2010 1ST SCHOOL OF ASTRONOMY
for university students from Arab, Middle East and the EU countries

DEPARTAMENTO DE FÍSICA TEÓRICA Y DEL COSMOS
Universidad de Granada

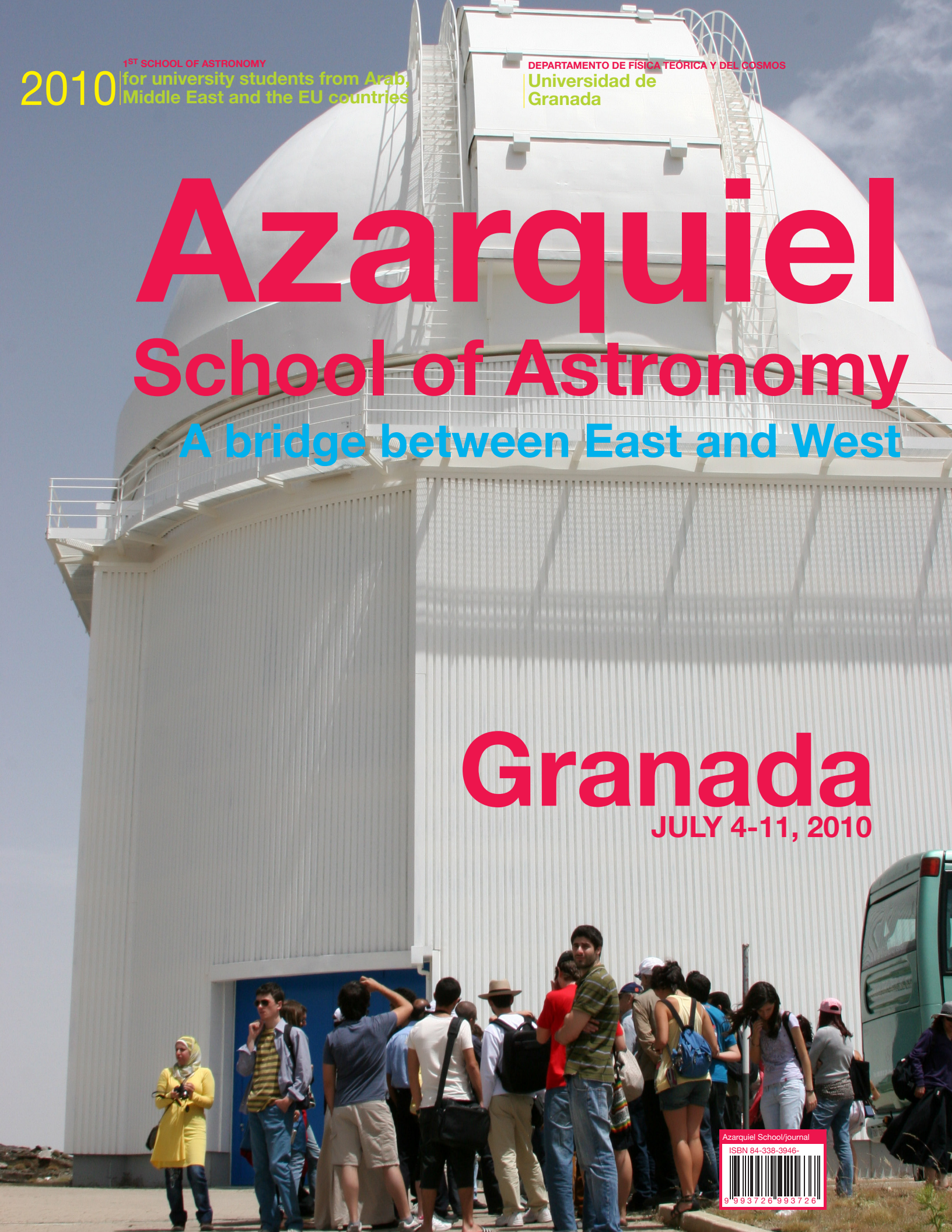
Azarquiel

School of Astronomy

A bridge between East and West

Granada

JULY 4-11, 2010



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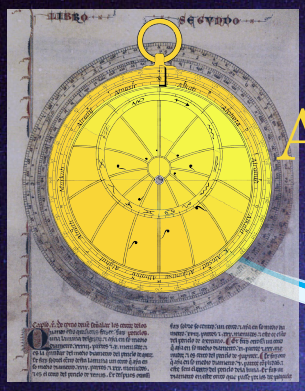

AZARQUIEL SCHOOL

ORGANISING COMMITTEE

- **Inma Domínguez (University of Granada, Spain)**
- **Carlos Abia (University of Granada, Spain)**
- **Maurizio Busso (University of Perugia, Italy)**
- **Mounib El Eid (American University of Beirut, Lebanon)**
- **Orhan Golbasi (Istambul Kultur University, Turkey)**
- **Claus Rolf (University of Bochum, Germany)**
- **Oscar Straniero (INAF, Italy)**

COURSES

I. The History of Arabic Astronomy
Prof. George Saliba (Columbia University, New York, USA)

II. Telescopes, Instruments and Forefront Astronomy
Prof. Rafael Rebolo (IAC-CSIC, Spain)

III. Physics and Stars
Prof. Oscar Straniero, Director of OACT (INAF, Italy)

IV. Stellar Systems: A Hierarchy of Ages, Sizes and Processes
Prof. Emilio Alfaro, President of SEA (IAA-CSIC, Spain)

CONFERENCES

Andalusian Astronomy in the 11th Century: Azarquiel (Ibn al-Zarqalluh or Ibn al-Zarqiyal) and his school
Prof. Julio Samsó (University of Barcelona, Spain)

Islamic Science and the Making of the European Renaissance
Prof. George Saliba (Columbia University, New York, USA)

From the Azafea of Azarquiel to the Contemporary Astrolabe
Prof. Orhan Golbasi (Istanbul Kultur University, Turkey)

High Energy Astrophysics (X and gamma rays) from Space
Prof. Margarita Hernanz (ICE-CSIC, Spain)

About the History of Elements
Prof. Claus Rolf (University of Bochum, Germany)

Plan Nacional para la Alianza de Civilizaciones

ugr Universidad de Granada
Vicerrectorado de Relaciones Internacionales

FUNDACION EUROARABE
المؤسسة الأورو بية-العربية

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Calar Alto

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Unesco

Azarquiel School of Astronomy Promoting Cultural Exchange through Science Education

This project proposes the foundation of a mobile school of astronomy for university students from Arab and Middle-Eastern regions and Europe called The Azarquiel School of Astronomy. The school is devoted to educating students, encouraging the teaching of astrophysics, promoting cultural exchange and bridging gaps in understanding between East and West.

Over a period of one or two weeks renowned international experts teach courses and give open conferences on subjects concerning observational and theoretical astrophysics and the contribution to science made by advances in astronomy in the Arab world. History shows how the Arabs were leaders in culture and science, especially astronomy, over a long period of time. The School is named after the XI-century Andalusian Arab astronomer Azarquiel, a representative of a multicultural world.

At least half of the participants should come from Arab and Middle-Eastern regions. Students will be selected on the basis of their curriculum vitae, geographical representation and an overall gender balance at the School.

The School will be hosted alternatively at Arab/Middle-Eastern and European universities: locations that represent the cultural connection between the East and the West will be preferred.

Special attention is given to the openess of the School and to the dissemination of information, promoting culture exchange, tolerance and mutual understanding.

The Azarquiel School is closely linked to the objectives of the U.N. initiative Alliance of Civilizations.

