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Abu Rayhon Beruniy: a multi-faceted scholar



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Turaev Bakhtiyor Omanovich

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An enduring legacy

Abu Rayhon Beruniy is considered one of the leading scholars of the East who made a considerable contribution to world civilization, and his discoveries are used in nearly all branches of modern science and culture.

Abu Rayhon Beruniy was a multifaceted genius of the Middle Ages. He was an astronomer, mathematician, geologist, geographer, biologist, doctor, historian, philologist, philosopher, sociologist, theologian and poet. It was said to be easier to count the sciences that he was not engaged in, than those he was. He wrote books on astronomy, mathematics, mineralogy, geography, religion, and history, and his works continue to be relevant today.

> “***Chronology* contains detailed information about the peoples and cultures of ancient Khwarizm**

Beruniy was born on September 4, 973, in Kath, the capital of Khwarizm, in present day Uzbekistan. Some sources suggest he was born in the suburbs, hence the name “Beruni,” meaning “from outside the city.”

At that time, the city of Kath was the central city of Khwarizm, the capital of the Afrighi dynasty of the 10th century and one of the main trading centres of Central Asia. Trade, mathematics, astronomy, and geodesy flourished. Historical sources inform us that people who were interested in these branches of science came to Khwarizm from different corners of the world and studied there; one could meet scholars from China, Syria, Rome, Spain, Greece, and other countries. They came there not only to study but also to share their knowledge with others. Beruniy grew up in this intellectually stimulating environment.

During the years of 928-1012, Khwarizm and the territories on the shores of the Caspian Sea were under the reign of Qabus ibn Vashmgir, a representative of the dynasty of Ziyaris. He offered Beruniy a vizier position, but the scholar kindly refused the offer in favour of engaging in scientific research.

First publications

In the year 1000, at the age of just 27, Beruniy completed his famous scientific work *Chronology*, dedicating it to his ruler, Qabus ibn Vashmgir. *Chronology* contains detailed information about the peoples and cultures of ancient Khwarizm including Muslims, Jews, Christians, fire-worshippers, and Muslims, including their cultures, traditions, holidays, calendars, religions, prophets, sacred books, and so on.

In 1010, the ruler of Ma’mun II gave orders to bring Beruniy to the capital city of Khwarizm, and Beruniy became a respected official in the royal court. There he had access to the royal storehouse of precious metals, where he carried out scientific research and published his famous book on mineralogy *A Collection of Information on Precious Metals*.

> “**Beruniy compiled the coordinates and sizes of 1,029 stars**

Beruniy lived for seven years at the court of Ma’mun II, where he also collaborated with the philosopher and physician Avicenna. From 1017 to 1030, he lived a dangerous and risky life under the control of Mahmud Ghaznavi, sultan of the Ghaznavid empire. Ghaznavi would take Beruniy with him on his military expeditions as an astrologist, and it was during their travels to India that he wrote his book *India*.

After the death of Mahmud Ghaznavi in 1030, his elder son Mas’ud acceded to the throne (1030-1041). Prince Mas’ud appreciated Beruniy’s work, and Beruniy wrote his book on astronomy and mathematics *The Laws of Mas’ud* for him, saying, “He kindly provided me with suitable conditions for my research, supported me in all cases and showed great respect for me.”



© Andrey Arakelyan

Statue of Abu Rayhon Beruniy in the town of Beruniy, Karakalpakstan, Uzbekistan.

A prolific output

Some sources inform us that Beruniy wrote more than 200 works in his lifetime, and from what we know, each book is an encyclopedic work of its own type and style.

On October 18, 1025, he completed his next book on geodesy titled *Definition of Destination to Define the Distance between the Places of Habitation*, on the basic notions of mathematical geography, and in 1029 finished *Primary notions about the Art of Astronomy*, to be followed by his exemplary anthropological work, *India*.

Beruniy's next book, *Al-Qanun al-Mas'udi* (The Laws of the Ruler Mas'ud) was written in 1030 and contains detailed description of the basic principles and main rules of mathematical astronomy, the main coordinates of the heavenly bodies and ways of counting their directions. This book also includes Beruniy's "table of stars". Based on tables compiled by Ptolemy and the Arabian astronomer al-Sufi, Beruniy compiled the coordinates and sizes of 1,029 stars.

During the last years of his life, in 1045-1048, Beruniy wrote his work about medicinal herbs titled *A Book about Medicinal Herbs*. Later known as *Saydana* (Pharmacognosy), its full manuscript was found in Turkey in the 1920s-1930s. This book contains detailed information about medicinal properties of herbs which grow in the East, mainly in Turkistan. Beruniy's numerous other works are of poetry, and cover various cultures, the history of religions, and stories, legends and verses.

Juan Pedro Monferrer Sala

Professor of Arabic and Islamic Studies at the University of Cordoba, Spain.

A wandering humanist

Abu Rayhon Beruniy was born in Khwarizm, a region that today encompasses parts of Uzbekistan and Turkmenistan. In this vibrant centre of science and trade, his early fascination with knowledge would shape his life. Yet political upheaval would also form his personal journey.

Throughout his life, Beruniy was compelled to traverse numerous towns, cities, and lands, adapting to shifting political realities. Over time, his wanderings became both a necessity and a gateway to unparalleled intellectual achievement, rendering him one of the greatest thinkers of the medieval Islamic world.

In an era when the Muslim world stretched from the Iberian Peninsula to Central Asia, Beruniy's life unfolded against a backdrop of constant political instability. Dynasties vied for supremacy, and scholars depended on the patronage of rulers whose fortunes were often precarious. Like many men of learning, Beruniy relied on princely support, yet each transition of power brought uncertainty. Often, he had to relocate to new courts in search of stability and resources. Despite this fragility, his forced mobility exposed him to an extraordinary range of intellectual ideas and materials, fostering an approach to scholarship that transcended sectarian and regional boundaries.

Early work

His first patron in Khwarizm was the Khwarizm-Shah (al-Ma'mun), whose court was a haven for scholars of astronomy, philosophy, and medicine. Even in his youth, Beruniy displayed a precocious interest in observing the heavens, calculating planetary positions, and unravelling geometric puzzles. Yet the courtly environment proved unstable, and when the ruling dynasty fell from power, Beruniy had no choice but to depart. This marked the beginning of his peripatetic existence, moving from region to region as dynasties rose and fell, all the while refining his intellectual pursuits.

At Rayy, in present-day Iran, he encountered diverse scholarly communities that enriched his scientific knowledge. The city provided an environment in which he could study different Islamic groups and refine his own perspectives on science and knowledge. This theological exposure paralleled his astronomical research, strengthening his conviction that knowledge should be pursued without sectarian bias. Yet again, changing circumstances obliged him to pack up his manuscripts and notes.

Royal support

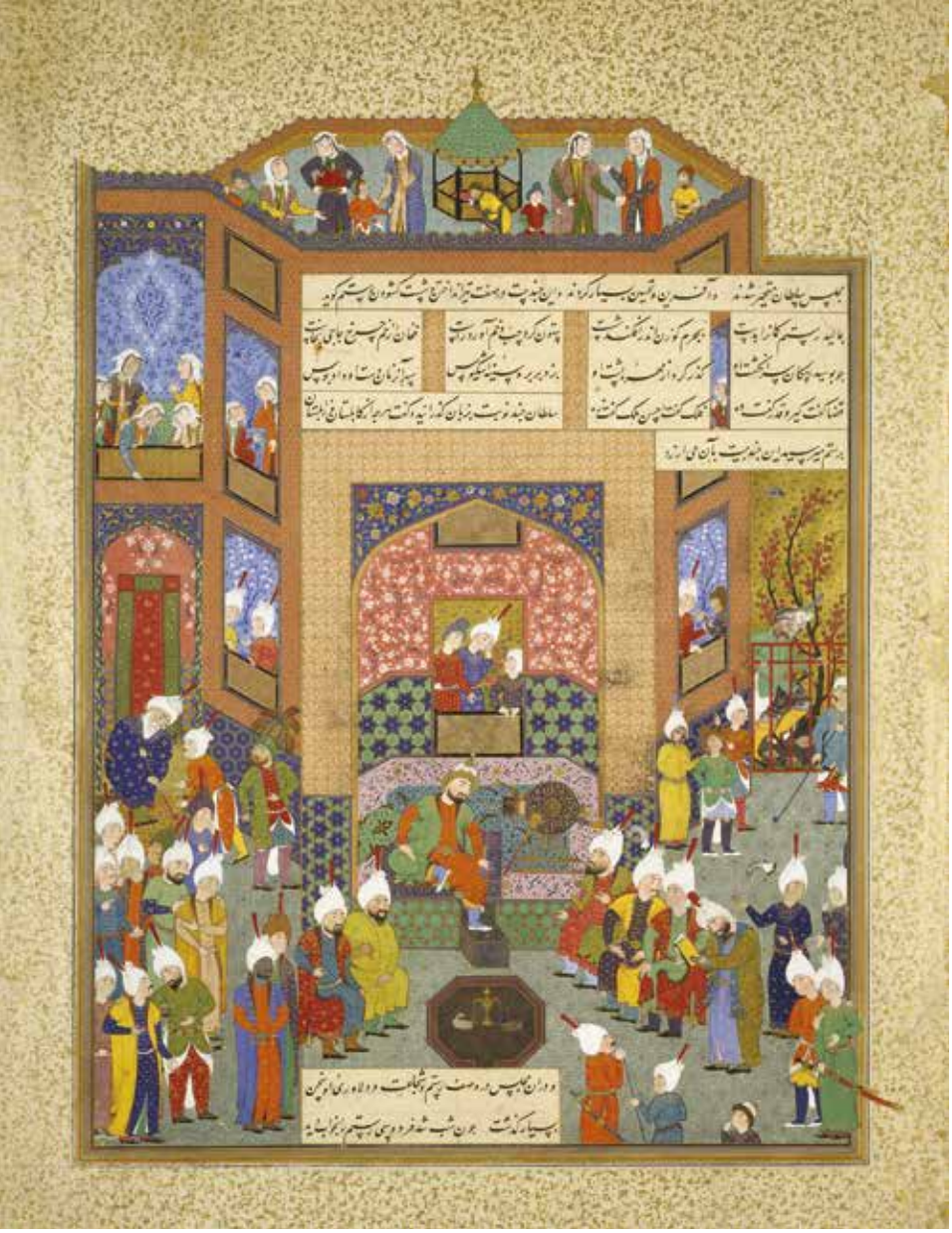
A defining episode in Beruniy's life began when he came under the aegis of the Ghaznavid dynasty, ruled by Sultan Mahmud of Ghazna. Whether he was invited or coerced to join Mahmud's court remains unclear, but what is certain is that this new chapter in his life opened fresh intellectual horizons. Most notably, the Ghaznavid conquests facilitated his journey into India, where he engaged in an unprecedented study of Indian culture, science, and philosophy.

By learning Sanskrit, Beruniy gained direct access to a vast corpus of Indian knowledge, which he meticulously studied and translated. His engagement with Indian mathematical and astronomical works introduced new ideas to the Islamic world. Through careful comparison of sources, he challenged inaccuracies, refined existing theories, and incorporated Indian advancements into the broader body of knowledge. His synthesis of Indian, Persian, Greek, and Islamic scientific traditions exemplifies the intellectual cross-fertilisation that defined the medieval Arabic Golden Age.

> **"Beruniy relied on princely support, yet each transition of power brought uncertainty**

Yet *India* was only one aspect of Beruniy's prolific output. He wrote extensively on subjects as varied as chronology, geography, mineralogy, botanics, literature, and religious practices. Wherever he travelled, he gathered data, compared it with past authorities, and documented his findings meticulously. Perhaps it was precisely his position as an outsider in each new land that sharpened his analytical acumen, allowing him to critique outdated ideas with remarkable independence.

Beruniy's cosmopolitan knowledge was also enabled by the libraries of rulers who valued his expertise. These royal collections housed Greek texts



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The court of Mahmud, the Ghaznavid sultan, was a centre for art and culture that welcomed a large number of scholars and artists, including Beruniy and the poet Firdausi. In this 16th century illustration, Firdausi is reciting from his work for the sultan.

transmitted via Syriac into Arabic, Persian works encompassing history and mythology, and Indian treatises on cosmology. Consuming this varied heritage, he synthesized insights from multiple civilizations. While political turbulence forced him to move frequently, each new seat of power offered fresh material to study. He never restricted himself to one tradition or school, recognizing that truth might emerge from any cultural sphere. Yet, far from merely absorbing ideas, Beruniy actively bridged civilizations, using Aristotelian principles to engage with Greek, Persian, and Indian knowledge, thereby fostering a truly global intellectual discourse.

Logical reasoning

One of the most salient aspects of Aristotle's impact on Beruniy lies in the logical framework underpinning his methodology. The structure of Aristotelian logic (*logikē* in Greek, Arabic *manṭiq*) had long been integrated into Arabic intellectual circles, providing Beruniy and his contemporaries, such as Avicenna, with powerful tools for systematic inquiry. Through syllogistic reasoning, classification, and empirical validation, he approached his astronomical, geographical, and ethnographic studies with remarkable clarity and coherence.

His investigative range extended to religious and cultural phenomena. Notably, he approached comparative religion with a degree of objectivity that was unusual for his time. Instead of demonizing unfamiliar beliefs, he attempted to describe them from the perspective of their adherents. His writings on India, for example, sought to explain Brahmanic customs in a systematic and sympathetic manner, striving to clarify conceptual differences rather than condemn them. This empathy for cultural nuance transcended religious barriers and demonstrated an intellectual maturity that remains compelling today.

The medieval Arab world was characterized by intellectual mobility, with Jewish, Muslim and Christian scholars frequently migrating between major cities such as Baghdad, Bukhara, and Cordoba in pursuit of knowledge and patronage. However, few matched Beruniy in terms of geographical breadth and the variety of political conditions he endured. At times, he struggled with the demands of powerful patrons, yet he retained a degree of independence that enabled him to critique both philosophical texts and courtly ambitions. Though this independence came at the cost of instability, he used each new setting as an opportunity to refine his scholarship.

Beruniy also made significant contributions to the standardization of calendars, studying how different cultures recorded time and structured their months and years. His grasp of chronology underscored the importance of cross-cultural comparisons, illustrating how astronomy, history, and religious beliefs shaped temporal frameworks.

Despite his intellectual achievements, Beruniy was not immune to political entanglements. The Ghaznavids were not only his patrons but also military conquerors. As he travelled in the wake of their campaigns, he had to navigate complex relationships with local populations. His willingness to learn their languages and customs was crucial in gaining access to their knowledge. Nevertheless, he managed to maintain a level of respect from many communities, a testament to his diplomatic acumen and genuine curiosity.

Ultimately, Beruniy's biography illustrates how political turbulence can paradoxically facilitate the dissemination of knowledge. Had he remained in Khwarizm, his insights might have remained confined. Instead, his forced migrations exposed him to diverse traditions, weaving a network of intellectual exchange that transcended empires and epochs. His works survived multiple dynastic collapses, leaving an indelible mark on science and the humanities. ■

Shawkat Barakat

Social sciences specialist Palestinian National Commission for Education, Culture and Science.

Learning cultures through language

Abu Rayhon Beruniy remains a towering figure in the annals of history, not just for his scientific achievements but for his extraordinary ability to integrate diverse fields of knowledge. His contributions show language as a key to unlock the study of civilizations.

Abu Rayhon Beruniy was far more than a traveler documenting his observations; he was a polymath who excelled in fields as diverse as philosophy, astronomy, geography, geology, pharmacology, mathematics, history, and translation. His travels were not ends in themselves but parts of a larger intellectual project aimed at comprehensively understanding human societies and their environments. This interdisciplinary approach is vividly reflected in his seminal work, *Tarikh Al-Hind* (An Enquiry into India), which transcends the conventional boundaries of travel literature to offer a scientific study of Indian society.

His work demonstrates the importance of integrating various disciplines to achieve a holistic understanding of the world. Beruniy's observations on Indian customs, scientific advancements, and societal structures were deeply analytical and often groundbreaking. By combining empirical research with theoretical insights, he provided a model for modern scientific inquiry.

Language as a catalyst

A cornerstone of Beruniy's success was his linguistic prowess. Fluent in Arabic, Khwarezmian, Persian, Sanskrit, Syriac, and Greek, he used language as a key to unlock the knowledge and traditions of different civilizations. His mastery of Sanskrit, for instance, enabled him to delve deeply into Indian texts, providing insights into Indian sciences, philosophies, and religious beliefs



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that were previously inaccessible to the Islamic world. This linguistic bridge allowed him to go beyond mere observation, facilitating a nuanced understanding of Indian culture and thought.

> **The significance of language in understanding societies is starkly evident**

The significance of language in understanding societies is starkly evident when comparing Beruniy to other travelers like Marco Polo or Ibn Battuta. While these travelers provided vivid accounts of their journeys, they often lacked the depth of cultural analysis that comes from linguistic immersion. Beruniy's ability to read and interpret primary texts in their original languages gave his work a level of precision and authenticity that set it apart.

His contributions to translation further exemplify his role as a cultural mediator. Beruniy translated 22 Sanskrit texts into Arabic, including works on mathematics, astronomy, and philosophy. Notable examples include his translations of *Brahmasphutasiddhanta* (a foundational text in Indian mathematics) and texts on Indian numerical systems. Conversely, he also translated key Arabic works, such as Euclid's *Elements* and Ptolemy's *Almagest*, into Sanskrit. These translations were not mere linguistic exercises; they represented a deliberate effort to facilitate cross-cultural exchange, enriching both civilizations.

This illustration from Beruniy's Chronology of Nations *is a complex computational diagram used for astronomical calculations related to timekeeping and calendar systems. It is connected to practical challenges addressed by Beruniy, such as the determination of the month of Ramadan.*

Anthropological insights

Long before anthropology emerged as a formal discipline, Beruniy pioneered its principles in his study of Indian society. His observations extended beyond surface-level descriptions to include analyses of economic activities, social hierarchies, and religious practices. For instance, his examination of Hindu rituals was not limited to describing their outward manifestations; he also sought to understand their philosophical underpinnings, revealing a profound respect for the complexity of Indian thought.

This depth of analysis distinguishes Beruniy from many medieval European travelers, whose accounts often reflected ethnocentric biases. Beruniy's work, in contrast, exemplifies an early form of cultural relativism, emphasizing the importance of understanding a society on its own terms. His balanced and respectful approach remains a model for modern anthropological studies.

One of the most practical applications of Beruniy's *Tarikh Al-Hind* was its use by Islamic missionaries during the Ghaznavid conquests of India (973-1027). Commissioned by Sultan Mahmud of Ghazni, the work provided a comprehensive guide to Indian society, enabling missionaries to approach their task with cultural sensitivity and informed strategies. By equipping them with a scientific understanding of Indian traditions and beliefs, Beruniy's work facilitated a more respectful and effective dissemination of Islam. This underscores how cultural understanding can serve as a powerful tool for achieving broader societal objectives.

Knowledge and integration

The enduring legacy of Beruniy lies in his ability to bridge civilizations through knowledge and cultural understanding. His emphasis on linguistic and cultural immersion offers valuable lessons for contemporary discussions on globalization and cultural integration. Beruniy's work demonstrates that genuine engagement with other societies requires more than superficial familiarity; it demands a commitment to understanding their languages, traditions, and intellectual contributions.

A compelling historical parallel can be drawn between Beruniy's approach and the fate of the Mongol Empire. Initially known for their destructive conquests, the Mongols eventually assimilated into the cultures they subdued, adopting Islam and contributing to its intellectual traditions. This transformation underscores Beruniy's assertion that a lack of cultural understanding can lead to the dominance of the more sophisticated society over the less cultured invader. His insights serve as a reminder of the power of knowledge and respect in shaping the dynamics of cultural exchange.

> **His emphasis on linguistic and cultural immersion offers valuable lessons for contemporary discussions**

Beruniy's cultural identity has also sparked debate. Born in Khwarizm (modern-day Uzbekistan), he lived and worked in regions that now comprise Uzbekistan, Iran, Afghanistan, and Turkmenistan. Today, Beruniy's identity can be seen as a product of the Islamic Golden Age, from the 8th to the 13th century—a period that transcended national boundaries and celebrated cultural diversity. His life and achievements underscore the importance of viewing cultural identity through a broader, more inclusive lens, recognizing the shared heritage that binds humanity.

Beruniy's legacy highlights the transformative power of language and knowledge in advancing science, anthropology, and cultural understanding. His work serves as a bridge between civilizations, fostering dialogue and mutual respect. Beruniy's life and works remain a timeless example of how intellectual curiosity, combined with linguistic and cultural immersion, can transcend boundaries and enrich humanity.

Akbar Ahmed

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An anthropologist for our times

Abu Rayhon Beruniy was an astonishing polymath whose work spanned astronomy, mathematics, geodesy, and many other fields. A thousand years before anthropology emerged in the West, Beruniy was already recording his first observations.

Abu Rayhon Beruniy's work spanned several disciplines and cultures. He calculated the circumference of the Earth with an accuracy of 1 per cent; in his work he relied on translations of Euclid, Ptolemy, and Hindu texts, as well as the works of Muslim scholars like Avicenna and Khwarizmi. His love of the Greeks led him to become an authority on Aristotle. There is a crater named after Beruniy on the moon, the Soviets published a stamp in his honor, and he has been called the Muslim Leonardo da Vinci.

