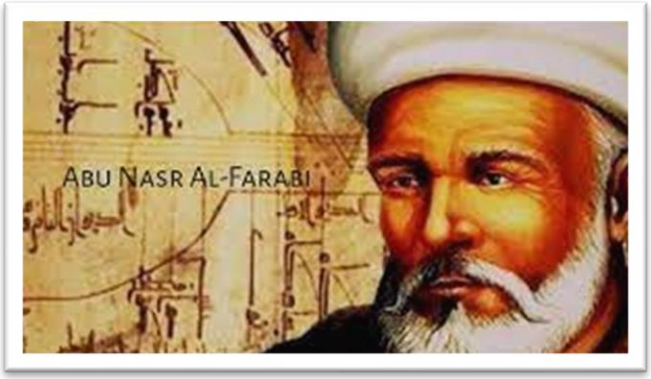


Abu Nasr Mohammad Ibn al-Farakh al-Farabi was born in a small village Wasij, near Farab in Turkistan in 259 A.H. (870 A.D.). His parents were originally of Persian descent, but his ancestors had migrated to Turkistan. Known as al-Phrarabius in Europe, Farabi was the son of a general. He completed his earlier education at Farab and Bukhara but, later on, he went to Baghdad for higher studies, where he studied and worked for a long time viz., from 901 A.D. to 942 A.D. During this period, he acquired mastery over several languages as well as various branches of knowledge and technology. He lived through the reign of six Abbasid Caliphs. As a philosopher and scientist, he acquired great proficiency in various branches of learning and is reported to have been an expert in different languages.

Farabi travelled to many distant lands and studied for some time in Damascus and Egypt, but repeatedly came back to Baghdad, until he visited Saif al-Daula's court in Halab (Allepo). He became one of the constant companions of the King, and it was here at Halab that his fame spread far and wide. During his early years he was a *Qadi* (Judge), but later on, the took up teaching as his profession. During the course of his career, he had suffered great hardships and at one time was the caretaker of a garden. He died a bachelor in Damascus in 339 A.H./950 A.D. at the age of eighty.

Farabi contributed considerably to science, philosophy, logic, sociology, medicine, mathematics and music. His major contributions seem to be in philosophy, logic and sociology and, of course, stands out as an Encyclopedist. As a philosopher, he may be classed as a Neoplatonist who tried to synthesize Platonism and Aristotelism with theology and he wrote such rich commentaries on Aristotle's physics, meteorology, logic, etc., in addition to a large number of books on several other subjects embodying his original contribution, that he came to be known as the 'Second Teacher' (*al-Mou'allim al-Thani*) Aristotle being the First. One of the important contributions of Farabi was to make the study of logic easier by dividing it into two categories viz., *Takhayyul* (idea) and *Thubut* (proof).

In sociology, he wrote several books out of which *Ara Ahl al-Madina al-Fadila* became famous. His books on psychology and metaphysics were largely based on his own work. He also wrote a book on music, captioned *Kitab al-Musiqa*. He was a great expert in the art and science of music and invented several musical instruments, besides contributing to the knowledge of musical notes. It has been reported that he could play his instrument so well as to make people laugh or weep at will. In physics, he demonstrated the existence of a void.



Although many of his books have been lost, 117 are known, out of which 43 are on logic, 11 on metaphysics, 7 on ethics, 7 on political science, 17 on music, medicine and sociology, while 11 are commentaries. Some of his more famous books include the book *Fusus al-Hikam*, which remained a text book of philosophy for several centuries at various centres of learning and is still taught at some of the institutions in the East. The book *Kitab lhsa al 'Ulum* discusses classification and fundamental principles of science in a unique and useful manner. The book *Ara Ahl al-Madina al-Fadila* 'The Model City' is a significant early contribution to sociology and political science.

Farabi exercised great influence on science and knowledge for several centuries. Unfortunately, the book *Theology of Aristotle*, as was available to him at that time was regarded by him as genuine, although later on it turned out to be the work of some Neoplatonic writer. Despite this, he was regarded the Second Teacher in philosophy for centuries and his work, aimed at synthesis of philosophy and Sufism, paved the way for Ibn Sina's work.

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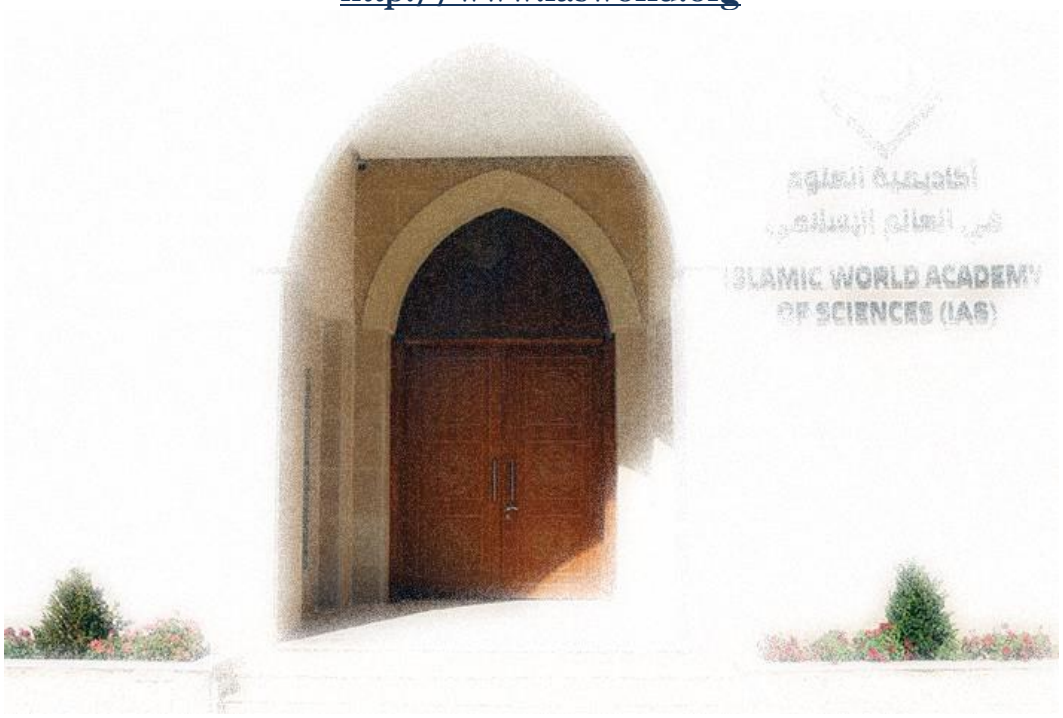

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