The 1st Azarquiel School of Astronomy: a bridge between East and West

The idea of founding the Azarquiel school came about in Granada (Spain) in 2006 during a workshop on Stellar Physics devoted to Azarquiel, which was attended by the majority of the board members of the proposed School. The line of thinking was to bring students from the East (trans-Mediterranean) and Europe so that they could get to know each other and learn together. Since earliest times humans have been attracted by the beauty of the clear night sky full of stars and this has stimulated their curiosity, making Astronomy one of the most ancient and universal sciences. To grow and prosper, science needs interaction between all those who want to learn and appreciate the scientific achievements of their fellows; who you are and where you come from is irrelevant. Astronomy, as an all-embracing science, can bring together and integrate people, and in this spirit the School was born.

The city of Granada, a historic crossroads between the Arabic and Western worlds, was proposed to host the first School. The Vicerrector of International Relations at the University of Granada was enthusiastic and offered to cover the lodgings expenses of all participants. It took sometime to find the required travel funding but eventually it was provided by the National Plan for the Alliance of Civilizations through the Ministry for Science and Innovation, with further support coming from the Euroarab Foundation and the Spanish Astronomical Society.

Although more than 90 applications were received, mostly from the Middle East, only 40 participants could be admitted. Finally, 35 students from 20 countries participated: 60% of them coming from the East, amongst whom 54% were women. There were four courses, twelve short presentations by the young participants and five conferences open to the general public. Some time was devoted to cultural activities, allowing participants to interact within an informal educational and social-learning context.

It was a very lively School, with the students frequently asking questions during lectures as well as in their free time. They also interacted intensively amongst themselves and new friendships and on-going collaborations were born.

Boards of the School

Inmaculada Domínguez.
Professor, University of Granada (Spain)

Carlos Abia.
Professor, University of Granada (Spain)

Mounib El Eid.
Professor, American University of Beirut (Lebanon)

Oscar Straniero.
Professor, OACT-INAF (Italy)

Maurizio Busso.
Professor, University of Perugia (Italy)

Orhan Golbasi.
Professor, Istambul Kultur University (Turkey)

Claus Rolf.
Professor, University of Bochum (Germany)

Invited Speakers

George Saliba.
Professor of Arabic and Islamic Science, Columbia University (USA)

Oscar Straniero.
Director of the INAF-OACT (Italy)

Emilio Alfaro.
President of the Spanish Astronomical Society and Researcher at the Instituto de Astrofísica de Andalucía (CSIC, Spain)

Orhan Golbasi.
Professor, Istanbul Kultur University (Turkey)

Margarita Hernanz Carbó.
Research Professor, Instituto de Ciencias del Espacio (CSIC, Spain)

Claus Rolf.
Professor, University of Bochum (Germany)

Rafael Rebolo.
Professor, Research Porfessor, Instituto de Astrofísica de Canarias (CSIC, Spain)

Julio Samsó Moya.
Professor of Arabic and Islamic Studies, University of Barcelona (Spain)

Plan Nacional para la **Alianza** de **Civilizaciones**

The Alliance of Civilizations aims to create a global political space to combat lack of communication and mutual understanding.

The underlying causes behind this growing misunderstanding spring from various kinds of phenomena:

- Worsening of manifestly unjust economic and political situations
- Lack of mutual understanding, one of the clearest and most recent examples of which was the cartoon crisis
- The capacity of certain governments—and above all, certain extremist groups—to multiply both phenomena, trying to justify violent actions

However, the Alliance of Civilizations does not want to limit itself to a certain issue. It is an initiative of the Secretary-General of the United Nations, and therefore aspires to be multipolar and global. As a shared task, it wants all civilizations to participate in this project. Based on such a premise, the objective should be to find common lines of action in order to:

- Strengthen mutual understanding amongst different civilizations
- Try to counteract the influence of those elements promoting intolerance
- Recommend practical measures able to help diminish those risks to world stability stemming from these extremist tendencies
- Promote the idea that security is indivisible from—and global cooperation indispensable to—security, stability, and development

The meaning of the Alliance of Civilizations is not entirely new. The Euro-Mediterranean, or Barcelona, Process - within the framework of the European Union - represented the first successful example of putting into practice the principles that inspire the Alliance of Civilizations initiative.

Participants

Ismahane Ami
Université Yahia Fares de Médéa, Algeria

Mukadder Igdi Sen
Istambul University, Turkey

Ghina Mahmoud
American University of Beirut, Lebanon

Narine Ayvazyan
Yerevan State University, Armenia

Mustafa A. Gharamti
American University of Beirut, Lebanon

Amir Bernat
Ben Gurion University, Israel

Ilyass Garara
Al Akhawayn University in Ifrane, Morocco

Mohamed Badaoui
Physics service, IAV Hassan II, Morocco

Fatima S. N. Romouz
Al-Quds University, Jerusalem

Munya F. J. Al-Zuhairi
Al-Mustansiriyah University, Iraq

Ahlam Farhan
Jordanian Astronomical Society, Jordan

Carlos Bernardino
University of Lisboa, Portugal

Gaye Danışan
Istambul University, Turkey

Aysegul F. T. Yelkenci
Istanbul Kultur University, Turkey

Hani M. Dalee
Jordanian Astronomical Society, Jordan

Soumina Lebbal
Hadj Lakhdar University of Batna, Algeria

Zohreh Khosravi
Isfahan University, Iran

Ehsan Moravveji
Institute for Advanced Studies in Basic Sciences, Iran

Ali Takey
Astrophysikalisches Institut Potsdam, Germany

Ali Al-Taani
Chinese Academy of Sciences, China

Mohamad Abbas
Bowling Green State University, USA

Arpine Kozmanyan
Oxford University, United Kingdom

Tanja Petrusevska
University of Triestre, Italy

Ivan Milic
University of Belgrade, Serbia

Andrej Obuljen
University of Belgrade, Serbia

Daniel Dumitru
University of Bucharest, Romania

Elie Badr
University of Stuttgart, Germany

Francesca Baldaccini
University of Perugia, Italy

Daniele Capezzali
University of Perugia, Italy

Manuel Gómez
University of Granada, Spain

Karen Pardos Olsen
Copenhagen University, Denmark

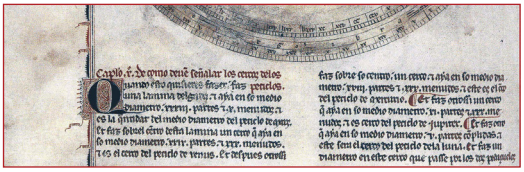
Giulia Schettino
University of Firenze, Italy

Marcos Villaverde
Instituto de Astrofísica de Andalucía, Spain

Paul Anthony Wilson
University of Exeter, United Kingdom

Rubén P. Hedrosa
University of Granada, Spain

Lectures



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J. Samsó
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R. Rebolo
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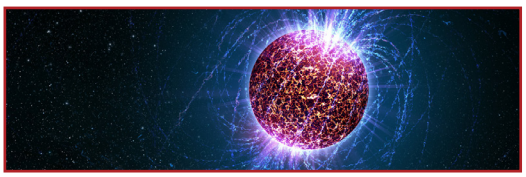

Physics and Stars
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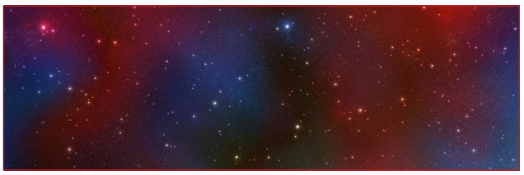
Islamic Science and the Transformation of Greek Science
G. Saliba
4



Stellar Systems: A Hierarchy of Ages, Sizes and Processes
E. Alfaro
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Public Conferences

History of Arabic Astronomy: Arabic Astronomy Defines Itself
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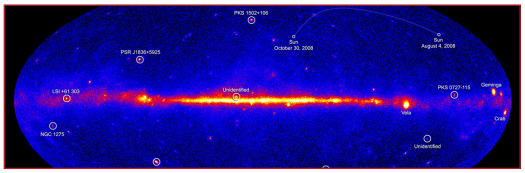

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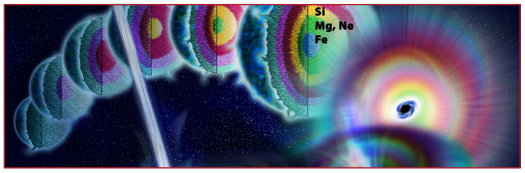


About the History of Elements
C. Rolfs

From the Azafea of Azarquiel to the Contemporary Astrolabe
O. Golbasi

Andalusian Astronomy in the 11th Century: Azarquiel and his School

Julio Samsó Moya
Professor of Arabic and Islamic Science at the Universidad de Barcelona.