Beruniy was a product of the Golden Age of Islam. At this time, the concept of what I call the *ilm*-ethos permeated society. The primacy of knowledge, or *ilm*, is undisputed in Islam. *Ilm* is the most used word in the Quran after the name of God and the Prophet's saying "the ink of the scholar is more sacred than the blood of the martyr" is widely known. Clearly there was the patronage of the rulers in support of knowledge. This environment fostered rigorous scholarship and cross-disciplinary mastery, exemplified by figures like Ibn Arabi, Ibn Rushd, Avicenna, Al Farabi, and Al Ghazali. Another factor at the time was the wide and general respect for scholars. Some were celebrity figures. Al Ghazali's lectures in Baghdad were attended by hundreds.

Today Beruniy is best known for his monumental study of India, *Kitab al Hind* or *The Book of India*. Beruniy's use of the word "investigation" in the original title *Tahqiq ma al-Hind*, or *Investigation of India*, reflects his own scientific disposition. The Kitab was written after some 13 years of research between 1017 and 1031. It was translated by Edward C. Sachau into German in 1887 and the following year into English as *Alberuni's India*. It remains a key source for our knowledge of Hindu society a thousand years ago, and his example shows that centuries before the discipline developed in the West, Muslims were conducting what we would now call anthropology.

> **"Beruniy's study opens both theoretical and methodological doors for social scientists**

Beruniy's study of India

The definition of anthropology includes learning the language of the group under study, extended participant observation, keeping careful notes and recordings, observing rites of passage, researching primary texts and requiring that the findings be presented with objectivity and neutrality using, where possible, cross-cultural comparisons.

Beruniy's study opens both theoretical and methodological doors for social scientists. A thousand years before European anthropologists such as Levi-Strauss, Louis Dumont and Adrian Mayer, Beruniy had suggested a methodology for the study of caste and kinship in India.

As Edward C. Sachau writes in his preface, "it is the method of our author not to speak himself, but to let the Hindus speak ... He presents a picture of Indian civilization as painted by the Hindus themselves". Beruniy leans heavily on primary Hindu sources, learning Sanskrit for this purpose, writing, "I do not spare either trouble or money in collecting Sanskrit books from places where I supposed they were likely to be found".

Beruniy throws a wide net for comparative purposes referring to Jews, Christians, Parsis and the ancient Greeks for whom he has undisguised admiration. And his sympathy for universal mysticism is reflected in the comparison he makes between Sufi, Hindu and Christian mystics.

In 80 chapters spread over 600 pages, Beruniy presents us with a study of Hinduism as a viable, mature and high-quality religion. He introduced Hindu philosophy, mathematics, and astronomy, subjects that had a great deal of interest for Muslims. He makes cross-cultural comparisons with the Arabs and Greeks. He sees Muslims and Hindus as two families living in the same house.

The different chapters of Beruniy's book and their titles reflect modern social sciences: "On the castes, called 'colours' (varna) and on the classes below them" (IX) and "On the rites and customs which the other castes, besides the Brahmans, practise during their life-time" (LXIV). Women's issues are also examined: "On matrimony, the menstrual courses, embryos and childbed" (LXIX). Beruniy stated his primary purpose was to provide "nothing but a simple historic record of facts". He wished to capture "the theories of the Hindus exactly as they are".

> **"His primary purpose was to provide 'nothing but a simple historic record of facts'**

Notably Beruniy maintains his objectivity in the face of what he observes are the differences between Islam and Hinduism: "the Hindus entirely differ from us in every respect ... they totally differ from us in religion as we believe in nothing in which they believe, and vice versa ... in all manners and usages, they differ from us to such a degree as to frighten their children with us, with our dress, and our ways and customs, and as to declare us to be devil's breed, and our doings as the very opposite of all that is good and proper".

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An 11th century statue of the Hindu god Shiva, in copper alloy. Beruniy would have learned about Shiva on his travels through India.

Lessons for today

It is an extraordinary tribute to Beruniy that modern Hindu intellectuals, like the celebrated Nirad Chaudhuri, in his classic *The Continent of Circe* (1965), cite him approvingly. Nimit Arora quotes Beruniy in his documentary *Exploring India's Past: From Al-Beruni, to Marco Polo and Ibn-Battuta*. Arora describes Beruniy as "tolerant, open minded and a big believer in science and evidence", "mildly devout", and a "decent" man.

How is Beruniy relevant to our times? First, he embodies the outstanding characteristics of a reliable scholar: these include accuracy, integrity and empathy. Scholars everywhere, regardless of their race or religion or politics, would benefit by adhering to these principles.

The quantity of Beruniy's academic output and its high quality, the originality of his thought and his consistent industry across disciplines make him an irresistible role model. In a time marked by fake news, misinformation and cultural misunderstanding, Beruniy's commitment to truth and scholarship stand as a beacon of intellectual excellence and cross-cultural understanding. ■

Prof. Bakhrom Abdukhalimov

Vice President of the Uzbekistan Academy of Sciences, Director of the Al-Biruni Institute of Oriental Studies, Tashkent, Uzbekistan.

Scientific heritage in a digital format

The scientific writings of Abu Rayhon Beruniy are a crucial part of global scientific history. Thanks to digitization, online catalogs, and international collaboration, modern technologies have significantly advanced the study of his legacy.

Abu Rayhon Beruniy authored about 150 scientific works in various fields, but only 33 of them have survived to the present day. To make his work accessible, electronic copies of his manuscripts have been gathered from archives and libraries around the world and made available online. International digital archives house manuscripts of the great scholar and make it possible to study his works.

> **He authored about 150 scientific works in various fields**

The Institute of Oriental Studies in Tashkent, part of the Academy of Sciences, was named after Beruniy and has a collection that contains 26,000 handwritten manuscripts, 39,000 lithographed and published books, and more than 5,000 historical documents in Arabic, Persian, and Turkish. The manuscripts cover subjects such as history, language and literature, Islamic sciences, and exact and natural sciences. Among these scientific works, there are more than 1,500 manuscripts by Muslim scholars from the 10th to the 19th centuries. Their works include studies in astronomy, mathematics, chemistry, medicine, pharmacology, mineralogy, and geography. Studying these scientific works is a priority of the Institute. Among these scholars, Beruniy's works hold a special place, as he authored about 150 scientific works in various fields. According to modern researchers, only 33 of these works have survived to the present day, but these include Beruniy's fundamental works, which have been translated and studied in Uzbek and Russian by the Institute's researchers for many years.

Some of Beruniy's translated books include major works such as *Chronology, India, Geodesy, Mas'ud's Canon, Mineralogy, Pharmacognosy, and Kitab al-Tafhim*, as well as several smaller mathematical (On Chords) and astronomical treatises (On Shadows, The Solar Equation, The Crown of Astronomical Tables, The Passage of Illuminators, and Cartography). Uzbek scholars have used microfilms of manuscript copies stored in various global collections since, unfortunately, Uzbekistan only possesses a single 13th-century manuscript copy of Beruniy's *Kitab al-Tafhim*.

Beruniy online

In 2023, the 1,050th anniversary of Beruniy's birth was celebrated under the auspices of UNESCO with an international conference on the role of his scientific heritage in the development of world science. At the event it was decided to collect electronic copies of his manuscripts from world archives and libraries, and publish them on one website. As a result, digital copies of Beruniy's manuscripts were gathered from scientific and educational centres and libraries in the United Kingdom, Germany, the Netherlands, Turkey, France, Iran, and India, given English descriptions, and uploaded



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to the new www.heritageofberuni.uz website in 2023 and 2024.

Until now, only a few library and encyclopedia websites have provided information about Beruniy's scientific heritage. For example, Russia's public library website contains Beruniy's biography and digital copies of his selected works translated into Russian, as well as electronic books of collected correspondence between Beruniy and Avicenna (980–1037).

Another important source is the website of the Turkey Diyanet Foundation Islamic Encyclopedia (TDV İslâm Ansiklopedisi), updated in 2018 and made available at https.islamansiklopedisi.org.tr. This website provides information on Islam, Islamic history and civilization, Arabic language and literature, the history of science, medicine, and other fields.

Besides the sites mentioned above, there is also a website dedicated directly to Beruniy himself, www.albiruni.nl. It was created by the famous Dutch historian of science, Professor J.P. Hogendijk, and provides information about the 26 surviving manuscript works of Beruniy, research conducted on them, works written in dedication to Beruniy, and works attributed to him. This site is a great help to those engaged in the study of Beruniy's scientific heritage.

UNESCO-Uzbekistan Beruniy Prize on the Ethics of AI

The legacy of the great polymath Abu Rayhon Beruniy — and his contributions to science and cultural exchange — have been evoked with a prize created in partnership with UNESCO and the government of Uzbekistan.

The UNESCO-Uzbekistan Beruniy Prize recognizes impactful contributions on the ethics of AI, and fosters scientific dialogue and international collaboration in this area.

It is awarded biennially to three laureates — individuals, institutions, or organizations, contributing to the implementation of the principles outlined in the Recommendation on the Ethics of Artificial Intelligence. The first edition of the Prize will take place in November 2025 in Samarkand, Uzbekistan, reinforcing UNESCO's mission to promote AI for the benefit of all humanity.

Unlike previous sites, the website of the Institute of Oriental Studies is the only one to contain the biography I published of Beruniy (*The Place of Abu al-Rayhan al-Biruni's Scientific Heritage in the Development of World Science*), as well as 12 detailed scientific descriptions in English of the manuscripts of Beruniy's works preserved in foreign collections. So far, the website has provided scientific descriptions of 172 manuscripts of 43 works.

New discoveries

Turkish libraries house the oldest and most decorative copies of Beruniy's works, as well as copies with historical significance. For example, in the Fatih Collection of the Suleymaniye Library, there is a copy of *Geodesy* written in Ghazna in 1025-1026. The oldest surviving copy of Beruniy's famous astronomical encyclopedia *Al-Qanun al-Mas'udi* dates back to 1136-1137 and can be found in the same library.

The only ancient copy of Beruniy's pharmacological work *Kitab al-Saydana fi al-Tibb*, copied in 1279-1280, is preserved in Turkey at the Kursunlu Jami Library.

Most manuscripts of Beruniy's works in Iranian libraries contain the name of the copyist and the date of copying. Copies of the work *Kitab al-Tafhim* are especially numerous, with the oldest Persian version, dated 1143, kept at the Library, Museum, and Documentation Center of the Iranian Parliament.

In the Encyclopedia Organization of Iran, there is an old collection compiled in 1162, which includes four works by Beruniy, as well as a fragment from *Al-Qanun al-Mas'udi*. Most copies of *Al-Athar al-Baqiyah* in Iran were copied in the 19th century.

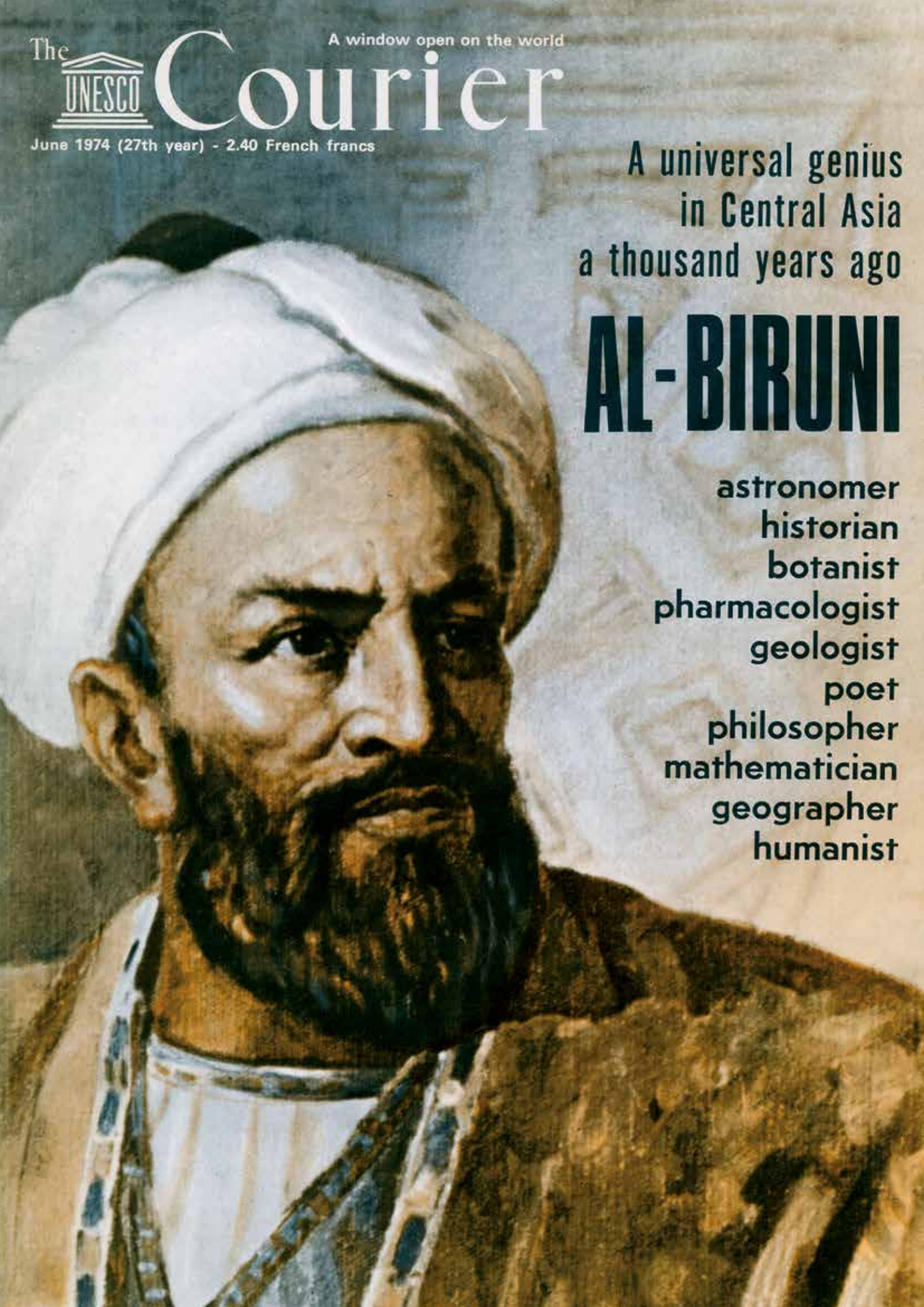
In the Bodleian Library in the United Kingdom, a copy of *al-Qanun al-Mas'udi* copied in 1082 and compared with the author's autograph is preserved. Another old copy, copied in 1108, is found in the National Library of France, which also houses a manuscript copy of *India*, copied from the author's original in 1149.

The ongoing development of all of these collections help ensure that the scientific legacy of Beruniy will continue to be recognized for its crucial role in world research. ■



◥ *The Abu Rayhon Beruniy Institute of Oriental Studies in Tashkent, Uzbekistan houses a unique collection of Islamic manuscripts inscribed as part of the UNESCO Memory of the World Register.*

The UNESCO Courier
A window open on the world
June 1974 (27th year) - 2.40 French francs



A universal genius in Central Asia a thousand years ago

AL-BIRUNI

astronomer
historian
botanist
pharmacologist
geologist
poet
philosopher
mathematician
geographer
humanist

The UNESCO Courier

JUNE 1974
27TH YEAR

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The following pages are a slightly redesigned reproduction of a special issue of the UNESCO Courier dedicated to Abu Rayhon Beruniy and published in June 1974.

The articles explore the many groundbreaking contributions of this scholar to the natural sciences, literature, history, and anthropology, including a mini anthology of his writings.

As these archive articles were first published in 1974, they reflect the research and geographical names of the time. Please note that in this issue, his name is written Abu al-Rayhan Mohammed ibn Ahmad al-Biruni.

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Cover : A portrait of the great Islamic scholar al-Biruni as he may have looked in his prime, to mark the 1,000th anniversary of his birth in 973.
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Few periods in man's history can boast the existence of one of those rare intellectual giants whose genius not only embraces the knowledge of his time but reaches out to uncharted, unknown frontiers. Such a man was al-Biruni, born a thousand years ago, who ranks among the greatest scholars of the Islamic world. Astronomer, mathematician, physicist, geographer, historian, linguist, ethnologist, pharmacologist as well as poet, novelist and philosopher al-Biruni's contribution to human learning was unique. Despite the political upheavals which interrupted his work, his sheer output was prodigious. He had a scientific spirit in the full sense of the term and displayed a spirit of understanding and respect for other cultures remarkable for his time. His contribution was such that many scholars put him on a par with or even higher than the great Avicenna. Yet unlike Avicenna, al-Biruni is virtually unknown except to the rare specialist. The *Unesco Courier* hopes that this special number will provide a small insight into the extraordinary genius of this universal scholar and man of science.

Abu al-Rayhan Mohammed ibn Ahmad

AL-BIRUNI

A universal genius who lived in Central Asia a thousand years ago

by Bobojan Gafurov



ABU al-Rayhan Mohammed ibn Ahmad al-Biruni, the great Central Asian scholar, is one of those intellectual giants whose stature continues to grow as we become more fully acquainted with their legacy.

One hundred years ago, when al-Biruni's *Chronology of Ancient Nations* was published in Russian, only one facet of his many talents was apparent, that of an outstanding medieval historian. But as more of his works were discovered—treatises on mathematics, geography and astronomy—and the more deeply they were studied, the higher al-Biruni stood out above the mass of his contemporaries.

Al-Biruni was so far ahead of his time that his most brilliant discoveries seemed incomprehensible to most of the scholars of his day. He was the first to arrive at an amazingly simple formula for measuring

BOBOJAN GAFUROV, *of the U.S.S.R. Academy of Sciences, is director of the Academy's Institute of Oriental Studies and chairman of the Unesco-sponsored International Association for the Study of the Cultures of Central Asia (comprising Afghanistan, India, Iran, Mongolia, Pakistan and U.S.S.R.). He is the author of many works on Asian history and culture.*



© Andrey Arakelyan

Monuments of Itchan Kala, the inner town of Khiva, Uzbekistan, a UNESCO World Heritage site. Built in the 19th century, Kalta Minor Minaret (left) is approximately 70 metres high and is considered a masterpiece of Islamic architecture. Its intricate brick and tile work includes a colourful zigzag pattern known as "viper's head". The Muhammad Aminkhan Madrasa (right) was built in 1852-1855 by the Uzbek ruler Muhammad Aminkhan.

the earth's circumference. He thought it possible that the earth revolved around the sun. He developed the idea that geological eras succeed one another in cycles. "With the passing of time, the sea becomes dry land, and dry land the sea," he wrote, and on this brilliant hypothesis he based his theory of the earth's geological history.

What enabled al-Biruni to move so far ahead of his contemporaries and to create works that made his name known in the East as a symbol of learning of the 11th century?

Khwarizm, in Central Asia, where al-Biruni was born and grew up, had long been famed for its advanced culture. Its cities had magnificent palaces, mosques and madrasahs (religious colleges), and in this prosperous, ancient state the sciences were esteemed and highly developed.

The 10th and 11th centuries saw the decline of the Arab caliphate in Baghdad. New states arose on its ruins, and a pleiad of illustrious Central Asian scholars appeared, including Abu-Nasr al-Farabi and ibn-Sina (Avicenna).

It was during this period that al-Biruni was born near Kath, the capital of Khwarizm, on 4 September, in the year 973. "In truth, I am not certain of my genealogy, for I do not really know who my grandfather was. And how could I know who my grandfather was, when I do not even know who was my father?" he wrote in a poem which appears in one of his treatises.

In his early youth, fortune brought him in contact with an educated Greek who was to become his first teacher. At the Greek's request, the young al-Biruni collected plants, seeds and fruit and this kindled his interest in the natural sciences.

Al-Biruni's foster father was Abu-Nasr Mansur ibn-Ali ibn Iraq, or simply Mansur, a member of the Khwarizmian royal family and a distinguished mathematician and astronomer. He introduced al-Biruni to Euclidean geometry and Ptolemaean astronomy, which equipped the young scholar to study astronomy.

"Most of my days were blessed by gifts

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AL-BIRUNI *(Continued)*

and privileges which were increasingly bestowed on me," wrote al-Biruni, describing this period of his life. "The Iraq family nourished me with their milk and their Mansur took it upon himself to rear me."

Al-Biruni studied the stars and minerals, probed the secrets of the heavens and the earth and read thousands of books in order to fathom the meaning of history. He constructed a globe of the earth — the first in Central Asia — and was equally gifted as a poet. He lived through the feverish final years of the powerful Samanid dynasty and witnessed the rise and fall of two early feudal empires — the Karakhanid and the Ghaznavid.

Social conflicts, feudal wars and barbarian invasions left their imprint on his manuscripts, since science does not exist in a vacuum, least of all the science of history. It might well have been the violent social upheavals in Khwarizm that suggested the theme of his first major work, in which he turned to the past for an understanding of how society was evolving.