J.Samsó. *He received his PhD at the University of Barcelona, developing part of his research activities at Rabat and Alexandria. Prof. Samsó has also been professor at the Universidad de La Laguna and at the Universidad Autónoma de Barcelona. He is an expert in History of Medieval Science, and in Astronomy in al-Andalus and the Maghrib. He has published 14 books and more than 180 papers, including his recent books Astronomy and Astrology in al-Andalus and the Maghrib (2007), Astrometeorología y astrología medievales (2008), and the well known Las Ciencias de los Antiguos en al-Andalus (1992) and Islamic Astronomy and Medieval Spain (1994).*

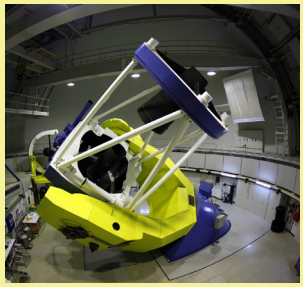
AL-ZARQALI, Abu Ishaq Ibrahim b. Yahya al-Naqqash al-Tudjibí, known as Walad al-Zarqiyal - whence the Hispanicised form Azarquiel, al-Zarqalluh, al-Zarqal or Ibn Zarqal. Al-Zarqali (sometimes al-Zarqani) and al-Zarqala seem to be classicised Eastern forms not documented in Andalusian sources. According to Ishaq Israeli he was an instrument maker in Toledo. He worked for Sacid al-Andalusi (420/1029 - 462/1070) and for king al-Ma'mun (435/1043 - 467/1075) among others. His patrons lent him the necessary books in which he taught himself astronomy and assumed a leading position in Sacid's group. The Tabaqat (460/1068) mention him as belonging to the younger Toledan generation (al-ahdath), but he was active from, at least, 440/1048-49 onwards and his solar observations must have begun between 441/1050 and 446/1055 at the latest.: Abu l-Hasan cAli al-Marrakushi states that he was observing in Toledo in 453/1061. Although no details are extant, these observations are confirmed in al-Zij al-Kamil fi 'l-Taclim by Ibn al-Ha'im al-Ishbili (fl. 600/1204-05): he attributes to Ibn al-Zarqalluh not only the usual twenty-five years of solar observations but also thirty-seven years of observations of the Moon. According to an anonymous Toledan contemporary, author of a Kitab al-Hay'a discovered by G. Saliba, he appears to have used a large sized instrument. Al-Zuhri describes a water-clock which marked the date of the lunar month and which was built in Toledo by a certain Abu 'l-Qasim b. cAbd al-Rahman known as al-Zarqal: it is doubtful whether he is referring to the same person. Ibn al-Zarqalluh left Toledo and went to Cordova either at the beginning of the reign of al-Qadir (473/1081-478/1085) (Ibn al-Abbar), or when Alfonso VI conquered the city in 1085 (postscript by Johannes Hispalensis (?) in a 15th c. MS of the Toledan Tables). In Cordova he was protected by al-Muctamid b. cAbbad (461/1069-484/1091) - to whom he had already dedicated a work in 440/1048-49 - and he continued his observations, with the help of one of his students (Ibn al-Kammad?) until, at least, 480/1087-88. He died in that city on the 8th of Dhu 'l-Hidjdja 493/15th October 1100 (Ibn al-Abbar).

Old Al-Andalus paper about Astrolabio design.

Telescopes, Instruments and Forefront Astronomy

Rafael Rebolo
Research Porfessor, Instituto de Astrofísica de Canarias (CSIC, Spain)

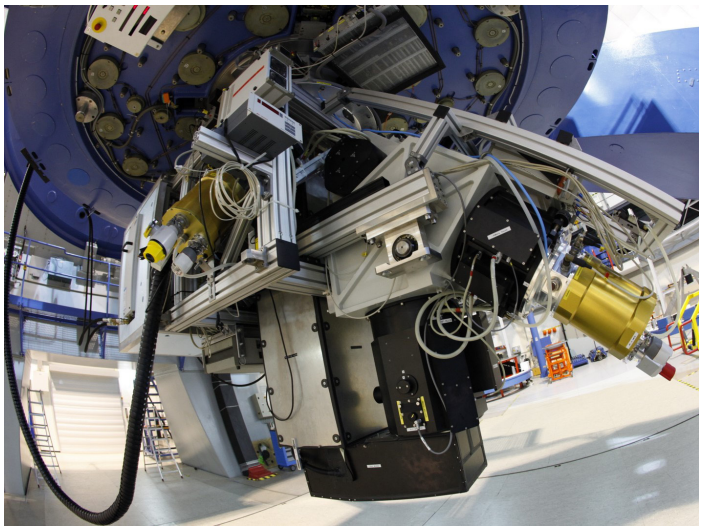
R. Rebolo. *He has pioneered in Spain experimental research on Cosmic Microwave Background, the radiation from the Big Bang which pervades the Universe, on nucleosynthesis processes in the Cosmos and on the formation processes of low luminosity objects like brown dwarfs, exoplanets and black holes. He is Research Professor at the High Council for Scientific Research (CSIC) and External Professor of the Max Planck Institute for Astronomy in Heidelberg. Co-investigator of the space mission Planck recently launched by ESA to investigate the Cosmic Microwave Background and of several international teams involved in the development of the most advanced astronomical instruments.*



The detection of extra-solar planets requires the development of high-precision and sensitive astronomical instruments

The major form of matter in the Universe, five times more abundant than ordinary matter, appears to be of a very weakly interactive nature.

The Big Bang model offers a framework to understand the basic phenomena that took place near the origin of the Universe and during its subsequent evolution until the formation of the first galaxies and stars. Observations of the large scale distribution of galaxies in the Universe, of Type I supernovae explosions in very distant galaxies and high sensitivity measurements of the anisotropy of the Cosmic Microwave Background - the relict radiation from the Early Universe - strongly support that the Cosmos is dominated by exotic forms of matter and energy. The major form of matter in the Universe, five times more abundant than ordinary matter, appears to be of a very weakly interactive nature. Major efforts are conducted in laboratories to identify the responsible subatomic particle. The dominant form of energy, the so-called vacuum energy causing an accelerated expansion of the Universe at present, is related to the cosmological constant suggested by Einstein in his equations for General Relativity or associated to a scalar field whose equation of state is not well established yet. Space missions like Planck and Euclid and other ground-based surveys will lead to advances in our understanding of these crucial components and their role in the evolution of the Universe. Major observational efforts in the coming decade will improve significantly the constraints on many of the parameters of the so-called Concordance Model of Cosmology.