Al-Biruni completed his *Chronology of Ancient Nations* at the age of 27, just before the 11th century was born. "My aim in this book," he explained, "was to establish as accurately as possible the time span of various eras." His study begins at the dawn of the human race, moves on to the period of the great flood, and covers everything then known about the times of Nebuchadnezzar and Alexander the Great.

The book explains various calendar systems such as the Arabian, Greek and Persian. The history of rulers, heroes and political events is interwoven with the history of culture, customs and morals. The *Chronology of Ancient Nations* should not be considered as a purely historical work, but as a partly historical and partly ethnographic study that retains its full significance to this day.

Soviet scholars of the 1930s referred to the Chronology again and again in their research on ancient Central Asia. Only in al-Biruni's work could they find an account of the Soghdian calendar, essential to their study of early 8th century Soghdian documents; only here could they find information about pre-Muslim Khwarizm, which archaeologists were just beginning to study.

Al-Biruni was no ivory tower scholar. He met and came to know people in many different walks of life and maintained close contacts with his fellow scholars. We know from letters written by al-Biruni in Khwarizm, in the year 997, to the 17 year-old Avicenna in Bokhara, that these young scholars discussed Aristotle's *Physics* and *On the Heavens*, as well as the structure of the universe, the physical laws covering a free-falling object and



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Al-Biruni was born near the town of Kath, north-east of the ancient city of Khiva. Kath has vanished from the map, but Khiva (today in Uzbekistan) still boasts palaces, religious colleges, mosques and burial monuments that testify to the talent of its medieval architects and craftsmen. Left, a view of the arched madrasah (religious college) in Khiva's old town in Uzbekistan, seen through a wooden door with intricate oriental carvings. Above, the ancient Anusha-khan bath complex at the gates of Kosh Darvaza in Khiva.

indivisible particles (atoms). Al-Biruni devoted his work, *Questions and Answers* to these exchanges.

Al-Biruni's letters reveal a deep respect for the ancient Greek philosophers and show him to be already a mature man of science, despite his youth. In the year 1010, he was admitted to the Academy of al-Mamun, which embraced a group of famous scholars, including the philosopher and natural scientist Avicenna, the historian and philosopher ibn-Maskawayh and the mathematician abu-Nasr Arrah.

Whereas European natural science was in a state of stagnation at that time, scholars in Khwarizm were vigorously advancing along the path traced by scientists of antiquity. Khwarizm's economic growth during the early feudal period had set the stage for a golden age of science in the early 11th century.

Commerce with northern peoples—the Khazars and Bulgars, the ancient Russians and the tribes of the Urals and Western Siberia—also influenced scientific advancement. Learning flourished in this fertile soil, with its traditions of a thousand year-old independent culture, combining the "wisdom of neighbouring India with the perfect lucidity of far-off Hellas."

Al-Biruni's frequent references to Greek philosophy and scientific thought demonstrate the encyclopedic scope of his interests. He was familiar with Homer's *Iliad* and *Odyssey*, and had studied Plato's treatises, *Laws* and *Phaedo*. He was well acquainted with the works of Aristotle, Archimedes and Democritus, and extolled what he considered the best of Greek philosophy.

The 11th century was a time of great turmoil. The armed hosts of Mahmud of Ghazna overran Khwarizm, in 1017, taking thousands of prisoners, including al-Biruni. The decade which followed was to be the most difficult period in the scholar's life, but at the same time his most productive. He studied astronomy, collected materials for a mathematics treatise, sought to comprehend the influence of the moon on the tides, and conceived his major work on India, which represents the zenith of his scientific thinking.

Arabic and Persian literature prior to al-Biruni's time had depicted India as a land of wonders. The Indians were knowledgeable in astronomy and arithmetic; they were said to have invented chess, which in al-Biruni's time was already considered an intellectual game; they were accomplished sculptors and poets; their doctors were highly reputed, and it was even affirmed that the science of philosophy had originated In India.

In Ghazna, al-Biruni became acquainted with Indian scholars who, like him, were

CONTINUED NEXT PAGE

exiled from their homeland. His meetings and conversations with them sparked his interest in their remarkable country. For a period of 12 years, up to the year 1030, al-Biruni was totally absorbed in India.

Many people before al-Biruni had travelled to India, especially to Sind and its southern coast, and some books that could serve historians as a guide to studying the country had been written. Al-Biruni's monumental work on India, however, clearly demonstrated a scientific, that is, objective, approach to the subject. At the age of 45, he began learning Sanskrit. He visited India several times, walked on its soil, breathed its air, compared and marvelled.

A true scientist, al-Biruni strove to share knowledge as well as to obtain it. He translated Euclid's *Elements* and his own treatise on astronomy into Sanskrit. He also began a translation of the *Panchatantra* into Arabic, as he considered the existing translation of this immortal literary classic to be inadequate.

Al-Biruni's *India* became the major source for studying 11th century India. It covered the caste system, philosophy, the exact sciences, religion, laws, customs, superstitions, legends, the system of weights and measures, the written language and geography. In writing it, al-Biruni quoted 24 works by 14 Greek writers and used 40 Sanskrit sources. He was an objective researcher, free of racial bias, with a deep respect for the advanced culture of another people.

During the reign of Mas'ud, who succeeded his father, Mahmud, as Ghaznavid ruler, al-Biruni's situation improved. The new king was an enlightened man who encouraged the sciences. Al-Biruni dedicated his major work on astronomy, *The Mas'udic Canon*, to him. In the opinion of al-Biruni's contemporaries and successors, he surpassed his ancient mentor, Ptolemy, in this work.

When the grateful Mas'ud sent the scholar an elephant loaded with pure silver, al-Biruni replied: "This gift would seduce me from science. Wise men know that silver is soon spent but science lives on. I would never exchange the perennial wealth of scientific knowledge for the short-lived tawdry glitter of silver."

Al-Biruni's main interests were mathematics, astronomy, geography, physics and geodesy but in his last work, the *Pharmacology*, he classified the physical features of plants, animals and minerals, and compiled an alphabetical list of medicinal herbs and their uses.

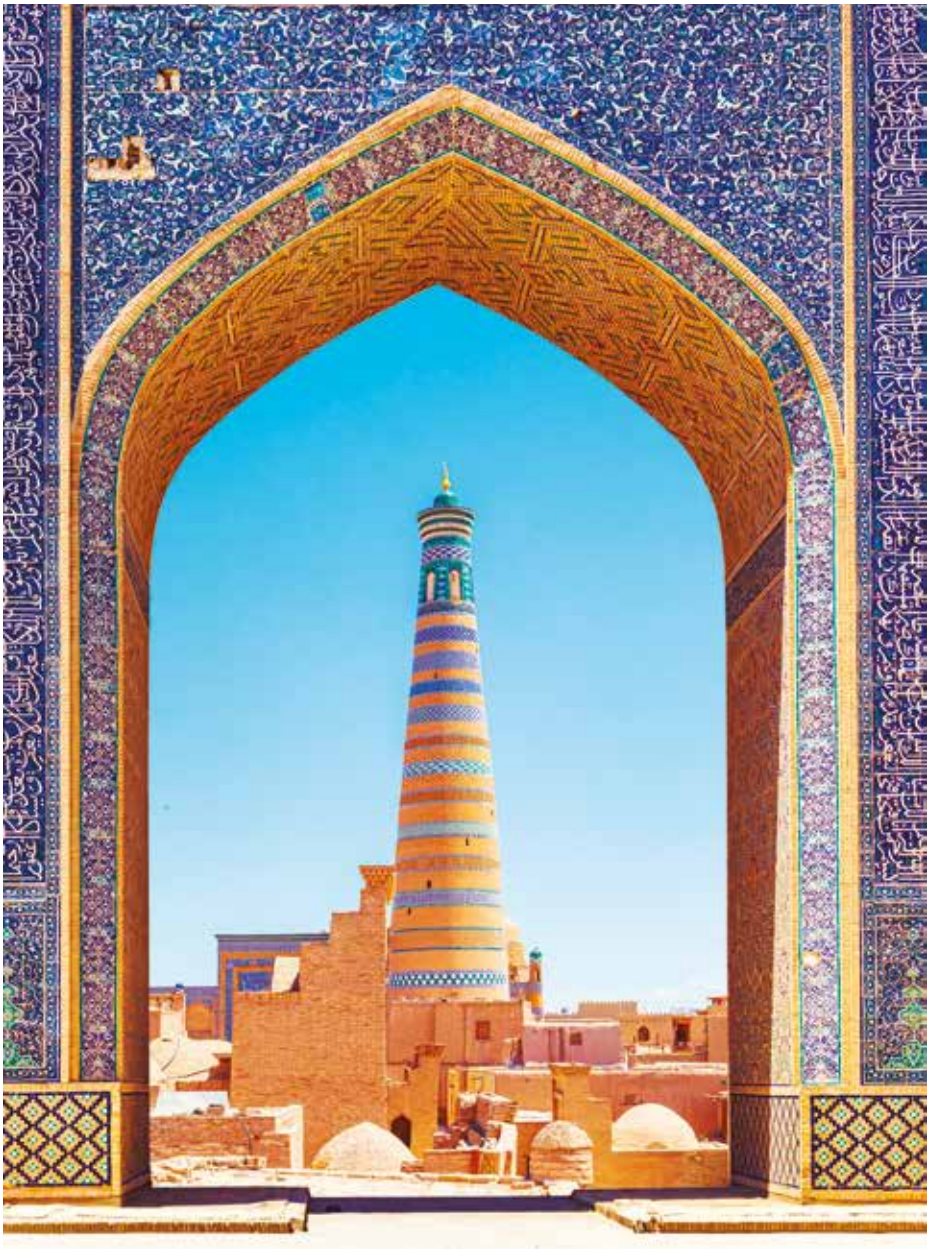
Besides Arabic names, al-Biruni listed about 900 Persian, 700 Greek, 400 Syrian and 350 Indian names in the *Pharmacology*. He referred to Aristotle's works on biology, and also to the writings of Dioscorides and Galen, physicians and pharmacologists of the 1st and 2nd centuries. Unfortunately, the *Pharmacology* was not completed, but even in the form it has come down to us its value is self-evident.

Al-Biruni's contemporaries spoke of him thus: "Except for two festive days each year, his hand never stopped writing, his eyes observing, his mind contemplating." When he died in 1048, at the age of 75, more than 150 works had flowed from his pen. They include 70 on astronomy, 20 on mathematics and 18 on literature, including translations, and bibliographies. He was famed as a cartographer, meteorologist, physicist, philosopher, historian and ethnographer.

Only 27 of his works have come down to us. Whether the rest were destroyed or simply have not been found is not known. Abu'l Faraj, the Syrian historian and physician, wrote of al-Biruni, the man he regarded as his mentor: "His works are numerous, exhaustive and completely reliable. There was no one, neither among his colleagues, nor to this day, so well versed in astronomy, from its main principles down to the smallest details."

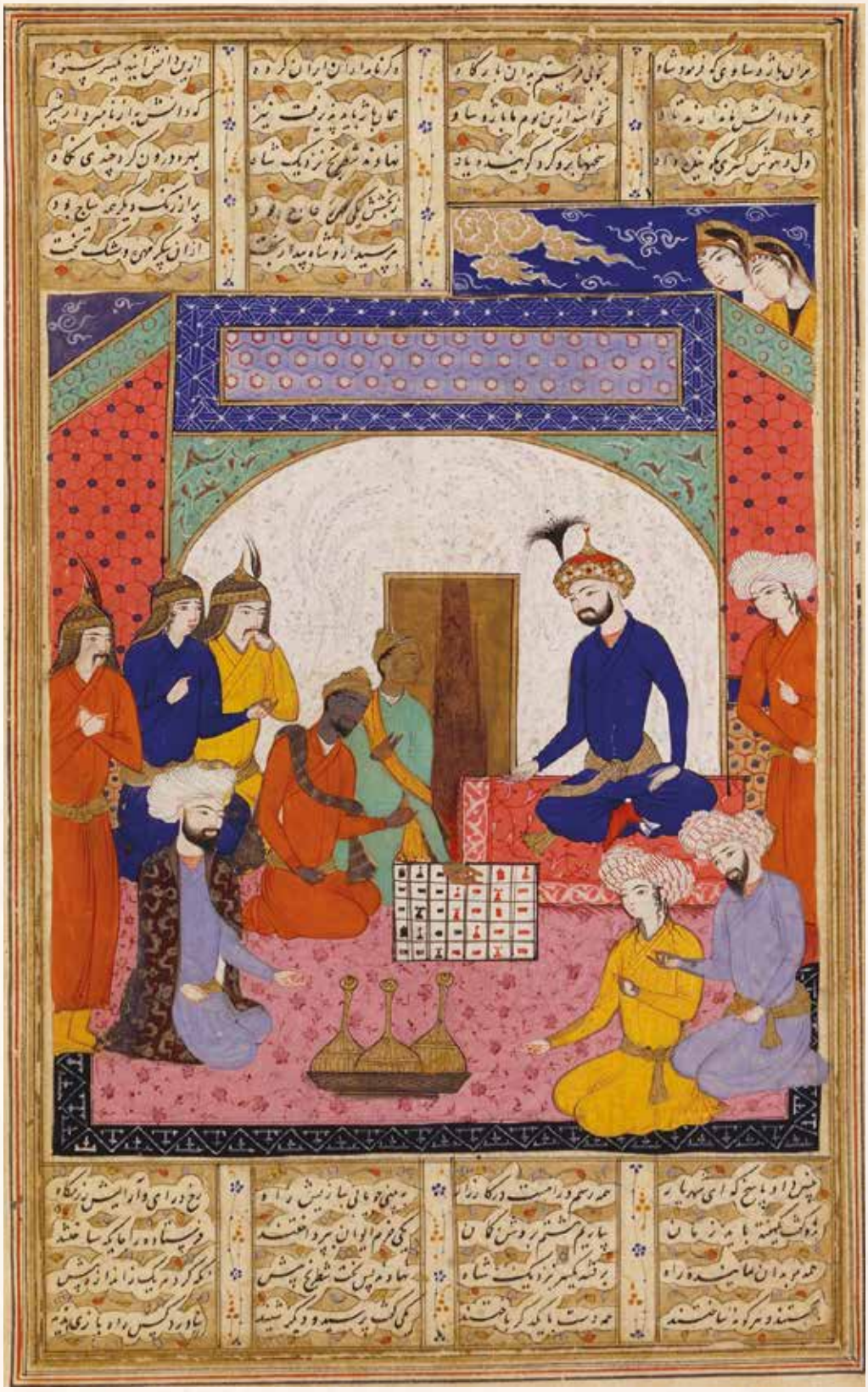
Al-Biruni had a vast impact on science in the East. Many countries claim him as their own, but this son of Khwarizm, one of Central Asia's most brilliant civilizations, belongs to all nations and to all time. ■

Bobojan Gafurov



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View of the Islam Khoja Minaret in Itchan Kala, the inner town of Khiva city in Uzbekistan.



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Chess was first played in Asia and many authorities agree that it originated in India. In al-Biruni's day it was already a popular game in Central Asia. This extract from *The Book of Kings* (1604-1610) depicts the introduction of chess, an Indian game, to Iran, when two envoys of the King of India present to Chosroes Anushirvân, the sovereign who ruled Iran from 531 to 579, a chess set that they have made for him.



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1

THE LONG ODYSSEY

In the footsteps of a Muslim scholar through a world in ferment

by Jacques Boilot

FATHER JACQUES BOILOT, *distinguished French orientalist, has devoted many years to the study of al-Biruni. His "L'Oeuvre d'al-Biruni : Essai Bibliographique" is regarded as the standard bibliographical work on the subject. He is a member of the Dominican Institute of Oriental Studies (formerly the French Institute of Oriental Archaeology) in Cairo. His article is abridged from a study on al-Biruni published in the Dominican Institute's review, "Mélanges" (No. 11, 1972).*



2



3

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Miniatures on these pages are from a manuscript of al-Biruni's *Chronology of Ancient Nations* copied in 1307. Opposite, a miniature portraying the Sassanian king Feroz addressing his court (1); a discussion between a sage and a peasant (2); a depiction of the birth of Augustus, the first Roman Emperor (Caesar), through a surgical operation which would bear his name—Al-Biruni himself used the term "Caesarian"(3); (4) individuals gathering at a place of worship to celebrate the autumnal equinox in India; (5) the festival of the Bahman Mah.

AL-BIRUNI is one of the greatest scholars of medieval Islam and probably the most original and profound of all. His Eastern contemporaries called him al-Ostadh (The Master).

How did his fame spread to the West in the Middle Ages? His major works were apparently not translated into Latin, with the possible exception of a few peripheral chapters dealing with natural magic, judicial astrology, talismanic art… The extraordinary features of his life as recounted by his Eastern biographers perhaps added to his reputation. Early French texts that speak of a "Maître Aliboron" are almost certainly alluding to "Master al-Biruni", scientist, doctor and man of deep wisdom.

While al-Biruni's work is of great value in itself and deserves serious study by historians of science, religion and philosophy, it is the Master's mental outlook and the nature of his intellectual interests that scholars today find stimulating.

Fifteen years ago we wrote: "Apparently not much given to making generalized syntheses by systemized deduction, or metaphysical speculation in the strict sense of the term, but constantly on the look-out for positive facts carefully and critically observed, trained to think mathematically, interested in everything concretely related to human life, he appears at the beginning of the eleventh century like a champion of the scientific spirit as it is understood today.

"He showed great religious tolerance and doctrinal objectivity. Above all, he wanted to learn and understand. He was relatively unprejudiced but prepared to take a courageous stand in defence of truth. He was one of the first Muslims to study the philosophy and science of India sympathetically, and in exchange he taught those of Greece."

So it is al-Biruni the man we wish to discover, by piecing together such facts as will help us to place him in his setting and his time.

This puts us in the latter part of the tenth century in Khwarizm, a central Asian country situated south of the Aral Sea, along the Amu-Dar'ya river, the Oxus of the ancients.

The sultanate of Khwarizm had enjoyed relative independence throughout its history but successive wars and changes in the course of the Amu-Dar'ya river brought about the destruction of one medieval city after another. As a result, it is difficult to determine the exact site of Kath, the city where al-Biruni was born in 973 A.D., beyond the fact that it was probably situated on the right bank of the Amu-Dar'ya river north-east of the modern town of Khiva.

The second largest city in Khwarizm was Jurjaniyya on the opposite bank and to the north of Khiva. Today it is known as Urgench. On the right bank across from Urgench, a new town has risen not very far perhaps from ancient Kath, and its name,"Biruni", commemorates the scientist's birthplace.

CONTINUED NEXT PAGE

THE LONG ODYSSEY *(Continued)*

Al-Biruni very early began scientific studies and at the age of 17 he used a ring graduated in halves of a degree to observe the height of the sun at the Kath meridian and thus calculate the latitude of the city. Four years later he made plans for a series of observations and measurements, and had prepared an astronomical ring 15 cubits (8 metres) in diameter along with other equipment.

At this time, civil war broke out in Khwarizm and al-Biruni, who was now 22, went into hiding and soon had to flee the country.

In order to understand al-Biruni's long career from then on, we must take into account the political situation in the countries where he was to live. In addition to what is now Uzbekistan, they comprised the northern part of present-day Iran, Afghanistan, Pakistan and northern India. Al-Biruni in the course of his life was directly involved with six princely dynasties.

Who was the prince that al-Biruni fled to for protection in 995? We do not know with certainty. It may have been then that he went to the town of Ray, near present-day Teheran. In his *Chronology of Ancient Nations* he quotes a poem on the tribulations of poverty, and recounts that when he was living in Ray without royal patronage and destitute, a local astrologer scoffed at his views on some technical matter simply because he was poor. Later, when his situation improved, the same man became friendly.

At that time, the flourishing Bowayhid dynasty, which had originated in the mountains south of the Caspian Sea, extended its domain south towards the Persian Gulf and west to Mesopotamia.

At the request of the Bowayhid prince, Fakhr al-Dawla, the astronomer al-Khojandi had built a large mural sextant on a mountain above the town of Ray. He used this "Fakhri Sextant" — so named after the prince — to observe the sun's transits throughout the year 994.

Al-Biruni wrote a treatise describing this sextant and giving a detailed account of the observations made, based on information given to him by al-Khojandi in person. As the astronomer died about the year 1000, his scientific discussions with the young al-Biruni in Ray, must have dated from shortly after the observations carried out in 994.

There is reason to believe that al-Biruni was also in the province of Gilan, along the south-west corner of the Caspian Sea about this time. One of his books is dedicated to the *Ispahbad* ("ruler" or "commander") of Jilan. In the *Chronology of Ancient Nations* which was finished by the year 1000, he speaks of having been in the presence of the *Ispahbad* of Jilan — perhaps the same official who protected Firdausi, the epic poet of Persia, from the wrath of Sultan Mahmud.