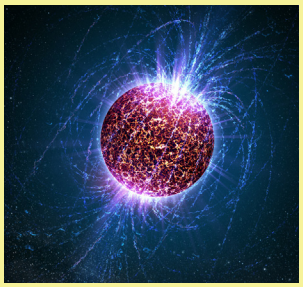
Lectures

Physics and Stars

Stellar evolution theory has been one of the major successes of modern astrophysics. The large variety of physical conditions, from the hot and high density core to the loose atmosphere, makes stellar interiors a natural laboratory for fundamental physics. From the classical thermodynamics to the neutrino physics, the list of the laws of nature at work in stars is too big to be reported in a short abstract. For a student, the study of the stellar structure theory is a unique opportunity to deeply understand fundamental physics and their observable consequences. For a scientist, it is a never-ending challenge, because many open problems, like the origin of the supernovae, are still looking forward to find definite answers. The balance between the gravitational force and the internal pressure guarantees the stability of a star. However, since stars shine, they lose energy from the surface. As a consequence, the stellar core contracts to restore the energetic balance by releasing a sufficient amount of gravitational energy (first principle of thermodynamics). So doing, the core heat up, until the temperature becomes large enough to allow the fusion of hydrogen nuclei. The nuclear fusions are generally hampered by the electrostatic force, being nuclei made by protons, which are charge particles, and neutrons). Nevertheless, when the temperature attains a few millions of degree, the probability for a proton to tunnel the high, but thin, Coulomb barrier of another proton becomes quite significant. This is a magnificent prediction of quantum mechanics, the so-called tunnel effect. The pp chain, a series of thermonuclear reactions starting with the fusion of 2 protons, allows in the solar core the burning of 4 protons into a He nucleus, plus 2 neutrinos. According to the famous result of the special relativity, $E=mc^2$, the positive mass difference between the 4 interacting protons and the resulting He nucleus provides about 26 MeV of energy. In this way, nuclear reactions keep the control of the stellar energetic budget. As a result, the hydrogen burning ensures to a Sun-like star a lifetime of about 10 Gyr. Nuclear reactions proceed until the nuclear fuel is available. Then, when the H is exhausted within the core, a new contraction phase starts, the temperature rise up again, until the fusion of He nuclei becomes possible. As heavier nuclei contain more protons, their charge is larger, so that the He nuclear fusion requires larger temperatures (about 100 millions of degrees). Stellar evolution is made of a series of short contraction phases, controlled by the gravitational energy release, alternated to longer nuclear-burning phases. This series may go on, until the core density and pressure become so large to prevent further contraction or until an iron core is formed. In the first case, the star ends its life as a slowly cooling white dwarf. In the second case, since the binding energy of a Fe nucleus is the largest in nature, the products of the iron fusion are heavier than the interacting nuclei and the reaction absorbs energy instead of release it. Trying to solve this energetic crisis, the core contraction accelerates, becoming faster and faster. Such a collapse is however suddenly stopped when the electrons are captured by the nuclei, forming a big neutronized core. Then, the more external layers bounce on the hard stellar core and a powerful explosion occurs. This is a core-collapse Supernova, one of the most violent events in the Universe history, after the Big Bang.

Oscar Straniero
Director of the INAF-Osservatorio Astronomico di Collurania in Teramo (Italy).

O. Straniero. *He took his degree in Physics in 1987 at the Universita La Sapienza (Roma) and, after 3 years at the Scuola Normale Superiore (Pisa), he got a permanent position at the Osservatorio Astronomico di Collurania in 1990. In 1989 he was a visiting researcher at the Instituto de Astrofisica de Canarias (Spain). Expert on stellar evolution and nucleosynthesis, he is associated to the Istituto Nazionale di Fisica Nucleare, collaborating in several projects related with Nuclear Astrophysics (like LUNA). Since 2000 he is Associated Professor at the Universita of Aquila and Universita of Teramo and recently became Research Director at INAF.*



The balance between the gravitational force and the internal pressure guarantees the stability of a star.

Islamic Science and the Transformation of Greek Science

George Saliba
Professor of Arabic and Islamic Science at the Columbia University (New York, USA).

G. Saliba. *He is the author of some eight books and more than ninety articles including his most recent book, Islamic Science and the Making of the European Renaissance MIT Press, (2007), that has now been translated into Turkish; Arabic is in the proofs stage, and just contracted to appear in Bahasa (Indonisian). He has also published Rethinking the Roots of Modern Science: The Role of Arabic Manuscripts in European Libraries (1999); A History of Arabic Astronomy: Planetary Theories During the Golden Age of Islam (NYU Press,1994); Greek Astronomy and the Arabic Scientific Tradition in American Scientist (July-August 2002) translated into Spanish and German.*

Astrolabe is a historical astronomical instrument used by astronomers, navigators, and astrologers.

In this talk I addressed the issue of the close relationship between the astronomical developments of the ninth century and thereafter and the ritual requirements of Islam as a religion. From the timing of the five daily prayers, all defined by astronomical aspects such as the determination of dusk and dawn and length of shadows, to the determination of the direction of prayers – all required to be directed to the holy sanctuary of the Ka´ba in the city of Mecca in Arabia – thus requiring mathematical geographical knowledge, which bears directly on astronomical considerations. The fact that the Greek astronomical tradition had no interest in such religious considerations, or problems related thereto, all particular to the practice of Islamic rituals, forced Islamic astronomy, under the influence of religion, to develop its own astronomical concepts and to develop complementary disciplines such as spherical trigonometric branches all required for the new research that was aimed to harmonize religious and astronomical requirements.

Stellar Systems: A Hierarchy of Ages, Sizes and Processes

Emilio J. Alfaro
President of the Spanish Astronomical Society, Granada.

For many years, astronomers have been looking for a predictive theory of star formation.

The process of star formation is perhaps the most fundamental process in the organization of the visible universe. The transformation of a cloud of low-density gas into shining stars with average densities 20 orders of magnitude higher than the gas is an intellectual challenge of first magnitude. For many years, astronomers have been looking for a predictive theory of star formation. That is, a theory that would predict the properties of a stellar population based on the physical properties of the molecular gas out of which the stars formed. Two observational boundary conditions constrain the problem: On the one hand, the star formation efficiency (the proportion of gaseous mass that collapses into stars) is, on average, 10% and, on the other hand, the mass distribution of newly formed stars appears to follow closely a universal power-law. These two well-established observational facts cannot be explained by the current scenarios of star formation that we have at our disposal. These lectures will outline the basic principles of a hierarchical scenario of star formation. Gravitation and magnetism reorganize the gas of the Galactic disk, forming gas clouds with sizes of about one kpc and masses over one million solar masses. As a result of a fierce battle between gravity and turbulence, a cascade of stellar systems is formed within these clouds, imitating a game of Russian dolls on great scales.

E. Alfaro. *He got his degree in physics at the Universidad de Sevilla in 1976 and his PhD at the Universidad de Granada in 1981, during that time he worked with Wilhem Becker at the Astronomical Observatory of the Bassel University and with José Manuel García-Pelayo at the Instituto de Astrofísica de Andalucía. From 1981 to 1987 Prof. Alfaro was professor at the Universidad de Cádiz. He has been CSIC scientist since 1987. In 1992 he was a "Visiting Scholar" at the Boston University. Nowadays Prof. Alfaro is the leader of the "Stellar System" group at the Instituto de Astrofísica de Andalucía (CSIC).*

The transformation of a cloud of low-density gas into shining stars with average densities 20 orders of magnitude higher than the gas is an intellectual challenge of first magnitude.

History of Arabic Astronomy: Arabic Astronomy Defines Itself

This development covered various aspects of astronomical activities starting with observational programs that were put into practice during the first half of the ninth century.

George Saliba
Professor of Arabic and Islamic science at the Columbia University (New York, USA).

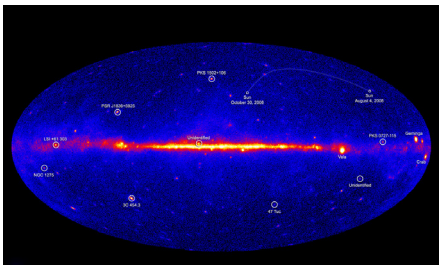
George Saliba in the Euroarabe

Calar Alto Astronomical Observatory

This talk covered an overview of the development of Arabic astronomy from its very beginnings towards the middle of the eighth century when it broke away from the earlier astronomical Greek and Indian traditions, defined itself as a separate tradition with its own character and purpose, and continued to develop till the sixteenth century when Arabic astronomy became a vital component of Renaissance astronomy. This development covered various aspects of astronomical activities starting with observational programs that were put into practice during the first half of the ninth century, and in Baghdad in particular. On the basis of these observational activities Arabic astronomy could begin to reveal the flaws of the earlier traditions, and in particular the flaws of the Greek tradition that constituted in themselves a research program for the then developing Arabic astronomy. Theoretical, cosmological, and mathematical considerations allowed the nascent Arabic astronomy to finally divorce itself from Greek astronomy and to build a much more coherent astronomical theory that took seriously the relationship between mathematical predictive models of planetary motions and the actual observations that accounted for those motions.

Conferences

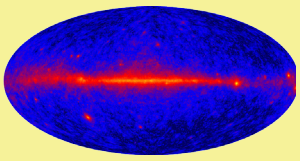
High Energy Astrophysics (X and gamma rays) from Space



All the information we get from the Cosmos reaches us in the form of light, i.e., electromagnetic radiation, with the sole exception of meteorites (matter from the Solar System). Such radiation spans a broad energy range, from the less energetic long wavelength range (radio) up to the highest energy photons (X- and gamma-rays). In order to catch these very energetic photons, instruments and their detectors should be placed above the earth atmosphere, which safely protects us from such cosmic radiation, onboard satellites or stratospheric balloons. The view of the Universe in X- and gamma-rays is very different than what we can see at lower energies; high energy photons trace the most violent phenomena, which often are not persistent but very variable; even it can happen that such phenomena have extremely short durations, like the famous Gamma-Ray Bursts, which emit huge amounts of energy in just a few seconds, fading very fast afterwards. Other examples are stellar explosions, like thermonuclear supernovae, where radioactive nuclei synthesized in the star before and during the explosion are violently expelled to the interstellar medium. One of the processes responsible for the emission of high-energy photons is accretion onto compact stars (white dwarfs, neutron stars or black holes) in an interacting binary system. In fact, the first cosmic X-ray source discovered (apart of the sun) was an X-ray binary (Sco X-1), where there is an accreting neutron star. Concerning high-energy photons, in the MeV gamma-ray range, they come from the decay of radioactive nuclei, which are synthesized during stellar explosions. In fact, one of the most important elements in the Universe, iron, comes from such a decay (the Ni-Co-Fe chain of decays) in thermonuclear (or type Ia) supernova explosions. A third crucial phenomenon related to the origin of high energy photons is the acceleration of charged particles, mainly electrons or protons; such a process can occur when the fast expanding ejecta from a supernova explosion interacts with the surrounding circumstellar matter. High energy astrophysics reveals the most violent phenomena of the Universe, and relies on the development of challenging ways to detect energetic photons, with detectors which should be flown on satellites.

Margarita Hernanz
Research Professor, Instituto de Ciencias del Espacio (CSIC, Spain)

M. Hernanz. *She is CSIC scientist 1990. She was previoulsly professor at the Polytechnical University of Catalonia (UPC) in Barcelona (1984-1990). PhD Thesis in Astrophysics at the University of Barcelona (1986). Her research topics include: Late stages of stellar evolution: white dwarfs, isolated and in interacting binary systems, stellar explosions on white dwarfs (novae and type Ia supernovae). – Nuclear astrophysics: nucleosynthesis, chemical evolution of the Galaxy, galactic radioactivity and cosmochemistry, impact of nuclear physics. - High energy astrophysics: X-ray and gamma-ray astronomy (theory and observations with XMM-Newton, Chandra, Swift, CGRO, INTEGRAL).*



All-sky view from Fermi satellite reveals bright emission in the plane of the Milky Way (center), bright pulsars and super-massive black holes. Credit: NASA/DOE. International Fermi/LAT team

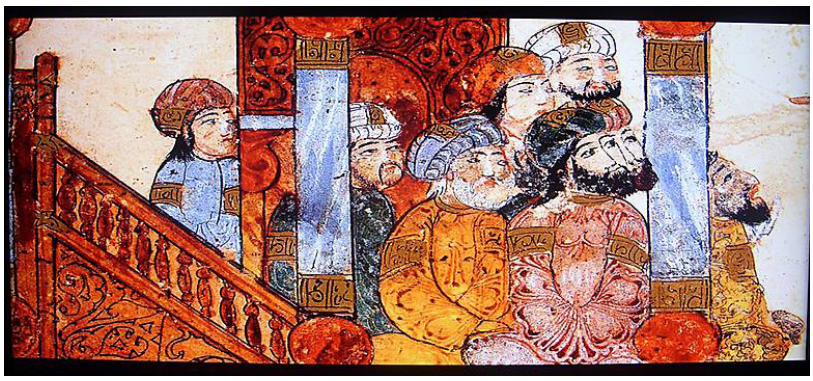
Islamic Science and the Making of the European Renaissance

Mathematical theorems that were developed in the Islamic tradition, specifically to confront the faults of the Greek astronomical tradition.

George Saliba
Professor of Arabic and Islamic science at the Columbia University (New York, USA).

Abu Ishaq Ibrahim Ibn Yahya Al-Zarqali or in his latin name Azarquiel

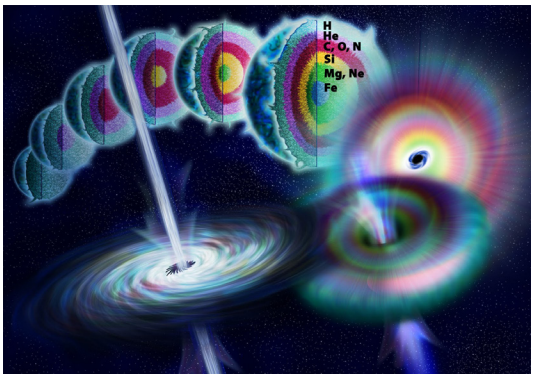
This talk detailed the relationship between the Arabic scientific tradition and the tradition that developed in Europe during the time of the Renaissance. Mathematical theorems that were developed in the Islamic tradition, specifically to confront the faults of the Greek astronomical tradition, on observational, theoretical and cosmological grounds, became the building blocks for renaissance astronomy itself. Many of the echoes of those theorems could be documented within the Latin works of such august renaissance figures like Copernicus (who incorporated the works of Mu'ayyad al-Din al-'Urdi (d. 1266), Tusi (d. 1274) and Ibn al-Shatir (d. 1375) in his De Revolutionibus) , Kepler (who interrogated his own teacher Maestlin about Copernisus's use of Urdi's theorem) , and Galileo (who in his turn found Tusi's theorem which was used by Copernicus useful in his own physical works on motion). Together with the rich works of other renaissance scientists like the architect Antonio de Sangallo (1546), Peter Apianus (1552), Andreas Vesalius (1564), Guillaume Postel (1581), Giambattista della Porta (1615), and Johann Hevelius (1687), to name only a few, document beyond any shade of doubt the degree to which Arabic/Islamic science was fully integrated with Renaissance science, to such an extent that it was impossible to separate the two traditions. Unlike the contacts between Arabic/Islamic science and that of Europe during medieval times, which is relatively rather well known to modern researches, the contacts during the renaissance are much less known, even though the latter contacts were much more sophisticated and of highly advanced technical nature.