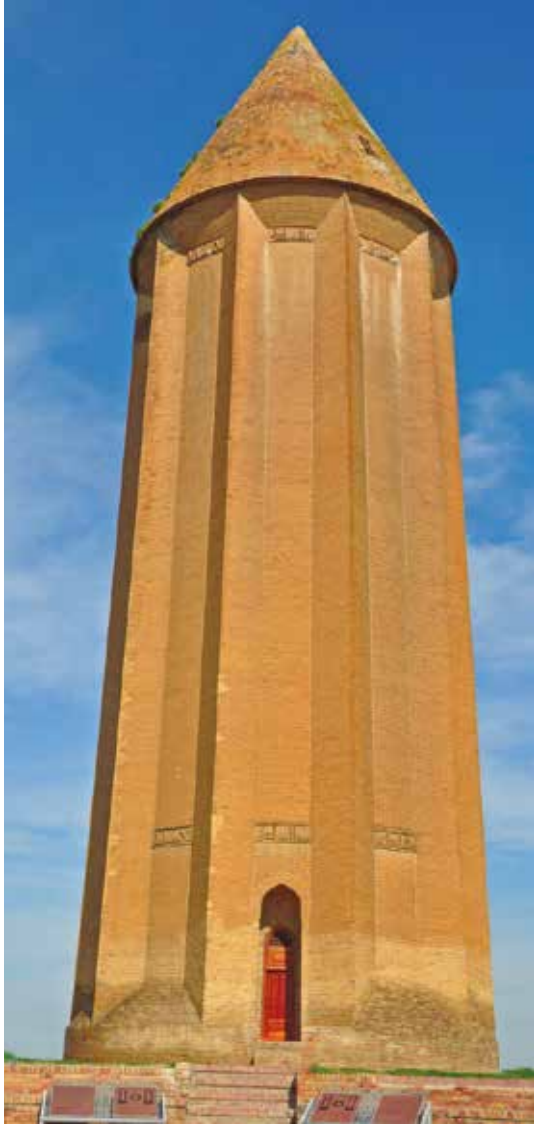
In any event, al-Biruni was certainly back in Kath by 997. On 24 May in that year, he observed an eclipse of the moon in Kath, after arranging to have the great Muslim mathematician, Abu'l-Wafa, observe the same phenomenon in Baghdad. The time difference between the respective observations enabled the two scientists to calculate the difference in longitude between the two points.

THE short reign of the Samanid Mansur II began the same year, 997, and it was also about that time that al-Biruni visited his court at the capital city of Bokhara. The Samanid dynasty, a royal house of Zoroastrian origin, but early converted to Islam, ruled an area comprising all of modern Afghanistan, Transoxiana and Iran.

Meanwhile, Qabus, the Ziyarid ruler of Gurgan, a city at the south-east corner of the Caspian Sea, had been driven from his lands, and was trying to obtain support from Bokhara in an effort to return to power. He succeeded in reinstating himself in Gurgan and al-Biruni followed him there.

The *Chronology*, al-Biruni's first major work, seems to have been written at the Gurgan court. This book, which treats of calendars and eras, and fundamental problems in mathematics, astronomy, meteorology, was dedicated to Qabus about the year 390 of the Islamic calendar (1000 A.D.). In it al-Biruni refers to seven other books that he had already completed, dealing with decimal numbers, the astrolabe, astronomical observations, astrology and history.

During this period al-Biruni was carrying on an acrimonious correspondence with a young prodigy, the brilliant philosopher and physician of Bokhara, Ibn Sina, known in the Latin countries as Avicenna, who was seven years his junior.



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Among the subjects on which they exchanged views were the nature and transmission of heat and light. Al-Biruni was not yet 30 years old at the time and Avicenna was in his early twenties.

In his book on geodesy, after describing the measurement of a degree along a terrestrial meridian, made at the direction of the Caliph Ma'mun, al-Biruni describes his own failure to repeat the operation. A suitable tract of land had been chosen between Gurgan and the land of the Oghuz Turks (on the deserts east of the Caspian) but the patron, presumably Qabus, lost interest.

The end of al-Biruni's stay at the Ziyarid court can be precisely established, for in 1003 he observed two lunar eclipses from Gurgan, one on 19 February and the other on 14 August. The following year he observed a third lunar eclipse, but this time from Jurjaniyya, on 4 June. Thus in the interim, he had returned to his homeland, high in favour with the reigning Khwarizmshah.

Thanks to the Khwarizmshah's liberality, al-Biruni was able to construct in Jurjaniyya an astronomical instrument which in gratitude he called the "Shah's Circle". In all probability it was a large ring

Al-Biruni lived in a great age of learning and the arts. About 1000 A.D., he was living at Gurgan, in north-east Iran, at the court of Qabus, to whom he dedicated his first known major work, the *Chronology of Ancient Nations*. Left, the famous tower of Qabus. It was long believed to be the ruler's tomb, but recent investigation has revealed no trace of a burial chamber. Al-Biruni may have watched the tower being built, since elegantly carved Arabic inscriptions at its summit and base record that Qabus ordered its construction in 1006 A.D. when al-Biruni was 33 years old. Below, a decorated plate from the era of al-Biruni found in Nishapur, Iran. Right, example of a carved stucco panel that would have adorned a dado, or the lower half of a wall, in 10th century Iran.



Public Domain / Purchase, Joseph Pulitzer Bequest, 1967 / The Islamic Art Collection of the Metropolitan Museum



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fixed on the plane of the meridian.

Al-Biruni speaks in several places in the *Tahdid*, his book on geodesy, and in his *Canon* on astronomy, of 15 observations of the sun's transit over the meridian in Jurjaniyya, the first one at the summer solstice on 7 June 1016, and the last one on 7 December of the same year. It was probably during this period of prosperity and royal favour that he had a hemisphere ten cubits (5.4 metres) in diameter built to help solve geodesic problems graphically.

Meantime the political atmosphere in the sultanate of Khwarizm was becoming more and more tense. In the *Tahdid* al-Biruni writes: "I had enjoyed only a few years of peace when the Lord of Time (God) allowed me to return to my own country; but there I was forced to take part in public affairs, which caused fools to envy me and wise men to pity me."

Ma'mun, the Khwarizmshah, confided several difficult political missions to al-Biruni, who carried them out skilfully "with tongue of silver and of gold". But Ma'mun was assassinated by some of his troops in revolt and this gave the Ghaznavid sultan Mahmud an opportunity to march against Khwarizm with a large army. From its base in east-central Afghanistan the kingdom of the Ghaznavids was swiftly expanding. By 1020, Sultan Mahmud had carved out a realm extending a thousand miles north and south and twice as far east and west.

AL-BIRUNI was among those deported by the conqueror to Ghazna in Sijistan (Afghanistan), partly no doubt to enhance the sultan's court with his presence, but also in order to get rid of an active supporter of the Khwarizmian pretenders. He was then 44 years old.

The following year we find him in a village south of Kabul, downcast and livinq in misery, but working hard on the *Tahdid*. On 14 October 1018 he wanted to measure the height of the sun but had no instrument to hand. So he was obliged to draw a calibrated arc on the back of a reckoning board and use it, with the aid of a plumb line, as a makeshift quadrant.

On the basis of the measurements made with this crude device he calculated the latitude of the locality. On 8 April, 1019, he observed an eclipse of the sun at Lamghan, a town to the north-east of Kabul.

Al-Biruni's relations with Sultan Mahmud were never cordial. It is evident, nonetheless, that he was given official support for his work. In his *Canon* he relates that he determined the latitude of Ghazna by a series of observations made between 1018 and 1020 with an instrument which he calls the "Yamini Ring". Yamin al-Dawla (Right Hand of the State) was one of the titles conferred on Mahmud by the Abbasid Caliph in Baghdad, and the monumental instrument was named, according to custom, after the royal patron.

It is also evident that al-Biruni's interests in Sanscrit and the civilization of India were due to his forced residence in an empire that now extended well into the Indian subcontinent. In 1021 the conquering sultan subjugated the Ganges Valley almost as far as Benares, and in 1026, by a daring raid south starting from Ghazna, he reached the Indian Ocean.

Al-Biruni took advantage of these events to visit various parts of India and stayed there more or less voluntarily. We know that he journeyed to the Punjab and Kashmir regions, though no dates can be given for his visits. He determined the latitudes of a number of towns, and reports that while he was living at Fort Nandana, he used a nearby mountain to calculate the diameter of the earth.

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THE NINE-DOMED MOSQUE OF BALKH

The mosque of Nouh-Goumbed with its nine domes, one of the early examples of Islamic architecture in Central Asia, is a relatively recent discovery. Its imposing ruins, hidden away in the remoteness of north-west Afghanistan on the site of the ancient city of Balkh, were first studied and described by archeologists in 1967. In this region al-Biruni set the scene of one of his romances, *The Two Idols of Bamian* (see page 42). Up to the 7th century, Balkh was an important seat of Buddhist learning. After its conquest by the Arabs in 663, its fame as an intellectual and artistic centre spread even wider and its splendours were recounted by Arab and Chinese travellers and historians. The nine domes of this almost square mosque were once supported on pointed arches resting on six central columns. The domes have fallen in, but even in its present state the mosque gives an impression of beauty and strength. This is in part due to the size of the six columns, 1.56 metres in diameter, and to the manner in which the baked bricks are separated by small decorated interstices 4 to 5 cm. wide. Work has been conducted to stabilize the structure and protect the plaster decoration, and a protective roof and scaffolding were installed to prevent further damage. The decorative features and form of construction enabled archaeologists to place the mosque in the 9th century and as "an architectural achievement without precedent".



© Aga Khan Trust for Culture / photo: Simon Norfolk



Nandana had been taken by Mahmud in 1014. It controlled the route by which he, the Moghuls after him, and Alexander the Great long before penetrated the Indus Valley.

Al-Biruni spent a long time in Ghazna itself and made many astronomical observations there, including transits of the sun across the meridian at the time of the summer solstice in 1019, an eclipse of the moon on 16 September 1019, and equinoxes and solstices up to the winter solstice in 1021. It was then that he completed his treatise *Shadows*.

In 1024, the ruler of the Turks along the Volga sent an embassy to Ghazna. The Turks had trade relations with the inhabitants of the polar regions, and al-Biruni was able to add to his knowledge of those countries by questioning the envoys. One of them stated in the sultan's presence that sometimes in the far north the sun did not set for days. Mahmud at first considered this as heresy and was enraged, but al-Biruni convinced him that It was perfectly plausible.

In 1027, the year that the treatise *Chords* was finished, a Chinese and Uighur Turkish legation came to Ghazna. From this mission, al-Biruni obtained geographical information about the Far East which he later included in his *Canon*.

Sultan Mahmud died in 1030, and soon afterwards al-Biruni completed his encyclopaedic book, *India*, but he did not dedicate it to any particular patron. Within the year (1030) the sultan's eldest son, Mas'ud succeeded to the crown and then the situation of his most famous scientist changed completely.

Al-Biruni put the final touches to his third major work, the *Canon* of Astronomy, and dedicated it to the new sovereign in florid terms.

In this book he takes issue with Ptolemy's system on several points. He holds, for example, that the sun's apogee is not fixed, and while he accepts the geocentric theory, he shows that the astronomical facts can also be explained by assuming that the earth revolves round the sun.

According to one chronicler, Mas'ud offered the Master an elephant-load of silver coins for this work, but al-Biruni declined the gift. Nevertheless he was provided with the means to continue his scientific and literary studies as long as he lived.

It may have been because of this change of regime that he was able to re-visit his native country. He made at least one trip back, for in his *Bibliography* he writes that for over forty years he had sought a certain Manichaean work, a copy of which he finally procured in Khwarizm.

Al-Biruni recounts that after the age of 50 he suffered from a number of serious ailments. In his distress, he questioned several astrologers about how much time he had left to live. Their replies were at total variance with one another and some were obviously absurd. In point of fact, towards the end of his 61st year (possibly his 61st lunar year) his health began to improve.

One night he dreamt that he was observing the new moon and when its crescent disappeared he heard a voice predicting that he would be able to gaze upon it 170 times more. As It turned out, he lived longer than 170 more lunations (14 lunar years).

It was during the reign of Mawdud, son of Sultan Mas'ud, (1040-1048) that al-Biruni wrote *Gems*, his book on precious and semi-precious stones and on metals. Following this period, even though his sight and hearing were failing, as he himself tells us in his last book, he carried on his research assiduously with the aid of a Greek assistant.

His final work was the *Pharmacology* which is a tribute to his prodigious erudition. Al-Biruni tells us that he was over eighty years old (lunar years?) when he was still working on this compilation, which brings us down to the year 1050 or later. The date of his death, as given by Ghadanfar —13 December 1048 — is therefore inexact. Ultimately, he survived his third Ghaznavid patron and lived longer than the time predicted in his dream.

Al-Biruni was Persian by birth. *(Editor's Note: There is a lack of consensus on this point.)* He was brought up in the Khwarizm dialect and later used Neo-Persian as his spoken tongue, but out of choice he preferred the Arabic language as an instrument of thought and a means of expression in his intellectual life, both for his scientific treatises and his purely literary works.

Thus his writings constitute a monument in the history of ideas and doctrines within the Arab world before forming part of the general history of human thought, as a contribution from the Arabic-speaking world where they came into being and first acquired their fame.

In point of fact, al-Biruni, personally and well ahead of his time, was a promoter of mutual understanding and fruitful cultural exchange between the East and the West—though he may not have thought of himself as such—through the active mediation of the Arabic language and the profoundly humanistic values inherent in it.

By virtue of his scientific method, which makes him a model for the Eastern world even today and ensures him the gratitude of Western science, he was a forerunner; and in his aptitude for inter-cultural understanding, he formed a connecting link between East and West, just as his work is a manifestation of their underlying unity and fraternity. ■

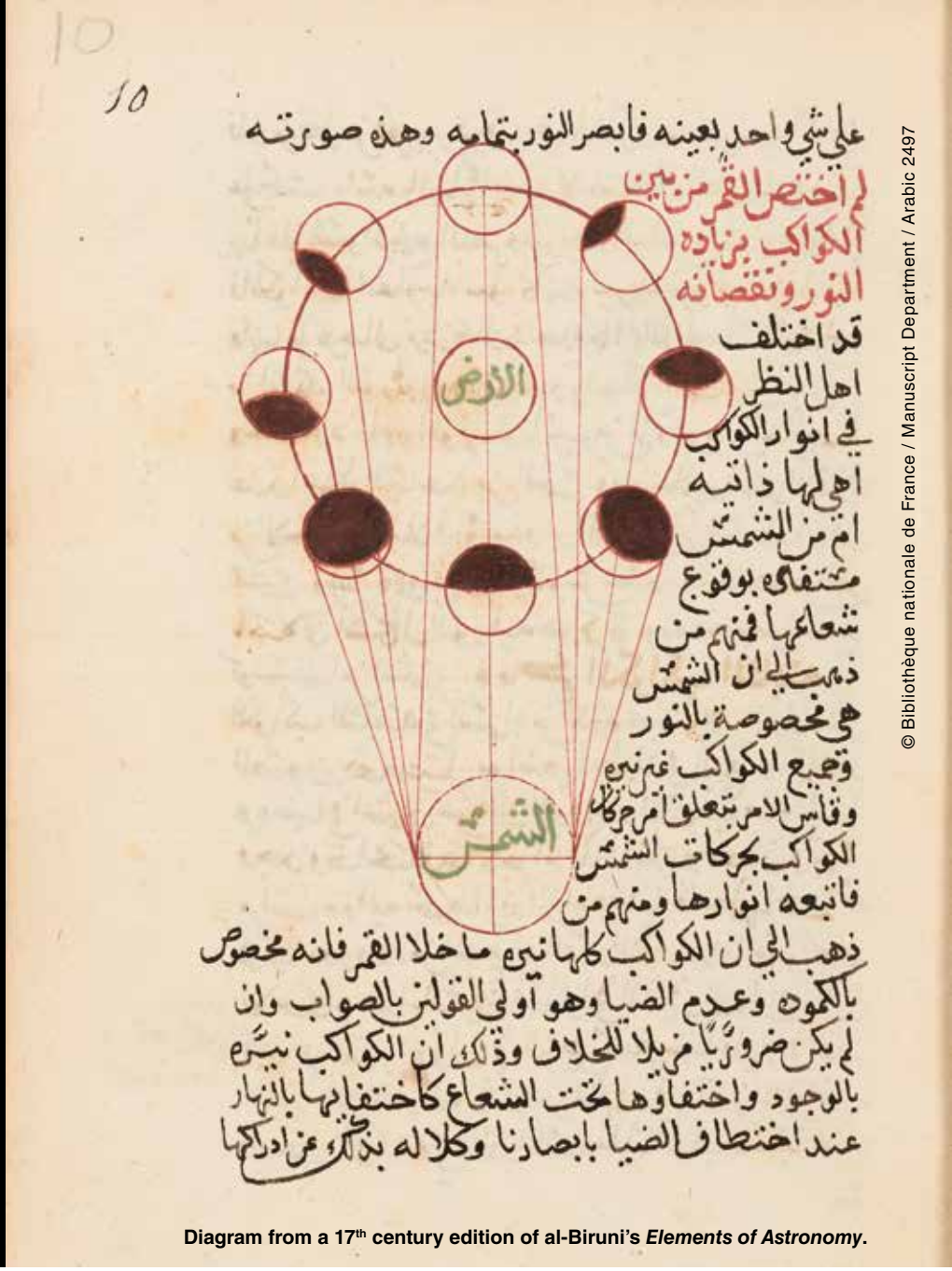
Jacques Boilot

A pioneer of scientific observation

by Mohammed Salim-Atchekzai

MOHAMMED SALIM-ATCHEKZAI, *of Afghanistan, is professor of Afghan language and literature at the New Sorbonne University, Paris. Mr. Salim-Atchekzal has made a special study of Afghan civilization and culture.*

1. The earth and the heavens measured with amazing precision
2. Al-Biruni's book on India : an unprecedented effort to understand a people and their culture



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Diagram from a 17th century edition of al-Biruni's *Elements of Astronomy*.

AFTER the dismemberment of the Empire of Charlemagne, the Christian West was at a low ebb. The tenth century was a sombre period when conditions favoured neither the growth of great political empire-building movements nor the dissemination of philosophical ideas.

In the Muslim East, however, the tenth century was a time of brilliant intellectual progress. The empires of the East, linked by a vigorous faith, attracted to themselves a great number of scholars who made a unique contribution to the cultural heritage of mankind.

In the empire of the Samanids (819-1005), with its capital in Bokhara, the talents of poets such as Rudaki and Daqiqi and of scholars such as Rhazes and Avicenna, flourished, while Ghazna, the capital of the empire of the Ghaznavids (977-1186), which stretched from western India as far as Khwarizm, was the home of many poets and scholars such as 'Unsuri and Firdausi, the author of the *Book of Kings*, epic masterpiece of Persian literature.

Al-Biruni was one of the many scholars and philosophers who were drawn to the court of Sultan Mahmud (998-1030) in Ghazna, where he was employed as the court astronomer. This mixture of astrology and astronomy was not, however, enough to satisfy the thirst for knowledge of a man with such an enquiring mind.

Al-Biruni's works, both before and after his arrival in Ghazna, show him to have been a man of many and varied interests. He carried out research in almost all the subjects known at that time. Among the pure sciences, astronomy was naturally the pivotal point around which all his other interests revolved.

The extent of his knowledge, particularly in astronomy, may be judged from two main works: the *Mas'udic Canon* and the *Kitab al-Tafhim* (a book of instructions on the elements of the science of astrology).

The *Mas'udic Canon* is an almost complete encyclopedia of astronomy and of the related sciences. It consists of 11 volumes dealing simultaneously with cosmology, chronology, geography and mathematics as well as astronomy. Avicenna's *Canon of Medicine* is justly famous, but the sheer scale and the intrinsic value of the *Mas'udic Canon* place it in the same category.

In compiling the works of his predecessors, al-Biruni corrected many of their mistakes, both theoretical and experimental. He never made a formal break with the geocentric system which was universally accepted in the Middle Ages. He was, however, aware of the existence of the heliocentric system from the works of Greek astronomers like Asistarchus of Samos, and also from the teachings of certain sages whom he had met in India.

CONTINUED NEXT PAGE

Al-Biruni hesitated for many years between the two systems and in fact remained undecided until his death; it is important to stress, however, that he always maintained that there was absolutely no contradiction between the heliocentric hypothesis and the laws of astronomy. As he himself said:

"I have seen the astrolabe called Zuraqi invented by Abu Sa'id Sijzi. I liked it very much and praised him a great deal, as it is based on the idea entertained by some to the effect that the motion we see is due to the Earth's movement and not to that of the sky. By my life, it is a problem difficult of solution and refutation . . . For it is the same whether you take it that the Earth is in motion or the sky. For, in both cases, it does not affect the Astronomical Science. It is just for the physicist to see if it is possible to refute it."

Al-Biruni was thoroughly familiar with the astronomical works of Ptolemy and other Greek astronomers. In geometry, his work is based on that of Euclid and of Archimedes and Theon (4th century A.D.), but he was also acquainted with the work of the great Indian astronomer Brahmagupta (6th to 7th centuries A.D.) and the astronomical works of the Indian, Tabahafara (7th century A.D.).

In his book on India, al-Biruni quotes a passage from Brahmagupta's book concerning the rotation of the earth:

"The followers of Aryabhata maintain that the earth is moving and heaven resting. People have tried to refute them by saying that, if such were the case, stones and trees would fall from the earth."