Public Conferences

About the History of Elements

The universe was created 13 eons ago. When the earth was born, the universe was already ancient. Countless stars were extinct and the most massive ones were torn into pieces and pulverised in giant explosions, to become the building material for new stars. The building material also for our sun and for the earth; here extraordinary favourable conditions allowed the evolution of biological life. This knowledge shows that we are connected to distant space and time not only by our imagination but also through a common cosmic heritage: the chemical elements that make up our environment and our bodies. These elements were created in the hot interiors of remote and long-vanished stars over many billions of years. Their fuels finally spent, these giant stars met death in cataclysmic explosions, scattering afar the atoms of heavy elements synthesized deep within their cores. Eventually this material, as well as material lost during the red giant stages collected into clouds of gas in interstellar space; these, in turn, slowly collapsed, giving birth to new generations of stars, thus leading to a continuing cycle of evolution.



In this scenario, the Sun and its complement of planets were formed nearly 5 billion years ago. Drawing upon the material gathered from the debris of its stellar ancestors, the planet earth provided the conditions that eventually made life possible. Thus, like every object in the solar system, each living creature on earth embodies atoms from distant corners of our galaxy and from a past a thousand times more remote than the beginning of human evolution. Thus, in a sense, each of us has been inside a star and truly and literally consists of stardust; in a sense, each of us has been in the vast empty space between the stars; and – since the universe has a beginning – each of us was there. Every molecule in our bodies contains matter that once was subjected to the tremendous temperatures and pressures at the centre of a star. This is where the iron in our blood cells originated, the oxygen we breathe, the carbon and nitrogen in our tissues, and the calcium in our bones. All were formed predominantly in fusion reactions of smaller atoms in the interior of stars. The smaller atoms themselves (i.e. hydrogen and helium) were created prior to star formation in the very early universe. The detailed understanding of our cosmic heritage combines astrophysics and nuclear physics and forms what is called nuclear astrophysics.

Claus Rolfs
Professor at the University of Bochum (Germany).

C. Rolfs. *He received his PhD in Physics in 1967 from the University of Freiburg. After that, he has developed his research and academic activities in several countries. He has published a reference book in Nuclear Astrophysics, recommended in universities all over the world: "Cauldrons in the Cosmos". Since 1990 he is Professor of Experimental Physics in Bochum (Germany). He has been awarded with several international prices, among them the four prestigious Röntgen, Millikan, Humboldt and Bethe. Prof. Rolfs has been a long-term collaborator of Nobel-Laureat Prof. Fowler (Pasadena, California).*

Crab Nebula, the remnants of a supernova explosion observed in 1054 in the constellation Taurus.

From the Azafea of Azarquiel to the Contemporary Astrolabe

Orhan Golbasi
Professor at the Istanbul Kultur University (Turkey).

O. Golbasi. *He accomplished his higher education in the Istanbul University where he received his Ph.D. in 1981. He won a position as Associate Professor at the Inonu University (Malatya) in 1990 and he has been Professor to the Akdeniz University from 2000 to 2007. During the last decade he has been involved in the developing of the Tubitak National Observatory (Antalya), in particular in the astrolabe and other instruments.*

Azarquiel´s Azafea.

Religious duties of Islam, which are compulsory for all Muslims, necessitate the use of complex calendar and clock mechanisms. Determination of the times of the "Namaz" (ritual of worship centered in prayer five times a day) depends on the rise of the Sun to a specific altitude from the horizon. Obviously, these times are different for each coordinate. Another complexity with Namaz is that one has to find and turn to the direction of the Mecca in order to perform the prayer. On the other hand, Moon Calendar is used for setting the date of the religious holidays and determining the times of the months according to the Muslim calendar. In the early ages and even still today, it is fairly difficult to fix the first day of the Moon. Therefore, it can be argued that the complexity and difficulty of the problems that Muslim scholars of the Middle Ages faced contributed to their notable success in the astronomy.

According to several sources, among these scholars, one of the most important astronomer of the era was Azarquiel, Abu Ishaq Ibrahim Ibn Yahya Al-Zarqali, who lived in Toledo and Cordova. His studies mainly focused on three subjects: precise observation devices, astronomical tables and celestial mechanics.

First important statement made by Azarquiel was the pronouncement of the non-circular nature of the orbit of planet Mercury, we have indirect reference of this work: "On the invalidity of Ptolemy's method to obtain the apogee of Mercury". For the first time ever, nearly 400 years before Copernicus, an astronomer was putting forward such a claim. Another interesting work attributed to Azarquiel, although some doubts exist, was the water clock which was able to calculate the phases of the Moon and the times of the Namaz in a very accurate way. This complex clock brought to his constructor fame and prestige.

His famous Toledo Tables have been used by astronomers for more than a century in the solutions of the problems related to the movements of the planets.

However, his biggest contribution to the astronomy is the universal astrolabe. In the middle ages, astrolabes were being used to determine the positions of the celestial bodies and for navigation purposes. The problem was that, one had to use a different plate for each latitude. Azarquiel, in his astrolabe named "Azafea", made it possible to use a single plate for each latitude by using a mobile circle of horizon. Taking into account the conditions of the period, the contribution of Azarquiel to the astrolabe can be compared to the GPS technology, which is widely used today. Astronomers continued to use Azafea astrolabe many years after Azarquiel's demise. In fact, it was nearly 900 years after Azarquiel, when the first modern astrolabe was built.

Caplo. x. De como deuē señalar los cētros delos peciclos.

Quando esto quisieres fazer, faz una lamina delgada. et aya en so medio diametro. xxxiij. partes et x. menutos. et es la quantidad del medio diametro del peciclo de mars. Et faz sobrel cētro desta lamina un cerco q̄ aya en so medio diametro. xxix. partes et xxx. menutos. et es el cerco del peciclo de uenus. Et despues otrossi faz sobre so centro. un cerco. et aya en so medio diametro. xviij. partes et xxx. menutos. et este es el cērco del peciclo de mercurio. Et faz otrossi un cerco q̄ aya en so medio diametro. xi. partes et xxx. menudos. et es cerco del peciclo de jupiter. Et faz otro q̄ aya en so medio diametro. v. partes cōplidas. et este sera el cerco del peciclo dela luna. Et faz un diametro en este cerco que passe por los dos paraguelos

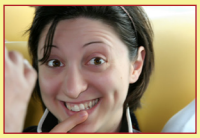
From the book: “Libro de las Láminas de las VII. Planetas. Azarquiel”

Student presentations

- K. Pardos Olsen: XO-3b: A transiting exoplanet.
- G. Danisan: A 16th century observatory in Istanbul: Its founder Taqi al-din, his instruments and observations.
- H. Dalee: The stars that have arabic names in the modern sky atlases.
- A. Yelkenci: IYA2009 events of Istanbul Kultur University in Turkey.
- M. Igdi Sen: X-rays analysis with XMM-Newton.
- E. Moravveji: Pulsations and mode selection mechanism in luminous massive blue supergiants.
- M. Abbas: Variable stars in NGC6496.
- A. Al-Taani: Influence of different synthesis routs as a mechanism of millisecond pulsars.
- A. Takey: 2XMMi-SDSS galaxy clusters survey.
- A. Bernat: Challenges and benefits of teaching astronomy in the Negev.
- I. Milic: Comparing observed prominence spectra with profiles computed using simple 1D models.
- M. Gharamti: 3D numerical simulations of the AGB phase using the FLASH code.

Ghina Mahmoud
American University of Beirut

"Students with different backgrounds got a great opportunity to learn new things, socialize and interact. It was perfectly organized and all the details were taken care of. I loved the experience and I hope that it will happen again someday."