But, says al-Biruni: "Brahmagupta does not agree with them, and says that that would not necessarily follow from their theory, apparently because he thought that all heavy things are attracted towards the centre of the earth…

"Besides, the rotation of the earth does in no way impair the value of astronomy, as all appearances of an astronomic character can quite as well be explained according to this theory as to the other. There are, however, other reasons which make it impossible. This question is most difficult to solve. The most prominent of both modern and ancient astronomers have deeply studied the question of the moving of the earth, and tried to refute it. We, too, have composed a book on the subject called *Miftah-ilm-alhai'a* (Key to Astronomy), in which we think we have surpassed our predecessors, if not in the words, at all events in the matter."

In his measurements of the circumference of the earth, he was only 110 km out by comparison with modern measurements. He studied the sun during the eclipse and ways of measuring the illuminated parts of the moon. He described the various phases of the dawn and the dusk and carried out observations of the new moon. He studied the astronomy of the stars. He classified the celestial bodies (planets and fixed stars) by order of magnitude (in fact by their luminosity). He noted stars' positions and observed their apparent motion around the poles. His list included 1,029 stars.

He learned about trigonometry from India, and was the first to establish it as a science distinct from that of astronomy.

He was the first geometrician to use the radius of the circle as unity, an idea which immensely simplified calculations. He wrote the best medieval account of the arithmetical systems used in India and on methods of extracting the cube root.

Al-Biruni compiled a table of the latitudes and longitudes of the 600 most important towns and localities in the Islamic world; this enabled him to determine with scientific accuracy the direction of Mecca, to which Muslims turn to pray. When constructing mosques, builders could thus place the mihrabs (semicircular niches in the wall indicating the direction of Mecca) correctly.

For the purposes of cartography, he invented a special system of stereographic projection, remarkably simple to use, whereby the part of the globe to be represented is projected on the great circle of which the point of vision is the pole.

Al-Biruni was severely critical of astrologers and their unscientific approach to their work. Thus it was that he came to write a treatise which he called *A Warning Against the Art of False Predictions by the Stars*. In the *Mas'udic Canon*, he denounced the alleged "secrets" of astrologers' predictions, pointing out that, although they were supposed to be dictated by the influence of the celestial bodies on human lives, one prediction often contradicted another.

He was also a geologist and observed the stratified structure of the rocks, noting that:

"We have to rely upon the records of the rocks and vestiges of the past to infer that all these changes should have taken place very long ago and under unknown conditions of cold and heat: for even now it takes a long time for water and wind to do their work. And changes have been going on and observed and noticed within historical times."

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REMPARTS OF GHAZNI

Part of the remains of the fortifications of ancient Ghazna (today Ghazni), in Afghanistan. It was here that al-Biruni spent many years at the court of the Ghaznavid emperors.

The Courier

AL-BIRUNI



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A series of stamps created to commemorate the 1050th anniversary of the birth of Abu Rayhon Beruniy, issued by the *UzPost* in 2023.

MINIATURE ANTHOLOGY

Selections from works by al-Biruni including many translated into English for the first time

Al-Biruni is believed to have written at least 150 works (180 according to some authorities) by the time of his death about 1050 A.D. The actual number is uncertain since roughly four-fifths of his writings have vanished. Al-Biruni himself recorded 113 titles in a bibliography he prepared in 1036 when he was 63 years of age. In this special supplement, the "Unesco Courier" presents passages from the writings of al-Biruni, including many translated into English for the first time. Those we present here have been chosen not only to show the originality and encyclopaedic scope of his thinking, but in particular his narrative talents and the scientific approach he made to every subject. Highly technical and scientific material has naturally been excluded. The passages published are taken from: *Alberuni's India* (translated by Edward C. Sachau, 2 volumes, London, 1888); *The Chronology of Ancient Nations* (translated by Edward C. Sachau, London, 1879); *Al-Biruni's Book on Pharmacy and Materia Medica* (translated by Hakim Mohammed Said, Karachi, 1973); *The Determination of the Co-ordinates of Cities* (Geodesy); *The Mas'udic Canon on Astronomy; Gems*, and *Bibliography of the Works of al-Razi.*

INTELLIGENCE AND REASONING

Some believe that science is of recent origin, others that it is as old as the world. The former affirm that its techniques were taught by "initiation" and go so far as to maintain that every technique was revealed and implanted by a particular prophet. But there are others who think that man discovers techniques with the help of intelligence and that it is reasoning which enables the mind to acquire understanding…

When one discovers, by reasoning, a law or principle, one must proceed from the general to the particular. At the same time, experiment and reflection allow us to compare one thing with another and so obtain knowledge in detail...

Time is limitless and successive generations traverse only stages. Each passes on its heritage to the next, which develops and enriches it. That is the true metempsychosis, not the soul, which simply passes from one body to another.

— Bibliography of the Works of al-Razi

ANTIQUITY'S SUEZ CANAL

When the Persian kings conquered Egypt they tried to cut a canal through the isthmus to link the two seas [the Red Sea and the Mediterranean]. Seagoing vessels would thus have been able to sail direct from west to east. The first king to dream of such a canal was Sesostris, whose idea was taken up by Darius. A waterway of considerable width was dug, of which traces can be seen to this day. The waters of the Red Sea flowed in at high tide and receded when the tide was low. However, when the level of the Red Sea was measured, the project was abandoned, for the Red Sea is higher than the Nile of Egypt and it was feared that its waters would engulf that river. During the reign of Ptolemy III, Archimedes completed the unfinished work without causing the slightest mishap. A Roman king blocked the canal, however, in order to bar the way to the Persians who threatened to invade Egypt.

— The Determination of the Co-ordinates of Cities (Geodesy)

SCUBA DIVING IN 1000 A.D.

Someone from Bagdad has told me that pearl divers have recently discovered a method for overcoming the problem of breathing under water. They are thus able to dive from morning till evening, for as long as they like... The device is a leather sack which the diver passes over his head and which extends to just below his chest. He attaches it very firmly just beneath the lower ribs then he dives and breathes the air contained in the bag. But a heavy weight is needed to draw the diver, with his air supply, towards the bottom and to keep him down. It would be more advantageous to fix to the upper part of the device a leather tube shaped like a sleeve, the seams of which are hermetically sealed by wax and tar. The length of the tube should correspond to the depth of water in which the diver has to work. The upper end of the tube should be fixed into a large vessel through an opening pierced in the bottom. One or more bladders attached to the vessel would keep it afloat. Breathing air in and out through the tube, the diver could then stay under water as long as he wished, even through the entire day.

—Gems



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THE NATURE OF GOD

…Some Hindu scholar calls God a point, meaning to say thereby that the qualities of bodies do not apply to him. Now some uneducated man reads this and imagines that God is as small as a point, and he does not find out what the word point in this sentence was really intended to express. He will not even stop with this offensive comparison, but will describe God as much larger, and will say "He is twelve fingers long and ten fingers broad." Praise be to God, who is far above measure and number! Further, if an uneducated man hears what we have mentioned, that God comprehends the universe so that nothing is concealed from him, he will at once imagine that this comprehending is effected by means of eyesight; that eyesight is only possible by means of an eye, and that two eyes are better than only one; and in consequence he will describe God as having a thousand eyes, meaning to describe his omniscience.

—Alberuni's India

THE ENCOMPASSING OCEANS

The northern regions are uninhabited because of the cold and the snow, but we find that the shores of the sea, called the Sea of the Varangians (Baltic Sea), which leads off the Encircling Sea to the north of the lands of the Slavs (1), are inhabited.

These folk live on the shores of the sea in localities parallel with regions which are beset by cold and snow, yet the cold in those places, though severe, is not so extreme.

Furthermore, there are among these folk fishermen and hunters who put far out to sea during the summer days and, following the Azimuth of the North Pole, reach places where the Sun at the summer solstice never descends below the horizon; observing this with their own eyes, they then boast among their kindred that they have been in places where there is no night at all.

As concerns the impossibility of the inhabited regions continuing uninterruptedly to east and west, there is no excess of heat or cold to prevent this, but habitability comes to an end because the dry land emerged from the oneness of the waters by the will of God as well as from natural causes. The dry land must therefore be a separate part without continuation and it must be bounded by the encompassing waters. Hence it must have boundaries both to the east and to the west.

The sea which lies to the south of the dry land I assume to be a sea leading out of the encircling sea to the East of China, stretching along the Equator parallel to China, then to India and to Persia, and then to the land of the Arabs, and ending in a gulf of the Sea of Kulzum [Red Sea]. In every place it is called by the name of the country off whose shores it passes.

Similarly, the sea which runs out of the Encircling Sea to the west of Zinj by the headland known as Rasun (2), stretches southward from the Equator parallel to the land of the Negroes and the Sofala of the Zinj (3).

Both these regions are located beneath the zenith of the Sun, Moon and Stars, for which reason their climate is mild and their waters are easily navigable.

As concerns the Encircling Ocean to the West [Atlantic Ocean], it is an enormous mass of water, but there are many shoals and shallows in it where the water becomes viscous, like a mud

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(1) Slavs who settled on the shores of the Baltic—the Pomeranians and the Novgorodian Slovenes.

(2) A name not found in other sources, it may refer to the Cape (Ras) Khafun, the extreme eastern tip of Africa.

(3) "Ethiopians"—East African Negroes.





Left, map of the world, from a treatise by al-Biruni on astronomy, drawn in Tashkent. The north is at the bottom. Below, the same map reversed with the north at the top to facilitate identification of different regions : 1. Caspian Sea, 2. China, 3. India, 4. Persian Gulf, 5. Red Sea, 6. Black Sea, 7. Mediterranean, 8. Egypt, 9. Morocco, 10. Andalusia, 11. Baltic Sea, 12. The "Encircling Ocean".

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spring, so that navigation is difficult and its paths are unknown. It was for this reason that the great Hercules set his signs and pillars opposite Andalus, so that sailors might be deterred from the ambition of sailing beyond them. The place where they were set up was then probably dry land which has since been covered by the waters.

A worthy traveller recounts in a message to Khamza ibn al-Hasan al-Isfahani (1) the wonders which he saw in the West. He recalls having sailed through a narrow strait, the strait [Straits of Gibraltar] connecting the Syrian Sea [Mediterranean] with the Encircling Sea. The shores were visible both on the side of Andalus and on the side of Tangier and Further Sus (2). He looked into the waters of the Strait and saw in its depths a mighty bridge of rock, and one of those present affirmed that it had been built by Alexander. But the Andalusians exclaimed: "The devil take your Alexander! Could he have taken the land of the Andalusians to build this? This was built of old by Hercules!"

I believe that "Hercules' crossing" mentioned in Ptolemy's "Geography" is nothing other than this bridge. It was undoubtedly once above water, but the water then rose up and covered it.

As concerns the Encircling Sea to the East [Pacific Ocean] it is often shrouded in darkness and is a place of frequent calms, where navigation is most dangerous.

(1) Famous 10th century historian and philologist.

(2) As-Sus al-Aqsa, medieval name of part of Morocco.

★

It is believed that these two seas, the one to the West and the one to the East of the dry land [the Atlantic and Pacific Oceans] are not joined together. But those who have sailed these seas and have suffered shipwrecks because of the storms recount things which lead us to believe that they may be joined. Recent evidence has furthermore strengthened these suppositions and indeed given them the character of truth. Ship's timbers have been found bound together in the Encircling Sea near its confluence with the Syrian Sea. But it is only in the Indian Sea that timbers are lashed together in this way (because of the many magnetic stones which are there and are a danger to shipping) and not in the Western Sea, where the ships' timbers are not lashed together but fastened with iron nails. The presence of these timbers in the Western Sea is proof that they arrived there by some waterway connecting it to the Indian Sea. This could not have happened by way of the Sea of Kulzum for between it and the Syrian Sea there lies an isthmus.

Nor is it easy to envisage a junction between the two by way of the sea which lies to the north. In such a case, the timbers, after being broken up in the Indian Sea, would have had to drift out of it through an eastern strait linking the seas (3) and would then have had to drift around those parts lying to the north beneath the zenith of the Polar Star or through the other northern quarters of the Earth lying opposite the dry land.

This cannot be what happened. Especially when it is considered that those who speak of the joining of the seas point out that the level of the eastern waters is higher than that of the western waters, just as it was discovered when the land was being surveyed that the waters of the Sea of Kulzum are higher than those which run into the Syrian Sea. The conclusion must be that the seas are linked to the south of the dry land.

—The Determination of the Co-ordinates of Cities (Geodesy)

(3) Al-Biruni may have known or conjectured about the existence of the Behring Straits.

SMART SCHOLARS

Once a sage was asked why scholars always flock to the doors of the rich, whilst the rich are not inclined to call at the doors of scholars. "The scholars," he answered, "are well aware of the use of money, but the rich are ignorant of the nobility of science."

—Alberuni's India

'SPEAK THE TRUTH'

That man only is praiseworthy who shrinks from a lie and always adheres to the truth, enjoying credit even among liars, not to mention others.

It has been said in the Koran, "Speak the truth, even if it were against yourselves" (Sûra, 4, 135); and the Messiah expresses himself in the Gospel to this

effect: "Do not mind the fury of kings in speaking the truth before them. They only possess your body, but they have no power over your soul." In these words the Messiah orders us to exercise moral courage.

—Alberuni's India

POWER OF MOONLIGHT

That the moon has certain effects on moist substances, that they are apparently subject to her influences, that, for instance, increase and decrease in ebb and flow develop periodically and parallel with the moon's phases, all this is well known to the inhabitants of seashores and seafaring people.

Likewise physicians are well aware that she affects the *humores* of sick people, and that the fever-days revolve parallel with the moon's course. Physical scholars know that the life of animals and plants depends upon the moon, and experimentalists know that she influences marrow and brain, eggs and the sediments of wine in casks and jugs, that she excites the minds of people who sleep in full moonlight, and that moonlight affects linen clothes which are exposed to it.

Peasants know how the moon acts upon fields of cucumbers, melons, cotton, etc., and even make the times for the various kinds of sowing, planting, and grafting, and for the covering of the cattle depend upon the course of the moon. Lastly, astronomers know that meteorologic occurrences depend upon the various phases through which the moon passes in her revolutions.

—Alberuni's India

DIAMONDS AND THE EAGLE

Many strange and unlikely tales are told about diamond mines and the way these precious stones are obtained. It is said for example that the diamond is called the eagle's stone. The origin of this name is that diamond prospectors are said to cover the nest in which eaglets are lying with a piece of glass. The eagle can see its young but, unable to reach them, it goes in search of diamonds, which it places on top of the glass. When a goodly number have been deposited, the prospectors purloin them, then remove the glass, so deceiving the eagle into believing that it has regained its young thanks to fetching the diamonds. The glass is then replaced, and the eagle flies off in search of more gems.

—Gems

THE GREAT ART OF THE HINDUS

In every place to which some particular holiness is ascribed, the Hindus construct ponds intended for the ablutions. In this they have attained to a very high degree of art, so that our people (the Muslims), when they see them, wonder at them, and are unable to describe them, much less to construct anything like them. The Hindus build them of great stones of an enormous bulk, joined to each other by sharp and strong cramp-irons, in the form of steps (or terraces) like so many ledges; and these terraces run all around the pond, reaching to a height of more than a man's stature. On the surface of the stones between two terraces they construct staircases rising like pinnacles. Thus the first steps or terraces are like roads (leading round the pond) and the pinnacles are steps (leading up and down). If ever so many people descend to the pond whilst others ascend, they do not meet each other, and the road is never blocked up, because there are so many terraces, and the ascending person can always turn aside to another terrace than that on which the descending people go. By this arrangement all troublesome thronging is avoided.



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Al-Biruni related the story of the eagle which collected diamonds. Many similar legends describing how precious gems were obtained in this way flourished in the East. A number were recorded in the "Thousand and One Nights", and so reached the West, where they inspired engravings such as this, which appeared in *Hortus Sanitatis*, published at Mainz, Germany, in 1491.

—Alberuni's India

THE PROPERTIES OF CHINESE TEA

It is said that *chah* is a Chinese word and is meant for a herb which grows at high altitudes there. It also grows in Katha and Nepal. Several varieties of it are distinguished on the basis of its colour: some are white, while the others are green, violet, grey and black.

White tea is the most excellent variety of the herb; its leaf is slender and fragrant, and exerts its effect on the body comparatively more swiftly than all the other varieties. It is rare and not easily available, followed with regard to availability by the green, violet, grey and black varieties.

The people (of China and Tibet) cook it, and preserve it in a cube-shaped vessel after desiccating it. Tea has the characteristics of water but is especially beneficial in overcoming the influence of tippling. For this reason it is taken to Tibet where people habitually quaff considerable quantities of wine, and there is no better medicine for negating the effect of liquor than this herb. Those who transport it to Tibet accept nothing in barter but musk.

In the book, *Akhbar al-Sin* it has been stated that thirty bags of tea cost a *dirham*, and its taste is sweet coupled with sourness. On boiling, however, the sourness disappears.

The people (of China and Tibet) drink it. It is said that they drink it with hot water and believe it to be a cholagogue [promoting the flow of bile] and blood purifier. A person who travelled to the place of its occurrence in China has stated that the king of that country resides in the city of Yanju. A big river like the Tigris traverses this city. Both sides of the river are studded with wine sellers' tenements, kilns and shops. People flock there to drink tea, and do not take Indian cannabis clandestinely. The king of the place receives the capitation tax, and the public cannot transact the sale of tea, since both tea and wine are in the possession of the king. He who transacts business in salt and tea without the king being aware of it is awarded the punishment due to a thief.

Profits from such places go to the coffers of the king and such profits equal those accruing from gold and silver mines. Some physicians have mentioned in their pharmacopoeia that tea is the plant produced in China. The people of that country

make tablets from it and take them to foreign lands.

These pharmacopoeia also describe the origin of tea. A Chinese king became displeased with one of his courtiers whom he exiled from the city in the direction of the mountains. The courtier was seized by a fever, and one day he trudged, in a desperate state, towards the mountain valleys. He was being gnawed by hunger, and he saw only tea plants, whose leaves he ate. After a few days, his fever began to abate. He continued eating tea leaves till he recovered completely.

Another courtier happened to pass that way. He saw the courtier who had made this remarkable recovery, and informed the king about it. The king was surprised and he recalled the exiled courtier and enquired from him the reason for his recovery. The courtier then narrated the remarkable medicinal properties of tea.

The king thereupon ordered that tea should be tested, and his physicians enumerated its advantages to him. They also began to incorporate tea in medicines.

—Book on Pharmacy and Materia Medica

THE LODESTONE

Like amber, the lodestone has the property of attraction. But it renders greater service, because it can draw a blade from a wound, the point of a lancet from a vein or a metal ring swallowed and lying in the stomach. According to Dioscorides, the best lodestones are the colour of lapis lazuli. When burnt, the lodestone becomes red ironstone. Yet, we have never seen this stone and no one has described it to us. In an anonymous work, it is said that the best lodestone is a reddish black, followed by lodestone the colour of fire. Some say that the most sought after lodestone is more plentiful in the Zabtara region, on the eastern confines of the Roman Empire, than anywhere else on earth.

It is said also that the hulls of ships built for crossing the Arabian Gulf are bound with palm fibres threaded through holes drilled in the planks, while the boards of ships sailing on the Mediterranean are secured with iron nails. The avoidance of nails in the former case is explained by the presence of hidden lodestone reefs in the Gulf, which could constitute a grave danger for ships built with iron fixings. This is a far-fetched argument, however, because the ships that cross the Arabian Gulf cannot dispense with anchors and are always laden with iron implements, notably weapon blades from India.

—Gems

WHY THE EARTH IS ROUND

As concerns the curvature of the Earth in the directions between longitude and latitude, it may be ascertained by means of the longest days in the towns we have mentioned. Let us consider, for instance, the town of Bulgar, in the far north, and the town of Aden, lying far to the south of it. In and around Aden, the length of the longest day is little more than twelve hours, whilst in Bulgar it is little less than seventeen hours. There is a difference of two hours between the hours of sunrise and sunset in those two towns. Consequently, at the time of sunrise over Aden, the Sun has already risen to a height of two hours' travel in the sky over Bulgar.



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15th Century engraving showing the foundering of a ship on rocks. From *Hortus Sanitatis*, Mainz, Germany, 1491.

Thus, in summer, an observer in Bulgar looking in the direction of the sunrise or sunset sees a part of the sky corresponding to that magnitude, whilst the same part of the sky is not visible in Aden, being situated in a circle beneath the very Pole. Similarly, a part of the sky of similar magnitude is visible at sunrise and sunset in winter, when it is not visible in Bulgar.

This being the case, we may assert that a line traced on the Earth in the direction of latitude, that is to say a meridian, must of necessity be either straight, or a concave or convex curve.

As regards the probability of its being a straight line... the facts themselves refute such a hypothesis, so that the surface of the Earth cannot be flat in this direction. As to the meridian being concave, if it were, the height of the Pole, that is to say the number of stars permanently visible in the far south, would diminish as the observer moved northwards, becoming fewer and fewer the further north he went. In fact, the opposite occurs, the number of such stars becoming greater, which implies the convexity of the meridian and hence the curvature of the Earth. Thus the Earth is round in this direction too, and if the same is true both in the directions of latitude and longitude, then the Earth's surface must be spherical.

Moreover, mountains, however high they may be, do not alter this shape, since they are small in comparison with the whole and are mere wrinkles which detract from the smoothness of its surface but not from the roundness of the whole.

If the observer still harbours certain doubts and thinks that this curvature is characteristic only of the inhabited parts of the Earth but not its other parts... let us turn for confirmation to another argument, the Earth's shadow... If an object is round, its shadow is round, if it is triangular its shadow is triangular, if square then square, if oblong oblong, and so forth with other shapes.

When we observe an object casting a shadow upon the Moon, we see that its edges are rounded, especially near the fullest point of the eclipse when we may see most of the circumference of the object casting the shadow and the roundness of the object, thus concluding that the intersection of the part of the Earth illuminated by the Sun and the part casting the shadow is a circle... Since such intersections are numerous, corresponding in number to the number of observations and since they concern different parts of the Earth, yet all have this in common, that they all throw a rounded shadow upon the Moon, there can be no doubt as to the shape of the Earth, which is indeed confirmed to be rounded on all sides.

—The Mas'udic Canon on Astronomy

THE CAPRICIOUS TURQUOISE

We have ceased to prize the turquoise since it changes rapidly with changes in the skies, as they clear or are covered with cloud, and also with the caprice of the wind. Further, perfumes diminish the brilliance of the turquoise, toilet water attacks its lustre and unguents dull it completely. For these reasons the turquoise does not rank as a precious stone. It Is thought to come from a "mud which has petrified". It may be polished with grease or the fatty tail of the sheep.

That is why it flashes with a brilliant fire in the hands of a butcher, particularly one who has flayed an animal's skin, while grasping it with his hand.

—Gems

INDIA WAS ONCE A SEA

…If you have seen the soil of India with your own eyes and meditate on its nature—if you consider the rounded stones found in the earth however deeply you dig, stones that are huge near the mountains and where the rivers have a violent current; stones that are of smaller size at greater distance from the mountains, and where the streams flow more slowly; stones that appear pulverized in the form of sand where the streams begin to stagnate near their mouths and near the sea—if you consider all this, you can scarcely help thinking that India has once been a sea which by degrees has been filled up by the alluvium of the streams.

—Alberuni's India

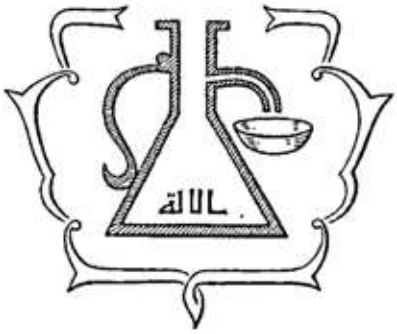
WITCHCRAFT AND SCIENCE

We understand by witchcraft, making by some kind of delusion a thing appear to the senses as something different from what it is in reality. Taken in this sense, it is far spread among people. Understood, however, as common people understand it, as the producing of something which is impossible, it is a thing which does not lie within the limits of reality. For as that which is impossible cannot be produced, the whole affair is nothing but a gross deception. Therefore witchcraft in this sense has nothing whatever to do with science.

One of the species of witchcraft is alchemy, though it is generally not called by this name. But if a man takes a bit of cotton and makes it appear as a bit of gold, what would you call this but a piece of witchcraft? It is quite the same as if he were to take a bit of silver and make it appear as gold, only with this difference, that the latter is a generally-known process, i.e. the gilding of silver, the former is not.

The Hindus do not pay particular attention to alchemy, but no nation is entirely free from it, and one nation has more bias for it than another, which must not be construed as proving intelligence or ignorance; for we find that many intelligent people are entirely given to alchemy, whilst ignorant people ridicule the art and its adepts. Those intelligent people, though boisterously exulting over their make-believe science, are not to be blamed for occupying themselves with alchemy, for their motive is simply excessive eagerness for acquiring fortune and for avoiding misfortune.

—Alberuni's India



Al-Biruni used a vase similar to this to calculate the specific gravity of various substances such as metals and stones. Ingeniously constructed, the vessel enabled him to ascertain the volume of water displaced by an immersed object and so determine its specific gravity with a high degree of accuracy. He put the specific gravity of gold at 19.0 (it is actually 19.3), iron at 7.92 (actually 7.9) and lapis-lazuli at 3.91 (3.90).

ON-THE-SPOT OBSERVATION

Reliance on personal observation and on-the-spot examination enhance the capacity to remember and distinguish facts and also to identify objects, not only in pharmacy but in other professions and crafts. Gathering data through direct handling and observation is a greater advantage to be encouraged over mere reading of books.

—Book on Pharmacy and Materia Medica

A HEMISPHERE 10 CUBITS IN DIAMETER

I began by correcting the distances and the names of places and towns, basing my work on what I had heard about those who had visited those places and what I could learn from the mouths of those who had seen them. I took the precaution of verifying the reliability of the material and of comparing the evidence of different witnesses.

I spared neither energy nor money in order to achieve my purpose and I constructed a hemisphere 10 cubits [5.4 metres] in diameter, on which to base the longitudes and latitudes of the places and towns as calculated from their distances, since time did not allow me to use mathematical calculations, the distances being so many and the calculations so long.

—The Determination of the Co-ordinates of Cities (Geodesy)

THE MISER & THE BOOK

"He who just collects books and prides himself on their possession is like a miser who fills his chests and locks them."

—Book on Pharmacy and Materia Medica

25 WAYS TO FREEDOM

According to the Hindu philosophers, liberation is common to all castes and to the whole human race, if their intention of obtaining it is perfect. This view is based on the saying of Vyâsa: "Learn to know the twenty-five things (i.e. the twenty-five elements of existence) thoroughly. Then you may follow whatever religion you like; you will no doubt be liberated."

—Alberuni's India

THE GEOMETRY OF FLOWERS

Among the peculiarities of the flowers there is one really astonishing fact, viz. the number of their petals, the tops of which form a circle when they begin to open, is in most cases conformable to the laws of geometry. In most cases they agree with the chords that have been found by the laws of geometry, not with conic sections.

You scarcely ever find a flower of 7 or 9 petals, for you cannot construct them according to the laws of geometry in a circle as isosceles (triangles). The number of their petals, is always 3 or 4 or 5 or 6 or 18. This is a matter of frequent occurrence. Possibly one may find one day some species of flowers with 7 or 9 petals, or one may find among the species hitherto known such a number of petals; but, on the whole, one must say nature preserves its genera and species such as they are.

For if you would, for example, count the number of seeds of one of the (many) pomegranates of a tree, you would find that all the other pomegranates contain the same number of seeds as that one the seeds of which you have counted first. So, too, nature proceeds in all other matters.

Frequently, however, you find in the functions (actions) of nature which it is her office to fulfil, some fault (some irregularity) …I, however, do not call them "faults of nature", but rather a superfluity of material beyond the due proportions of the measure of everything. To this category belong, for example, animals with supernumerary limbs, which occur sometimes, when nature, whose task it is to preserve the species as they are, finds some superfluous substance, which she forms

into some shape instead of throwing it away.

—Chronology of Ancient Nations

AN AGE OF IMITATORS

The most important requirement of medicine is that the man of medicine should examine the terms of reference as regards natural science and should be fully acquainted with the natural laws. When he comes to the resolution of the ingredients of a drug every medicinal ingredient is arrayed in a different aspect before him and each one has properties that argue differently. This is what the art of pharmacy should achieve, but alas! ours is an age of blind imitation, and people mostly go by hearsay. Only he who sedulously learns from the masters the fundamentals of the art and follows their directions can ever hope to achieve mastery.

—Book on Pharmacy and Materia Medica



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In his treatise on precious stones, al-Biruni wrote, "I used to have a disc of onyx, on which wavy lines formed the perfect figure of a duck, the legs being invisible as if it was swimming or sitting on its eggs; the representation was faultless, as if done by a skilful artist". The onyx featured here is from the private collection of the French intellectual and author Roger Caillois.

LAWS OF NATURE

…The bees kill those of their kind who only eat, but do not work in their beehive.

Nature proceeds in a similar way; however, it does not distinguish, for its action is under all circumstances one and the same. It allows the leaves and fruit of the trees to perish, thus preventing them from realizing that result which they are intended to produce in the economy of nature. It removes them so as make room for others.

If thus the earth is ruined, or is near to be ruined, by having too many inhabitants, its ruler—for it has a ruler, and his all-embracing care is apparent in every single particle of it—sends it a messenger for the purpose of reducing the too great number and of cutting away all that is evil.

—Alberuni's India

THE NATURE OF TIME

Some people maintain that time consists of cycles, at the end of which all created beings perish, whilst they grow at their beginning; that each such cycle has a special Adam and Eve of its own, and that the chronology of this cycle depends upon them. Other people, again, maintain that in each cycle a special Adam and Eve exist for each country in particular, and that hence the difference of human structure, nature, and language is to be derived.

Other people, besides, hold this foolish persuasion, viz that time has no *terminus a quo* at all.

Now, personal observation alone, and conclusions inferred therefrom, do not prove a long duration of the human life, and the huge size of human bodies, and what else has been related to be beyond the limits of possibility. For similar matters appear in the course of time in manifold shapes. There are certain things which are bound to certain times, within which they turn round in a certain order, and which undergo transformations as long as there is a possibility of their existing. If they, now, are not observed as long as they are in existence, people think them to be improbable, and hasten to reject them as altogether impossible.

This applies to all cyclical occurrences, such as the mutual impregnation of animals and trees, and the forthcoming of the seeds and their fruits. For, if it were possible that men did not know these occurrences, and then were led to a tree, stripped of its leaves, and were told what occurs to the tree of getting green, of producing blossoms and fruits, etc., they would certainly think it improbable, till they saw it with their own eyes. It is for the same reason that people, who come from northern countries, are filled with admiration when they see palm-trees, olive-trees, and myrtle-trees, and others standing in full-bloom at wintertime, since they never saw anything like it in their own country.

Further, there are other things occurring at times in which no cyclical order is apparent, and which seem to happen at random. If, then, the time in which the thing occurred has gone by, nothing remains of it except the report about it. And if you find in such a report all the conditions of authenticity, and if the thing might have already occurred before that time, you must accept it, though you have no idea of the nature nor of the cause of the matter in question.

—Chronology of Ancient Nations

PARABLE OF THE FOUR PUPILS

A man is travelling together with his pupils for some business or other towards the end of the night. There appears something standing erect before them on the road, the nature of which it is impossible to recognize on account of the darkness of night. The man turns towards his pupils, and asks them, one after the other, what it is. The first says: "I do not know what it is." The second says: "I do not know, and I have no means of learning what it is." The third says "It is useless to examine what it is, for the rising of the day will reveal it. If it is something terrible, it will disappear at daybreak; if it is something else, the nature of the thing will anyhow be clear to us." Now, none of them had attained to knowledge, the first, because he was ignorant; the second, because he was incapable, and had no means of knowing; the third, because he was indolent and acquiesced in his ignorance.

The fourth pupil, however, did not give an answer. He stood still, and then he went on in the direction of the object. On coming near, he found that it was pumpkins on which there lay a tangled mass of something. Now he knew that a living man, endowed with free will, does not stand still in his place until such a tangled mass is formed on his head, and he recognized at once that it was a lifeless object standing erect. Further, he could not be sure if it was not a hidden place for some dunghill. So he went quite close to it, struck against it with his foot till it fell to the ground. Thus all doubt having been removed, he returned to his master and gave him the exact account.

—Alberuni's India

SOLAR AND LUNAR YEARS

...People distinguish two kinds of years—the Solar year and the Lunar year. They have not used other stars for the purpose of deriving years from them, because their motions are comparatively hidden, and can hardly ever be found out by eyesight; but only by astronomical observations and experiments...

The Solar Year. According to the statement of Theon (1), in his Canon, the people of Constantinople, and of Alexandria, and the other Greeks, the Syrians and Chaldaeans, the Egyptians of our time... all use the solar year, which consists of nearly 365 ¼ days. They

(1) Fourth century Greek astronomer.

reckon their year as 365 days, and add the quarters of a day in every fourth year as one complete day... This year they call an intercalary year, because the quarters are intercalated therein. The ancient Egyptians followed the same practice, but with this difference, that they neglected the quarters of a day till they had summed up to the number of days of one complete year, which took place in 1,460 years; then they intercalated one year.

The Persians followed the same rule as long as their empire lasted; but they treated it differently. For they reckoned their year as 365 days, and neglected the following fractions until the day-quarters had summed up in the course of 120 years to the number of days of one complete month and until the fifth parts of an hour, which, according to their opinion, follow the fourth parts of a day (i.e. they give the solar year the length of 365 ¼ days and 1/5 hour), had summed up to one day; then they added the complete month to the year in each 116th year.

The Luni-Solar Year. The Hebrews, Jews, and all the Israelites, the Sâbians, and Harrânians, used an intermediate system. They derived their year from the revolution of the sun, and its months from the revolution of the moon—with this view, that their feast and fast days might be regulated by lunar computation, and at the same time keep their places within the year. Therefore they intercalated 7 months in 19 lunar years.

—Chronology of Ancient Nations

ON HINDU RELIGIONS

Everything which exists on this subject [the religions of the Hindus] in our literature is second-hand information which one has copied from the other, a farrago of materials never sifted by the sieve of critical examination.

...I have written this book on the doctrines of the Hindus, never making any unfounded imputations against those, our religious antagonists, and at the same time not considering it inconsistent with my duties as a Muslim to quote their own words at full length when I thought they would contribute to elucidate a subject. If the contents of these quotations happen to be utterly heathenish, and the followers of the truth, i.e. the Muslims, find them objectionable, we can only say that such is the belief of the Hindus, and that they themselves are best qualified to defend it.

—Alberuni's India

THE WEAK FOUNDATIONS OF ASTROLOGY

The art of astrology in general is built upon weak foundations and its deductions are insubstantial. Its calculations are confused and it is mostly supposition rather than reliable knowledge. The subject matter of astrology consists of the various configurations of heavenly bodies which are themselves contingent on the chosen points on the heavenly sphere itself or on a certain relationship between that and the horizon. Astrology therefore can never produce positive results since its very basis is unreliable.

How indeed could it be reliable, when the exact location of the object for which the calculations are made and for which the future is foretold by means of horoscopes of "conjunctions" and "oppositions" is unknown and when the actual positions of these configurations conflict with those which are used!

—The Determination of the Co-ordinates of Cities (Geodesy)

ON LEARNING

Learning is the fruit of repetition.

—Alberuni's India

THE PERFUMER'S ART

Dari was a port in the old days where scents and perfumes were unloaded and therefrom perfumers went from one city to another selling them, or bought by the people of the Quraysh tribe. The Quraysh possessed a masterly expertise in this art. It Is because of this that the Arabs call apothecaries Dari. In the hadith the Holy Prophet (peace be on Him) said: "The example of a noble and sincere person is like that of a Dari whose perfumes, even if he does not give any of them to you, will all the same have their pleasant smell; and a bad companion is like an ironsmith who, even though he may not singe you with the sparks of his furnace will at least harass you with its smoke."

—Book on Pharmacy and Materia Medica

THE DESALTING OF WATER

People say that on the 6th [of January] there is an hour during which all salt water of the earth becomes sweet. All the qualities occurring in the water depend exclusively upon the nature of that soil by which the water is enclosed, if it be standing, or over which the water flows, if it be running. Those qualities are of a stable nature, not to be altered except by a process of transformation from degree to degree by means of certain media. Therefore this statement of the waters becoming sweet in this one hour is entirely unfounded.

Continual and leisurely experimentation will show to any one the futility of this assertion. For if the water were sweet it would remain sweet for some space of time. Nay, if you would place—in this hour or any other—in a well of salt water some pounds of pure dry wax, possibly the saltiness of the water would diminish. This has been mentioned by the experimenters, who go so far as to maintain that if you make a thin vase of wax and place it in sea water, so that the mouth of the vase emerges above the water, those drops of water which splash over into the vase become sweet.

If all salt water were mixed with so much sweet water as would overpower its nature, in that case their theory would be realized (i.e. all salt waters would become sweet). An example of this process is afforded by the lake of Tinnis, the water of which is sweet in autumn and winter in consequence of the great admixture of the water of the Nile, whilst at the other seasons it is salt, because there is very little admixture of Nile water.

—Chronology of Ancient Nations

QUALITIES OF ARABIC

All the arts of the world have been transferred to the Arabic language; it has penetrated deep into our hearts, and its charms have crossed into the innermost reaches of our being, although to every people their own language appears to be sweet, since they use it day in, day out.

When I observe my language, I find that if any art is rendered into it, it would look *de trop* and odd. On the other hand, if the same art is rendered into Arabic, it would look natural and good, even though Arabic does not happen to be my mother tongue.

—Book on Pharmacy and Materia Medica

THE RUSE OF ALEXANDER THE GREAT

Some say that the diamond was brought by the Bicornutus (Alexander the Great) from the valley of the diamonds, a valley teeming with snakes. Whoever set eyes on these reptiles would instantly perish. The Bicornutus advanced on the snakes with a mirror carried by men who were hidden behind it. When the snakes saw their reflections, they died on the spot. Yet these snakes had looked upon each other without dying and the sight of the real thing should have been more deadly than the mere reflection.

— Gems

MUSLIM ADAGE

"Your knowledge should not be like the clothes that you wear, and not likely to be washed away while you are taking your bath."

Adage quoted by al-Biruni.

—Book on Pharmacy and Materia Medica

AL-BIRUNI vs. AVICENNA IN THE BOUT OF THE CENTURY

Two geniuses aged 24 and 17 debate the nature of the universe

by Seyyed Hossein Nasr

SEYYED HOSSEIN NASR, *rector of Aryamehr University, in Teheran, is the author of a remarkable study on al-Biruni, published in his "An Introduction to Islamic Cosmological Doctrines" (Harvard University Press, 1964), in which he dealt with al-Biruni, Avicenna and Ikwan al-Safa. Professor of the History of Science and Philosophy at Aryamehr University, he has devoted another book to great Islamic scholars, "Three Muslim Sages" (Avicenna, Suhrawardi and Ibn 'Arabi) published by Harvard University Press. Last year his "Al-Biruni and Ibn Sina - Questions and Answers" was published by the High Council of Culture and Art in Teheran. Our text is abridged from the English introduction to this work.*

IN the rich tradition of Islamic intellectual history there are several instances in which leading thinkers have left in writing the exchanges of ideas and debates which they have carried out with each other on the highest intellectual level.

One of the most important is the series of *Questions and Answers* exchanged between al-Biruni and Avicenna (Ibn Sina) in which Avicenna's student Ma'sumi, also took part. This series of exchanges stands as a peak of Islamic intellectual history and a key to the understanding of an aspect of al-Biruni's thought not discussed extensively in his other writings.

The *Questions and Answers*, include ten questions pertaining to Aristotle's *De Caelo* (On the Heavens) and eight other questions posed by al-Biruni himself. These are answered by Avicenna one by one. Then al-Biruni once again responds to Avicenna's answers, discussing eight of the first ten and seven of the last eight questions. Finally Ma'sumi answers al-Biruni once again on behalf of Avicenna.

There are then altogether two sets of exchanges on some of the most fundamental points of "natural philosophy" between al-Biruni, the "independent" scientist and thinker, and Avicenna the most eminent representative of the Islamic Peripatetic (*ma-shsha'i*) school, and one of his foremost pupils, Abu Sa'id ibn Ali al-Ma'sumi.

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Beruniy and Ibn Sina **by Uzbek artist Chingiz Akhmarov, 1981.**

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Detail of a statue of al-Biruni in Laleh Park, Tehran, Iran.

Bronze statue of Avicenna, polymath and a pioneer of early modern medicine, in Dushanbe, Tajikistan.



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In one question al-Biruni criticizes the reasons given in Aristotelian natural philosophy for denying that the celestial spheres have gravity or levity. Al-Biruni does not reject the view of Aristotle but criticizes the reasons given to sustain such a view. Moreover, he attacks the Aristotelian thesis that circular motion is innate to heavenly bodies, asserting that although the heavenly bodies do move in circular motion, such a motion could be "forced" and accidental while the motion natural to these bodies could be straight.

Avicenna replies to these objections along the lines of argument presented in standard works of Aristotelian natural philosophy.

In another question al-Biruni criticizes Aristotle's over-reliance on the views of the ancients and his predecessors concerning the conditions of the heavens without relying upon his own observation. Al-Biruni gives an example of the Hindu description of mountains which he says cannot be relied upon because if one observes them today one sees that they have altered.

Avicenna reminds al-Biruni of the difference between mountains which undergo generation and corruption and the celestial bodies which do not do so. Furthermore, he accuses al-Biruni of having learned this argument from either John Philoponus, who was opposed to Aristotle because he himself was a Christian, or Mohammed ibn Zakariyya' al-Razi, who according to Avicenna should have remained content with medicine and not meddled in metaphysics, in which he had no competence.

AL-BIRUNI criticizes the Aristotelian denial of the possibility of the existence of another world completely different from the one we know, and unknown to us because it is completely veiled to our senses. He cites as illustration the fact that it is impossible for the person who is born blind to conceive of vision. In the same way there might be other worlds for the perception of which man does not have the necessary faculties. Avicenna accepts the existence of other worlds which differ from this world but defends the Aristotelian view that there cannot be another world such as this with the same elements and nature.

After these questions which are related to Aristotle's *De Caelo*, al-Biruni poses eight other questions himself related to natural philosophy.