Francesca Baldaccini
University of Perugia

"The best knowledge experience I've ever had: mix of cultures, languages cognisances and competences, and you could get all at once."

Ilyass Garara
Al Akhawayn University

"As a computer scientist and amateur astronomer, the school was a wonderful experience where I got introduced to a more advanced side of astronomy. However, the most important aspect was the great opportunity I got to meet nice people with different cultures and religions."

Daniel Dumitru
Bucharest University

"It was a great experience indeed, we were all students gathered from Arab and EU countries in a scientifically and cultural meeting discussion on various topics of astronomy and its history."

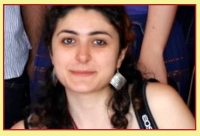
Comments of the students

Soumia Lebbal
University of Batna

"This school has been very constructive both culturally and scientifically. At the cultural level, being hosted in Granada city, It had been a very interesting opportunity for me to get acquainted with the history of Arabic contribution to astronomy, Scientifically speaking, the school constituted an opportunity for me to meet few of the most prominent names in Astrophysics, who were lecturing during the school, as well as (young) breakthrough astrophysicists from all around the globe One thing is for sure, is that every single day of the school was constructive... Thanks to Inma Dominguez, Carlos Abia, and everyone who made sure that this school would see the day."

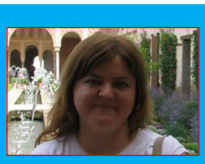
Ehsan Moravveji
IASBS

"The most remarkable features in my opinion are listed below.
1° It united a harmonic assortment of contemporary reaches of astronomy, and the history of astronomy developed by Muslims.
2° A short visit to the Calar Alto which is one of the main ground-based observatories. For me, even watching the instruments and their capabilities was very fruitful.
3° Discussions with some of the lecturers was very critical in some aspects of my PhD dissertation.
4° And finally, Alhambra was a perfect complementary."



Arpine Kozmanyan
Oxford University

"So many beautiful moments to remember and a lot of interesting information as well!!"



Mukadder Igdi Sen
Istanbul University

"Organizing Committee of the School helped us every time. The lectures were very enjoyable and educational. At this school I got many friends: both Spanish and of other nationalities. I had a nice roommate from Persian. I will remember them with good memories. The school took us Calar Alto Observatory where are very big telescopes. Alhambra Palace in Granada is historical and famous place. When I saw there I understood that Spain includes different cultures. I liked Spanish meal "Tapas" and seafood. Everyone was resting in siesta time that was little interesting for me. When I was in Spain, they won World Cup semifinal. Their celebrations were wonderful. Spanish people are very open, warm-hearted, nice and friendly. I am going to visit again Spain especially Granada."

Ivan Milic
Belgrade Faculty of Mathematics

"I think this school is an excellent idea since one can get a great insight and fresh ideas just by meeting new people of similar age and similar interests. This school should endure and continue with its work and if there is any way that we as participants could help, we must do it and all together try to make it even better."

Narine Ayvazyan
Yerevan State University

"The best organized school I have ever been. Thanks a lot!!"

Comments of the students

Karen Pardos Olsen
Copenhagen University

"This school has opened my eyes in two ways. Now I see how astronomy is a dynamical sculpture that is being made and carried forward in time by many hands, hands that do not know borders. It has also allowed me to see how my interest in astronomy is shared by wonderful and inspiring people across the world! I will never forget this experience."

Andrej Obuljen
University of Belgrade

"Looking back on Azarquiel School I have only nice memories and it always brings a smile on my face.
I met some really amazing people that share the same passion for science as I do and became very good friends with them, which I think, is of greatest importance."

Zohreh Khosravi
Isfahan University

"First and foremost, many useful and new ideas were well expressed and exchanged between participants who came from different countries with different levels activities in Astronomy and Astrophysics in fact, we look at this Heavenly and surprising science from different windows since many years old from west and east till now. The program of Azarquiel School was more exciting for me by Visiting Calar Alto Astronomical Observatory, Museum and also some historical places such as Alhambra Palace also this school was a good chance for me to find many scientific and nice friends whom I can enjoyed of their experience fortunately. I would like to appreciate the Organizing Committee especially dear professor Inma Domínguez and professor Carlos Abia. Thanks to their kindness."

Comments of the students

Ismahane Ami
Université Dr. Yahia Farès de Médéa

"The school was very interesting for me; I have been in touch for some day in beautiful place with student, Phd students and researchers from various countries. We were so different, and it was so enriching!!!
The conferences given in the fundacion Euroarab with Mr. George Saliba are just unforgettable!! Conference with Oscar Straniero was very interesting for me. The entire places that I visited in Granada are engraved for ever in my heart and memory:
Casa del Chapiz, the Calar Alto Observatory (Almería), the Al-Andalus Science Pavilion, Science Park Interactive Museum and the the Alhambra Palace being there was a nice and beautiful real dream.
Thanks Inma and Carlos, thanks for all."

Mohamad Abbas
Bowling Green State University, USA

"I am so glad for participating in Azarquiel School of Astronomy as I had the opportunity to meet people from all over the world who are interested in astronomy. Moreover, the lectures, speakers and the whole program were so interesting. In addition to that, teachers and speakers were so friendly which reflected a friendly atmosphere between the students. In addition to the scientific and historical facts that we learnt about astronomy, we had the chance to visit many of the historical places in Granada, Spain. I am so grateful to be part of the school."

Manuel Gómez Jiménez
Universidad de Granada

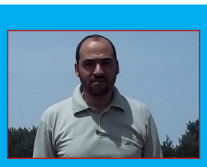
"My experience about the school was great and special. The remarkable points were not only academic, but also personal. At the level of academics, all the talks were very informative and interesting. The visit to Calar Alto impressed me quite a lot, since I had not seen so huge telescopes before. At a personal level, all the people (both teachers and students) were great at talking to each other and sharing personal experiences."

Amir Bernat
Ben Gurion University

"The Azarquiel school has been a great place for me to meet new friends from diverse backgrounds and to learn about astronomy, not just 'astrophysics' but also about its historical aspects."

Carlos Bernardino
University of Lisboa

"I dont bring back home any bad experience from Granada, enjoyed the contact with every student and professor in that School, but I must mention a few names:
+ Saliba and Rebolo by the fantastic scientific lectures and posterior private talks, those 2 men from different areas of astronomy gave the feeling of being in touch with one of the best world scientists in the field.
+ Inma, Carlos and Oscar for their kindness, hard work and their personal qualities as citizens intending to unite cultures fighting against prejudice and political issues.
+ Claus by the personal respect that after a polite arguing we became more close.
I'm decided to pick my family and visit Granada. It was fantastic, even the high summer temperatures. Carmen de la Vitoria was the most relaxing and beautiful resting place I ever been. I'll never forget."



Hani M. Dalee
Al al-Bait University

"I really enjoyed the school, I met some very famous scientists and scholars such as Prof. George Saliba. Lectures were not compact, excursion to Alhambra was superb, although I lost all of the photos I took during it.
I was visiting Europe for the first time in my life. Granada was an exception. I wish I spoke Spanish so that I stay there for study. I came to know some good friends at this school. They all were kind. I gave myself and my friends in JAS a new record by visiting the 4.6 m telescope.
Thanks for everybody in the organizing committee. Hope to meet again and soon."

Munya F. J. Al- Zuhairi
Al-Mustansiriyah University

"It was a great chance for me to participate in the 1st Azarquiel School. I have got a good knowledge about Astronomy and Astronomical Observations. The effort of the organizing committee was very remarkable."

Comments of the students

Activities

Venue: Carmen de la Victoria and Euroarab Foundation
Granada

1

Casas del Chapiz
Granada

2

Visit to the Alhambra & Generalife
Granada

3

Visit to the Observatory of Calar Alto (CAHA)
Almería

4

Visit to the Al-Andalus Science Pavilion
Granada

5

Visit to Science Park Interactive Museum
Granada

6

Activities programme

Venue:
"Carmen de la Victoria" and "Euroarab Foundation"

Every evening, after the student presentations, we walked to the Euroarab Foundation along the Darro river or through the narrow streets of the Albayzin. The Euroarab is "a space for dialogue and cooperation between Europe and the Arab World". The Vice-Secretary for Research and Cooperation, Prof. Pilar Carrasco, was enthusiastic and support the School since the very beginning.

All the staff at the Carmen and the Euroarab gave us a warm welcome and took care of everything.

C/ Cuesta del Chapiz,9
Granada, Spain






Student Photos

Activities: Visit to Casas del Chapiz

Casas del Chapiz
School of Arabic Studies, CSIC

On Tuesday, July 6th, we visited the Houses of the Chapiz, located just in front the Carmen de la Victoria - where the School was hold-.

We are grateful to architect Dr. Antonio Orihuela, expert on islamic architecture, who showed and explained us the two houses. As Dr. Orihuela pointed out, *"The houses constitute a very valuable example in evaluating the typological evolution of the Nasrid (last Islamic dynasty in Spain, which ruled the Granada emirate from 1237 to 1492) domestic architecture from its mature stage until what would be considered its last phase of continuity already in the 16th century, the Morisco period."*

Participants from arab and Middle East countries identified several architecture elements in common with houses in their own countries.

Cuesta del Chapiz 22, 18009 - Granada, España
web: http://www.eea.csic.es

Student Photos

Visit to "Casa del Chapiz" Museum

Activities: Visit to the Alhambra Palace and Generalife

Visit to the Alhambra
and Generalife

On Wednesday morning we visited the Alhambra. It was a guided visit offered by **M. Angeles Navarro**, Director of the Al-Babtain chair. Participants were surprised by its extraordinary beauty and culture heritage. As the current Director, M. del Mar Villafranca says: "*The Alhambra, in pace with its history, has become the destination of many tourists and probably the best treasure of the city of Granada. To enjoy the beauty of the palatine chambers, the scents of the courtyards and gardens, the games of light and colour of the richly decorated halls and the impressive views of the Albaycin and the Vega constitutes a privilege for our senses*".

The Alhambra and Generalife. Carlos V Palace. Granada, Spain.
Web: www.alhambra.org

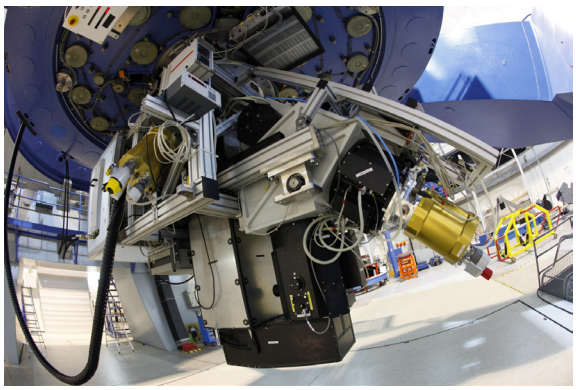
Student Photos

Alhambra Palace and Generalife

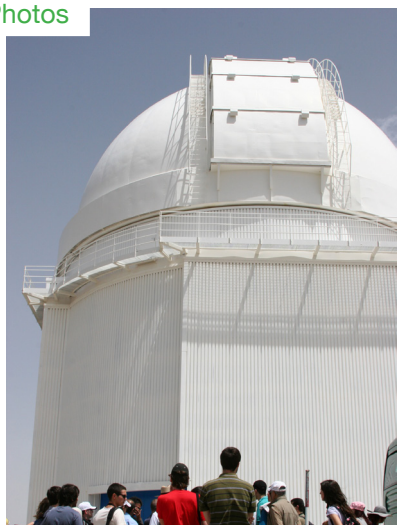
Activities: Visit to the Calar Alto Astronomical Observatory

Visit to Calar Alto (CAHA)
Astronomical Observatory

On Thursday morning, July 8th, we went to Calar Alto. It was a 3 hours travel by bus from Granada and we had the chance to see the landscapes around. Once at the Observatory, participants were fascinated. For some of them it was the first time at a professional astronomical observatory. Astronomers Jesús Aceituno and Santos Pedraz showed us the 1.23, 2.2 and 3.5 meters telescopes. Students asked questions, wanted to stay over-night and work in a place like Calar Alto. A delicious late lunch was offered by the Observatory and after lunch conversations made this trip a unique experience for everyone.



Student Photos



Activities: Visic to Al-Andalus Science Pavilion

Visit to the Al-Andalus
Science Pavilion

On Saturday, July 10th, we visited the Al-Andalus Science Pavilion as a courtesy of the Legado Andalusi, our special thanks to Juan Manuel Cid. The Pavilion offers the visitor a complete vision of the arab heritage in Al-Andalus: Astronomy, Mathematics, Medicine, Alchemy, Geography and Physics. Students were delighted discovering this amazing legacy

Avda de la Ciencia s/n. Granada, Spain.
Web: www.parqueciencias.com

Student Photos

Visit to the Al-Andalus Science Pavilion

Activities: Visit to Science Park Interactive Museum

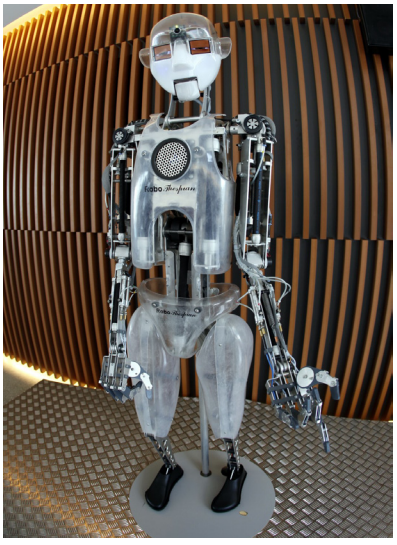
Visit to Science Park
Interactive Museum

The Science Park is an interactive museum about science and technology. It is the most visited museum in Andalucía. The Azarquiel School participants visited it on Saturday, July 10th. It was a hot summer morning.

The science park staff kindly guided as us through all the astronomical experiments, including the astronomical observatory. At the Planetarium we relaxed and enjoyed traveling trough the Universe.

Avda de la Ciencia s/n. Granada, Spain.
Web: www.parqueciencias.com

Student Photos



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SOCIEDAD ESPAÑOLA DE ASTRONOMIA

CÁTEDRA AL-BABTAIN DE ESTUDIOS ÁRABES

FUNDACIÓN EL LEGADO ANDALUSÍ

Special Thanks

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Driving towards the next schools

Board of the Azarquiel School

The Azarquiel School is a mobile school, alternating in location between a host institution in Europe and one in the Arab world.

The 2nd Azarquiel School of Astronomy will be held in Beirut, hosted by the American University of Beirut, from June 19 to 26th, 2011. The LOC is formed by Prof. Mounib El Eid, Prof. Wafic Sabra and Prof. Marwan Gebran.

The 3rd Azarquiel School will be in Istambul, hosted by the Istambul Kultur University in June-July, 2012. The LOC is formed by Prof. Dr. Dursun Kocer (Rector), Prof. Dr. Orhan Golbasi, Prof.Dr. Zeki Aslan, Dr. M. Hakan Erkut, Dr. Emre Isik and Dr. Aysegul Yelkenci

In 2013 the School is expected to come back to Granada, in coincidence with the celebration of the "Millenium of the Granada Kingdom 1013-2013".

Editors:

Prof. Inmaculada Domínguez
Prof. Carlos Abia
Francisco Matías

University of Granada

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