Al-Biruni, for example, asks how vision is possible. Why can we see beneath water whereas water is an opaque body which should reflect the rays of light at its surface? Avicenna states that according to Aristotle vision results from the eye becoming affected by the "qualities" of visible colours contained in the air that is in contact with it. According to this theory the problem mentioned by al-Biruni does not arise since both water and air are transparent bodies that can transmit the colours to the sense of sight, thus making vision possible.

If there is no vacuum either inside or outside this world, al-Biruni asks, why is it that if the air within a flask is sucked out water rises up in it? Avicenna answers that this is not due to a vacuum. Rather, a certain amount of the air remaining in the flask contracts as a result of the coldness of the water causing the water to rise within the flask.

If things expand through heating and contract through cooling then why, al-Biruni asks, does a flask full of water break when the water within it freezes? Avicenna believes that it is the air which upon being cooled contracts, almost causing a vacuum to be created in the flask, and since that is not possible, causing the flask to break.

Finally, al-Biruni queries, why does ice float on water while its earthy parts are more than water and it is therefore heavier than water? Avicenna replies that upon freezing ice preserves in its internal spaces and lattices airy parts which prevent it from sinking in water.

An examination of the questions posed by al-Biruni reveals their vital significance for the history of science. In Islamic civilization the main school of natural philosophy which served as the immediate philosophical background for most Muslim scientists was the Peripatetic, itself a synthesis of the views of Aristotle, his Alexandrian commentators and certain elements of later Neoplatonism. Avicenna in his Peripatetic writings represents this main current in its most mature form.

But there was also an anti-Aristotelian current which is of much importance for an understanding of Islamic science, to which the questions of al-Biruni belong. Some of the anti-Aristotelian elements derived from schools related to the Pythagorean-Hermetic heritage of Antiquity such as the writings of Jabir ibn Hayyan and the Ikhwan al-Safa' while others issued from the logical criticism of individual philosophers and scientists such as Mohammed ibn Zakariyya' al-Razi and al-Biruni.

Al-Biruni's criticism of Peripatetic natural philosophy is one of the sharpest attacks on this dominant school. It touches upon the most difficult and thorny problems of Aristotelian physics and for that reason resembles some of the arguments against this form of physics by Renaissance and 17th century scientists in the West, although the point of view of al-Biruni is very different from that of the Western critics of Aristotle. ■

Seyyed Hossein Nasr

LOST HORIZONS IN THE LAND OF POETRY

The vanished works of a scientist turned man of letters

by Zabihollah Safa

IT is sometimes difficult to make a distinction between the "scholar" and the "man of letters" of Islamic civilization. In both the Arab and the Persian worlds, the two cornerstones of Islamic literature, it frequently happens that great scholars in the fields of philosophy, medicine, natural history or mathematics are also poets and men of letters.

In some cases they even put aside their scientific preoccupations and set about recounting or writing tales or anecdotes. Philosophers and thinkers such as Avicenna and al-Biruni, in the 11th century, and Suhrawardi In the 12th, have thus left behind them novels and stories written in Arabic or in Arabic and Persian.

Avicenna wrote two well-known philosophical novels in Arabic, which foreshadowed certain later Persian works.

Islamic scholars found a welcome source of diversion in writing poetry, and there are very few Iranian scholars who did not at some time or another apply themselves to verse in Arabic or Persian. One of the earliest among them is al-Farabi, some of whose quatrains in Persian are still extant.

ZABIHOLLAH SAFA *is the author of a book on the life and works of al-Biruni. He is president of the Iranian National Commission for Unesco and professor of literature at the University of Teheran. He has written several works on Avicenna, and is now compiling for Unesco an annotated bibliography in Arabic and Persian on the writings of al-Biruni. He also prepared, for Unesco's Collection of Representative Works, the "Anthologie de la Poésie Persane", published by Editions Gallimard, Paris, in 1964.*

At a later date when scholars versified to their heart's content, Avicenna became a prolific writer of verse in Arabic as well as Persian. Al-Biruni, an author of serious scientific works, also wrote poetry in Arabic, and others, such as the great 12th century mathematician, philosopher and doctor, Omar Khayyam, became so well known for their literary work that their names have been handed down to posterity as poets rather than as scholars.

These are but a few of the many examples we could quote, for Arabic and Persian literary history is rich in such many-sided talents. At that time the language of science was Arabic, and the approach to any scientific discipline necessarily involved learning Arabic. In Irano-Arablc schools the teaching of Arabic language and literature preceded all other subjects; Arabic prose and poetry were used as a means to enable pupils to benefit from text books written in Arabic, and students learned by heart works of prose and verse by leading writers and poets.

This meant that the student began Islamic schooling with an introduction to Arabic, which he continued to study throughout his life, and which often led him to an interest in literature, even when his main preoccupation was the rational study of a specific field of science. So it is hardly surprising that the great scientist-scholar al-Biruni became interested In literature and composed verses for his own pleasure.

Yaqut of Hama examined some of al-Biruni's literary works in the library at Marw (or Merv) shortly before the Mongol invasion of Khorassan in the 13th century. The vestiges of Merv, former capital of Khorassan, can still be seen near the modern city of Mary in the Soviet Turkmenistan Republic.

Yaqut's bibiography of al-Biruni shows that the latter wrote a considerable number of literary and critical works: among many others, an Arabic etymology, commentaries on the poems of the great Arabic poet Abi Tamman, and even an anthology entitled "Selection of Verse and Literary Works".

One of his most important works, of a literary rather than a scientific stamp, deals with his native region of Khwarizm. Although this book was widely known during the 11th and 12th centuries, it has since disappeared. Fortunately, part of it is quoted by the 11th century Persian writer-historian Balaghi, and the fragment which has reached us demonstrates al-Biruni's scrupulous and impartial research into historical events, their causes and their consequences.

The value of al-Biruni's work lies in the vast scope of his knowledge, which, particularly in respect to pre-Islamic nations, was not shared by his contemporaries. This is largely due to his command of languages—Iranian, Arabic, Syriac and Sanskrit were as familiar to him as Soghdian, the language of his native Khwarizm. He was also able to use Arabic translations of works written in Greek and Syriac.

Al-Biruni was of both a serious and lighthearted turn of mind; perhaps his penchant for humour and jokes was a counterweight to the scientific rigour of his studies. In his personal relationships and



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Al-Biruni wrote several novels which unfortunately have not come down to us. One of these, entitled *The Two Idols of Bamian*, is about two Buddhist statues, of a man and a woman, carved from the face of a huge cliff of Bamiyan in northwest Afghanistan. The two colossal stone Buddhas, one of which is shown above, dated from the 4th-5th century A.D. and were destroyed in March 2001.

in his conversation, as his biographers have noted, he reveals a pleasant open nature and a spirited wit. Occasionally, he surprises his readers by the use of earthy terms in his poems.

It may have been this trait that led him to translate or write a number of popular or folk romances while engaged in exacting scientific work. In the inventory of his writings, which he made when he was 65 years old, he lists six novels, which have all unfortunately been lost. Works by other authors and poets, however, record passages from these novels, but it is not known whether they were written in Arabic or in Persian.

The adventure of "Vamegh and Azra", an ancient legend of Greek origin which found its way Into Pahlavi literature, is a love story. Onsori, a poet of the time, seems to have used this as a source of inspiration for his own poetic work, "Vamegh and Azra"; it was at a much later date that several other poets put this tale into verse. It is worth noting here that the story also entered Persian literature through pseudo-Callisthenes' novel on Alexander the Great.

Qassim al-sorur wa'ayn al-hayat is another tale put into verse by Onsori. It has never been clearly established whether the original was written by Onsori or by al-Biruni, but neither version exists today.

"Urmasdyar and Mehryar" is an old story adapted by al-Biruni; the names indicate that it is certainly of Iranian origin.

"The Two Idols of Bamian", a folk tale adapted by al-Biruni, is about two Buddhist statues, a man and a woman, carved in the rock of a mountainside at Bamian, near Balkh in northern Afghanistan. The statues still exist and the local people, believing that they were two lovers who were turned to stone, still recount their adventures and the reason for their metamorphosis. The story was also put into verse by Onsori, under the title "The Red Idol and the White Idol". This story, like that of "Dadmeh and Geramidokht", has also disappeared. "Ninufar" (water lily), the last of these works appears to have been a tale of Hindu origin.

The six titles clearly demonstrate al-Biruni's interest in legend; it is unfortunate that they should have been lost, for they would have provided excellent material for analysis. From the narrative skill and descriptive power al-Biruni displays in his various works, especially when dealing with historical or contemporary subjects, one can easily imagine the excellence of the stories that have disappeared.

In short, in addition to some twelve thousand pages of erudite and scientific writing, this prodigiously industrious scholar produced a great number of literary works: Arabic poetry, romances, etymology, literary criticism, history—which in Islamic civilization is a part of literature.

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It is interesting to note that both Arabic, the scientific language of Islam, and Persian, were greatly enriched by the contributions of the major scholars of Iranian origin and of the Islamic civilization within the Iranian cultural sphere living at the beginning of this civilization (between the late 8th century and the end of the 12th century).

This was brought about firstly by the addition of many words, phrases, explanations and expressions from Greek, Syriac, Pahlavi and Hindu, with a few minor changes in pronunciation; secondly, by the translation of scientific expressions and terminology; and finally, by the invention of turns of phrase or expressions using the rules and the flexibility of Arabic and Persian grammar.

The debating skill of such scholars as al-Biruni, Avicenna, Suhrawadi, among others, contributed greatly to the elucidation of many concepts in the field of philosophy and disputation in the Arabic and Persian languages. Al-Biruni was one of the master-artisans of this enrichment.

What differentiates him especially is his knowledge of Sanskrit and Syriac, Greek texts and ancient Iranian sources, by virtue of which he introduced a considerable number of words, expressions and turns of phrase into the Arabic and Persian languages.

His *Pharmacology* gives ample evidence of this. In this work each drug is named in Persian (Pahlavi), Arabic, Greek, Syriac and Sanskrit, and sometimes even in local dialects of the Iranian plateau, together with directions for its use, its composition and cases where its use would be harmful, written in Arabic. This book alone would suffice to establish al-Biruni's contribution to the enrichment of Arabic.

The same considerations apply to the only book of his which is written in Persian and which is still extant, namely the *Astrology*, where his terminology shows extensive use of Sanskrit and Pahlavi sources.

Al-Biruni's literary work adds a particularly engaging aspect to his complex genius. It presents an inexhaustible field of linguistic research, which Iranologists have now begun to investigate.

At the start of the present century Carra de Vaux, the French orientalist, wrote in his basic study "Thinkers of Islam": "Like other great thinkers of the more recent past, a Leonardo da Vinci or a Leibniz, al-Biruni combines the most varied talents. Philosopher, historian, traveller, linguist, scholar and poet, mathematician, astronomer and geographer, he has left his mark in all these spheres...spanning the gap of time, he is a figure whose youthfulness strikes us today; it is as though he stands out and breaks away from his own era and comes to meet us." ■

Zabihollah Safa

'FATHER' OF ARABIC PHARMACY IN MEDIEVAL ISLAM

by Hakim Mohammed Said

MORE than nine hundred years have passed since al-Biruni wrote his Book on Pharmacy (the *Kitab al-Saydanah*, or *Saydalah*), a work that has rightly earned him the title of Father of Arabic Pharmacy in medieval Islam.

Today the science of medicine is characterized by disciplines unknown in al-Biruni's age. A proper appraisal of al-Biruni's work can, therefore, only be made by referring to his age and its standards.

Lest it be understood that al-Biruni's book is concerned with the aetiology of diseases and their treatment, it must be made clear that this is by no means the case. In fact, it is a treatise on materia medica, patterned somewhat on the 1st century A.D. treatise of the Greek physician Dioscorides, which lists 600 medicinal plants.

But al-Biruni sets forth five times as many medicinal plants as Dioscorides, although he makes the latter the main source on which to base his discussion of the drugs. It has, however, been said that the description of the drugs, given by Dioscorides, is so vague as to make most of them, with the exception of about a hundred drugs, unidentifiable today. It is rather interesting to see how al-Biruni overcame the problem.

One of the advantages that al-Biruni enjoyed was his command over both Persian and Arabic and his own Khwarizmian dialect. He lived on the fringe of the Iranian mainland, and had an intimate knowledge of Persian customs and traditions, and, since most of his extant works are in Arabic, felt even more at home with the Arab background, although he never visited the Arab part of the world.

The procedure that he commonly adopts with regard to the description of a drug is that he first discusses it under its Arabic name, and then examines its equivalents in other languages, finally establishing its identity. For example, if a drug is known as *hum al-majus* in Arabic and *arzad maghushi* in Syriac, the probability is that it is the same drug, that is, the Magian plant, which is today known by the botanical name of Ephedra pachyclada from which the alkaloid, ephedrin, is extracted.

Primarily a geodesist, geographer, mathematician and historian, during the course of his sojourn in Afghanistan and north India, he studied the customs of different people at close quarters. In short, he was a polymath who aimed at what is known in Arabic as *takhrij* (extraction of the essence). One cannot say that he was as much of a rationalist in science as the Egyptian scientist Ibn al-Haytham (he was not); nevertheless, he knows how to sift the grain and separate it from the chaff.

One may smile today on reading that, after the hatching of the eggs of the *timsah* (skink lizard), the offspring either make their way to the river and become crocodiles, or remain on land and become skink lizards.

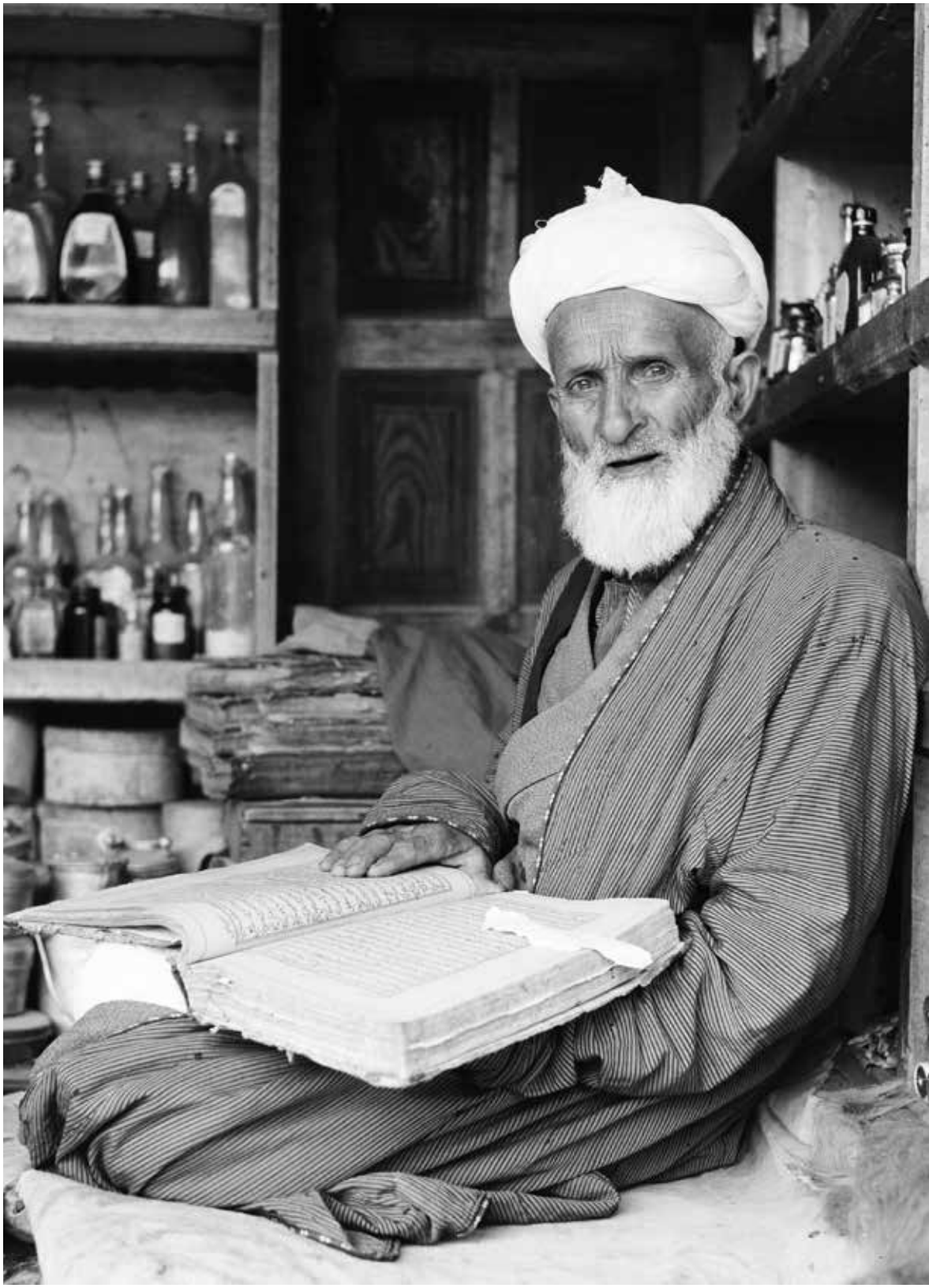
But al-Biruni who had never been to Egypt, to which the skink lizard is indigenous, describes what he has been told by the earlier masters, and, after describing this, he comes to the ecology

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HAKIM MOHAMMED SAID, *a medical doctor of Pakistan, is president of the Hamdard National Foundation, Karachi. This foundation, devoted to scientific and medical research, has just published "Al-Biruni's Book on Pharmacy and Materia Medica" (two volumes, Karachi, 1973), the first translation into English of the complete text of al-Biruni's "Pharmacology". Dr. Said was the organizer of the Al-Biruni International Congress, held in Karachi, last November.*

A binomial method of classifying plants seven centuries before Linnaeus

Al-Biruni has rightly been called the Father of Arab Pharmacy in medieval Islam. In his *Book on Pharmacy and Materia Medica*, he laid down the credo that pharmacy was an independent entity from medicine and "the first step in the hierarchy of the health professions", a calling requiring much study, observation and experimentation. Right, a present day apothecary of Faizabad (Afghanistan) in his shop.



© Dominique Darbois

of the skink lizard, how it is obtained, its medicinal usages, and substitutes.

There are also priceless gems of information scattered throughout the text of the *Kitab al-Saydanah*. Al-Biruni's is among the first detailed descriptions of tea, telling us that tea was taxed in China. His is the first description of the plant, *faghirah* (Zanthoxyllum species) which he describes as coming from Sufalah, the present-day Sangla Hill in Pakistan. This shows how the horizon of the Arabic materia medica was widening to embrace new drugs from the Indo-Pakistan Subcontinent, Iran, Afghanistan, and other regions. It amply shows, too, that what he was writing was not merely a piece of compilation but bears the stamp of an original mind.

Let us give a concrete example of his approach. The winter truffle is known in Arabic as *urjun qabal*, and *faswat al-dab*. While describing this variety of the mushroom, al-Biruni says:

"When tender, fresh, and lush, it is cooked for food as any other edible mushroom. But when it dries, the top scatters away leaving what looks like the Ceylon cornet tree—which gives the mushroom its name… It shoots out of the ground in a rectangular shape, like a white stick with a top…"

Maimonides, the famous Jewish philosopher and rabbi, wrote his Exegesis of Drugs much later than al-Biruni. He holds lisan al-kalb (the hound's tongue) to be *lisan al-hamal* (Plantago major), belonging to the Plantaginaceae family.



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Above, a page from the Arabic version of *De Materia Medica*, an ancient guide to pharmacology, copied in Baghdad in 1224. The image depicts two doctors preparing medicine, using a funnel over a vessel.
Left, a page from a Persian version of *De Materia Medica*, dating from the 16th century. It includes detailed descriptions of the medicinal effects of many plants, trees, and substances derived from animals.

Al-Biruni, on the other hand, holds it to be a Cynoglossum species, and he is correct, for the name given by him is a direct translation of the Greek word. Although he did not know Latin—for he always equates Rome with the Byzantine Empire—and Greek, al-Biruni's transcription of Greek names is generally scrupulously correct.

Al-Biruni's book of pharmacy offers a view of several new tendencies which were crystallizing during the 10th-11th century Muslim world:

■ The vague notion of the binomial notation which is at the very heart of the Linnaean system. For example, in the Linnaean notation a species is described by means of its genus and its specific characteristic, after the name of the discoverer, or its location, e.g., *Rosa damascena* (that is, the damask rose—of Damascus). In a similar manner, al-Biruni describes the maiden-hair fern as *sh'ar al-juyad* (the hair of the giant). The description of *sh'ar al-juyad* is followed by that of *sha'ar al-ghul*, also a fern and known as Onychium japonicum in botanical parlance. This tendency is rather vague in al-Biruni, but he resorts to it wherever possible.

■ The ethnography of plants. Al-Biruni describes different plants and their occurrence in relation, wherever possible, to the folklore associated with them. When he calls a certain drug Roman or Persian, he does not mean that the drug is only in use in those countries but that it has originated there.

■ Drug substitution. In this field al-Biruni has been very liberal in providing the names of substitute drugs in case the drug described is not available. He had little leeway, however, for originality here since the workings and active principles of drugs as we understand them today were not known in his day, and even the application of some rule of thumb would not have been possible.

A critical appraisal of al-Biruni's materia medica would also demand an examination of the shortcomings of the treatise. Al-Biruni rarely describes the Galenic properties of drugs and even when he discusses poly-pharmaceuticals he hardly ever describes how they are prepared.

Most of such descriptions are copied from earlier texts. Sometimes he simply indulges in etymological exercises as in his descriptions of the excreta of different animals. For example, an interesting account of the dolphin is given but not its medicinal relevance. At times he is so irrelevant that he makes one laugh. To quote one such example, he says that the excrement of the dog is ironically called *dawa-i-kabir* (i.e. panacea) in Persian!

All the same, al-Biruni's materia medica provides us with a picture of the expanding materia medica of the time; of the Muslim

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approach in general to science; how the Muslim *Weltanschauung* was embracing an enlarging world-picture supported by a Greek base which was being gradually dug out and replaced by a new one; and as a bridgehead to modern science.

Perhaps the finest materia medica of all times, *Jami Mufradat al-Adwiyah wa'l Aghdhiyah* (A Definitive Treatise on Medicinal and Nutritional Simples) was written two hundred years after al-Biruni's death by Diya al-Din Ibn Baytar Mulaghi, one of the Hispano-Arabs, who quotes al-Biruni as one of his sources while elucidating the occurrence and properties of the drugs.

Since al-Biruni wrote — or rather dictated—the book during the ebb-time of his life, identical drugs are described in different parts of the work. Also, while citing authorities, he does not generally specify the works from which the passages are taken. He seems to have been a man of strong dislikes: Avicenna (Ibn Sina) is not mentioned at all! He also holds Abu Bakr Zakariya al-Razi—generally conceded to be one of the greatest clinicians of all times—in scant respect, although he draws upon him with recurring frequency. Succeeding generations have noted this fact, and one famous historian, Ibn abi 'Usaybi'ah, the Syrian chronicler, has particularly written on this aspect of al-Biruni.

On the other hand, al-Biruni held the Greeks in the highest respect, although his acquaintance was greater with the latter-day masters. He mentions the philosopher Theophrastus only occasionally and Aristotle mostly when referring to the pseudo-Aristotelian treatise on the magical and talismanic properties of certain stones. Galen is mentioned comparatively less frequently, as he was more a physician than an exponent of the materia medica. Occasionally al-Biruni commits real howlers: thus ambrosia (ambrosiya) is held to be a plant!

But, as I have stated earlier, al-Biruni was not a physician; at best he could be called a dilettante in so far as medicine was concerned. And yet, when he describes the mandrake plant, the marking nut, balsam, the poppy, the iris, the aloes, he writes with the ease of a master. Very rarely in a book of materia medica have minerals been described in such delightful detail, and here he is at both his worst and best. For he does his best to extricate himself from the prison of traditionalism and one can well see that he goes more to the Greek sources here than to the oriental ones, tradition-fraught as the latter were.

Among the animal drugs, his descriptions of the civet cat and the beaver are among the best. One also gets the impression that, even while traversing the beaten path, al-Biruni would like to ferret out something new, something not known to the ordinary man in the street.

Thus the impression that this book leaves, along with his other pieces like the *Qanun al-Mas'udi* (his great work on astronomy), the *Kitab al-Hind* (his book on India), and *Athar al-Baqiyah* (The Chronology of Ancient Nations) is that of a man writing at breakneck speed to communicate his own learning to his contemporaries and posterity, a fantastically industrious being, rather vain, egotistical, but self-effacing, ever keen to gain more and more knowledge, ready to scrutinize the different hypotheses without bias and arrive at his own opinion; of a man eager to forswear narrow interests (he discards Persian and accepts Arabic), not prone to glossing over the foibles of his own people he makes a devastating attack on *Dayh Nam* (Ten Names), the Persian source book for medicinal synonyms and holds it to be far inferior to the Syriac Christian, Yashaq Samahi or Chahar Nam (Four Names); of a man determined to leave not a single moment of his life go to waste.

It should also be noted that his age was one of disquisitions, argumentation, and internecine quarrels not only between orthodoxy and heterodoxy but between the four orthodox Muslim schools of jurisprudence. Al-Biruni seems to have been a liberal orthodox Muslim who did not find it necessary to condemn the other schools of thought. A greater exponent of live-and-let-live is rare to find. This alone should be sufficient to place him among the ranks of the really great. ■

Hakim Mohammed Said



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MANDRAKE THE MAGICIAN

"Two forms appear, if it is cloven in the middle, and these are the male and female human shapes." This is part of a long description which al-Biruni gives of the mandrake root in his treatise on pharmacy.

A page from a Persian version of *De Materia Medica* dating from the 16th century (opposite). It describes the qualities of the mandrake, known for its flowers resembling a face with a protruding tongue and roots in the form of the human body. Left, a striking example of this strange root which might be taken for the statue of a man, his hands clasped. Above, a colourful depiction of mandrake picking from a 17th century manuscript of *The Wonders of Creation*, by the 13th century Iranian scholar al-Qazwini.

FREE-WHEELING PHILOSOPHER

Al-Biruni was a model of the thinker who could harmonize various forms of knowledge without becoming the slave to a particular method or school



Detail of a miniature from the 11th century literary tales *Al-Maqamat*, by al-Hariri, depicting a library in Basra, Iraq. At the time of al-Biruni, students met in libraries, where manuscripts were read and copied. Books were stored flat in pigeonholes, with the title written on the edge, as depicted here.

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by Seyyed Hossein Nasr

IN classical Islamic civilization the name "philosophy" (*al-falsafah* or *al-hikmah*) is reserved for a particular set of disciplines associated with various schools of "Islamic philosophy".

Therefore the title of "philosopher" (*al-faylasuf*) is usually reserved for those who are masters of the doctrines of one of these "philosophical" schools. Considered in this light al-Biruni has never been classified by classical authors as a "philosopher", nor associated with one of the well-known schools of traditional Islamic philosophy.

But if we understand philosophy in its more general sense as logical and rational discourse upon the nature of things, then al-Biruni must certainly be considered as a philosopher of note to be studied for his significance in the general context of Islamic intellectual history and also for the innate value of his intellectual vision.

Al-Biruni was a scientist, scholar, compiler and philosopher for whom the quest for knowledge was held as the supreme goal of human life. He respected knowledge in all its forms and hence sought it wherever and in whatever form possible. He saw in knowledge an almost divine quality very much in conformity with the fundamental tenets of Islam.

Hence, al-Biruni, with the universal vision and the remarkable intellectual qualities which he possessed, turned to Greek as well as to Persian and Indian sciences, to both the religious Islamic sciences

SEYYED HOSSEIN NASR. *See biographical note page 39.*

and the intellectual ones. He holds the rather unusual distinction of being at once one of the greatest mathematicians and historians of humanity. And he wrote in nearly every field, from astronomy to pharmacology.

But strangely enough, unlike his contemporary scientist Ibn al-Haytham, al-Biruni has not left behind independent philosophical works of a systematic nature. The only exception among his extant works is the *Questions and Answers* exchanged with Avicenna (Ibn Sina), which deal with cosmological, physical and philosophical problems.

As for his lost works, he apparently wrote several philosophical narratives, including *Qasim al-surur wa ayn al haya* and *Ur-muzdvar wa Mihryar* which if found would be very significant, considering the importance of this kind of philosophical narrative romance in the writings of Avicenna, Suhrawardi and many other Islamic philosophers.

IN order to understand al-Biruni's philosophical thought, it is therefore necessary to turn to his other writings dealing with history, geography or even astronomy, for in nearly all of these works, one will find elements dealing with philosophy, cosmology and metaphysics interspersed within the main scientific or historical discussion at hand.

In his encyclopaedic work, *India*, not only does al-Biruni describe Indian doctrines, but often comments upon them and offers his own metaphysical and philosophical ideas and interpretations. In his *Chronology of Ancient Nations* profound observations are made about the nature of time and the cycles of human history as well as the origin of the order observed In nature. In *The Determination of the Co-ordinates of Cities*, the origin of science and its classification are discussed as are themes related to the question of the origin and creation of the universe.

One could go on in the same vein with his other writings. Moreover, the very fact that he chose to translate into Arabic a work on Indian yoga such as the *Patanjali Yoga* shows his intense interest in metaphysical and spiritual matters.

When all of these sources are extracted and studied it becomes clear that al-Biruni was neither a follower, nor a member of any of the established philosophical schools of his time.

The well known schools of "Islamic philosophy" included the Peripatetic (*mashsha'i*) (1), the Illuminationist (*ishraqi*) (2), and also that of theology (*kalam*).

The most noteworthy aspect of al-Biruni's philosophical views is his strong and often original criticism of Aristotelian philosophy, which is reflected in the questions and answers he exchanged with Avicenna and his student Abdallah al-Ma'sumi.

Al-Biruni thus belongs to a series of independent anti-Peripatetic thinkers of the early period of Islamic history who were also scientists, such men as Mohammed Ibn Zakariyya'al - Razi, whom al-Biruni both admired and criticized.

Al-Biruni did not oppose all of the teachings of Peripatetic philosophy *en bloc*. Rather, basing himself on firm religious faith in Islam on the one hand and the tool of logic, rational analysis and observation on the other, he refuted many of the theses of Peripatetic philosophy, such as the eternity of the world and the possibility of indefinite division of matter.

What is important for an understanding of Islamic intellectual history is that such a strong and rigorous criticism of Peripatetic thought did not come from a rationalist, as was to happen from the end of the Middle Ages to the 17th century in the West, but that it came from a man like al-Biruni who was deeply immersed in both the life of faith and metaphysical and cosmological doctrines of Islam and other traditions.

It is of great significance for an understanding of the reason for the different paths that Islamic and Christian civilization were to take at the end of the Middle Ages that one of the foremost critics of the Aristotelian world view in Islam should also be the person who introduced the *Patanjali Yoga* to the Islamic world and one of the Muslim figures really well-versed In the Hindu Vedanta philosophy.

In questions of cosmogony and creation, al-Biruni rejected violently the idea of the "eternity" of the world. Like the Islamic theologians, he held that to believe in the eternity of the world is to negate the need for a cause for the world and therefore to negate indirectly Divine Unity, which was the principle most dear to him.

In fact the whole of al-Biruni's works can be interpreted as a quest for the realization of unity in various forms of knowledge and planes of existence. It was most of all with the aim of preserving the inviolability of the doctrine of unity that he criticized the Peripatetic view of the eternity of the world in the second of the questions he posed to Avicenna.

The debate between al-Biruni and Avicenna as well as al-Ma'sumi on this subject concerns one of the most important questions of Islamic philosophy, namely the condition under which something needs a cause. Al-Biruni identified the idea of the eternity of the world with its not being created. For him, in contrast to Avicenna, the "newness" of the universe implied its being created and the denial of this "newness", or an acceptance that the world does not have an origin in time, destroyed the conception of creation and ultimately the unity of the Creator and his power. Hence in other works such as *The Determination of the Co-ordinates of Cities* he affirmed his belief in the created nature of the world and tried to provide both scientific and theological reasons for it.

As a result of his vast and varied study of nature, history and various traditional doctrines of time and of the world, al-Biruni became clearly aware of the qualitative nature of time, of the fact that it is not uniformly stretched out like a mathematical co-ordinate. He also strongly denied the idea of uniformitarianism so dear to modern geology and paleontology and provided both scientific and philosophical arguments to disprove it.

FOR al-Biruni time has a cyclic nature, but not in the sense of returning to the same point again, which is a metaphysical absurdity and a modern caricature of the real traditional teachings. Rather, by "cyclic" al-Biruni understands qualitative changes and correspondences between various elements of time within each cycle.

Without doubt his profound study and intimate knowledge not only of the Koranic conception of time, which is based on cycles of prophecy, but also of the teachings of the *Puranas*, the 18 Hindu epics, and of many other traditions on the meaning of time and history, helped al-Biruni develop perhaps more profoundly than any other Islamic philosopher and scientist the meaning of qualified and cyclic time and its implications for the study of nature and of man.

A basic aspect of al-Biruni's thought, which is closely related to his treatment of time, concerns the development and becoming of things, which many have by mistake identified with the modern theory of evolution, the latter being no more than a parody of the traditional doctrine of gradation (3).

Al-Biruni was fully aware of the long

(1) Muslim school of philosophy influenced by the philosophy of Aristotle.

(2) A philosophy with origins in Ancient Persia, postulating inward spiritual enlightenment and mystical experience, and contrasting with the philosophy of Aristotle based on reasoning and logical argument.

(3) The principle that the universe is composed of an infinite series of forms ranging in order from the barest type of existence to ultimate perfection.

CONTINUED NEXT PAGE



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FREE-WHEELING PHILOSOPHER *(Continued)*

history of the earth, of the cataclysms which changed mountains into seas and oceans into continents, of the fact that certain species preceded others on earth and that each species has its own life cycle.

Pondering over the vast panorama of nature in both time and space and the teachings of various sacred writings on the creation and subsequent history of the Universe, al-Biruni became aware of the basic principle that the development and becoming of things in this world is the gradual unfolding and actualization of all the possibilities that are inherent within each being.

Nothing evolves from one form into another as a result of external additions or accretions; rather whatever transformation does take place is no more than the manifestations of possibilities already present in that being. In the same way, what becomes manifested at a particular period of history is no more than the unfolding of possibilities inherent in that particular cycle of time.

This principle, which is one of the cornerstones of al-Biruni's thought and is a crystallization of well-known traditional doctrines, is applied by al-Biruni to his study of various domains of nature, both animate and inanimate, as well as to history and man.

Being an outstanding physicist, al-Biruni was deeply interested in the general principles of natural philosophy, in such questions as motion, time and matter, as is again seen in his criticism of Aristotelian natural philosophy presented in the series of questions and answers exchanged with Avicenna.

As far as the nature of matter is concerned, he sided with the Islamic theologians.

It is somewhat strange that a scientist such as al-Biruni should support the view of the theologians concerning the structure of matter, for usually the Muslim scientists believed in the continuity of matter.

Of paramount importance for an understanding of al-Biruni's philosophical ideas is his view of knowledge and the methods used for its attainment. Al-Biruni held a view of knowledge which was at once dynamic and static, that is, he believed clearly in the gradual development of particular forms of knowledge and at the same time in the immutability of principal knowledge derived from revelation.

In addition to being the founder of the discipline of comparative religion or the history of religion he must also be considered as one of the founders of the history of science. Yet, he never lost sight of immutable knowledge, which for him is always the revealed Scriptures and which provides the matrix for all the human sciences which change and develop.

Moreover, al-Biruni was the great champion of pure knowledge and its value for the perfection of man. In Islam there has never been the idea of "science for science's sake" as is found in the West. But within the context of Islamic civilization al-Biruni emphasized the importance of pure knowledge and the pursuit of knowledge for the sake of the perfection of man as against those who stressed the importance of its utility.

Of course, inasmuch as al-Biruni spoke within the context of the traditional world view, his defence of pure knowledge and the view of those who emphasized its utility

As rose petals rain down, a devotee offers sacred earth to the Ganges during the Maha Kumbh Mela, a festival anchored in Hindu mythology (opposite).



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A 14th-century Persian manuscript illustration (lower right) shows Sultan Mahmud of Ghazna crossing the Ganges, the sacred river to which Indians go on pilgrimage (above), to pray and meditate on its banks.



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met at the highest level. For what can be more "useful" to man than the knowledge which is an adornment for his soul and the means for its attainment of perfection?

Al-Biruni himself was aware of these two poles and attitudes involved and in his own writings combined the pleasure aspect associated with the attainment of knowledge with its aspect of utility. For him the two were not completely divorced from each other but were complementary in the deepest sense.

Al-Biruni never became the slave of a particular method nor accepted that kind of tyranny of methodology characteristic of so much of modern science. He used different methods in different sciences in conformity with the nature of the science in question. Where it was necessary he used induction, or observation, or experimentation, or deduction or had recourse to intellectual intuition.

He was the most exact of scientists without ever being fooled into believing that the methods of experimental science could be applied to the domain of religion or the sciences of man. That is why in al-Biruni, who in a sense summarizes the whole history of Islamic science, there is no single method, but methods for acquiring various forms of knowledge in conformity with the innate nature of the sciences in question.

The basic significance of al-Biruni for the modern world, and especially the contemporary Islamic world, in fact, is not only in that he was the father of geodesy or that he weighed several precious stones and metals carefully or even that he criticized Aristotelian natural philosophy profoundly. It is above all in his success in being an outstanding scientist, in being scientific without being scientistic. It is in being logical without losing sight of the spiritual empyrean, the knowledge of which is not irrational nor illogical but unattainable through logic and reason alone.

It is also in his remarkable sense of discernment which was able to give each form of knowledge its due, to assign to each element the place to which it belonged by nature, so that he could practise mathematics with the rigour of the greatest of mathematicians and at the same time write of human affairs with a vision that is much more profound than the view of those in the modern world who try to ape the methods of the exact sciences in the field of the humanities and who do not possess a fraction of al-Biruni's scientific knowledge.

Al-Biruni stands as the model of the thinker who was able to harmonize within his own intellectual vision various forms of knowledge, from the sciences of nature to religion and philosophy.

He also stands as proof that it is possible within a traditional worldview to develop and even found various branches of the sciences without becoming enslaved by them and without falling under the deadly influence of belief in the unilateral and tyrannizing power of science so prevalent today, a belief whose end cannot but be the stifling of the human spirit and the destruction of the natural environment which itself serves as support for man's terrestrial journey. ■

Seyyed Hossein Nasr

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Front and back view of an astrolabe, an instrument used to make astronomical measurements. This example dates from 1221 and resembles the one described by al-Biruni. It has a mechanical calendar and indicates such information as the phases of the moon, the relative position of the sun, and the number of days in the month.

A PIONEER OF SCIENTIFIC OBSERVATION *(Continued from page 30)*

He wrote of the great geological changes which had occurred in the remote past, long before the creation of man, and also during human existence, and some of his observations are of great Interest. His discovery of fossils of marine animals led him to the conclusion that:

"Sea has turned into land and land into sea; which changes, if they happen before the existence of man, are not known, and if they took place later they are not remembered because with the length of time the record of events breaks, especially if this happens gradually. This only a few can realize.

"This steppe of Arabia was at one time sea, then was upturned so that the traces are still visible when wells or ponds are dug, for they begin with layers of dust, sand and pebbles, then there are found in the soil shells, glass and bones which cannot possibly be said to have been buried there on purpose. Nay, even stones are brought up in which are embedded shells, cowries and what is called 'fish-ears', sometimes well-preserved, or the hollows are there of their shape while the animal has decayed."

His interest next turned to the determination of specific gravities, to vacuum theory, the propagation of heat, the dilatation of bodies and the reflection and refraction of light. He even attempted to establish a tentative comparison between the speeds of light and sound.

In a totally different field, we find references in his works to the construction of a canal linking the Mediterranean and the Red Sea, to the desalination of sea water and even to the atomistic theories of Democritus. Furthermore, and it is in this respect that he really emerges as a precursor of the great geniuses of the Renaissance and the Enlightenment, he also turned his attention to the human sciences, in which his achievement is quite extraordinary for someone living in an age which was certainly not noted for its tolerance.

By virtue of his official post at the court of Sultan Mahmud, al-Biruni was required to take part in the Sultan's campaigns. This did not prevent him realizing his greatest wish, which was to make contact with Indian thought. The long periods which he spent in India left an indelible impression upon him, resulting in some of his most remarkable works, in particular his great work on India.

He went to India in the train of a military conqueror, but it was in the guise of a simple student that he introduced himself to his Indian masters. He learned Sanskrit in order to study Indian sacred writings and scientific texts. He was soon to be regarded as the equal of his masters, both for his learning and for his desire to spread the knowledge he possessed. His erstwhile teachers thus became his pupils and he taught them the elements of Islamic, Manichean, Christian, Mazdaist and Hebrew thought—with such success that they gave him the affectionate sobriquet "Boundless Ocean".

Al-Biruni's profound study of the Hindu religion enabled him to undertake a comparative study of the major religions of his day, examining for the first time the ties which bind the Greek, Christian, Manichean, Jewish and Hindu faiths. He particularly stressed the Hindu belief in the transmigration of souls.

His work on India is not, however, concerned solely with religion, but also contains chapters of the greatest value on the Hindu social system and Indian geography, mathematics and medicine. It is greatly to his credit that, unlike so many of his contemporaries, he saw India as something more than merely a place where rich booty was to be had. His work is thus an objective and complete record of Hindu civilization and a source-book for his fellow-Muslims who had until then been ignorant of Hindu culture.

Al-Biruni's work thus presents us with an outstanding example of an encyclopaedic mind ranging over both the exact sciences and the human sciences, and a model of respect for other people's manners, beliefs and customs—in short, for other people's cultures. He teaches us tolerance through understanding of other nations, and for this reason we respect al-Biruni as he respected others. As he himself said:

"If you are to learn to like other peoples, learn their language and show respect for their way of life, for their customs, their thought and their religion." ■

Mohammed Salim-Atchekzai

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An oil painting depicting al-Biruni by Uzbek artist Malik Nabiev, 1973.



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