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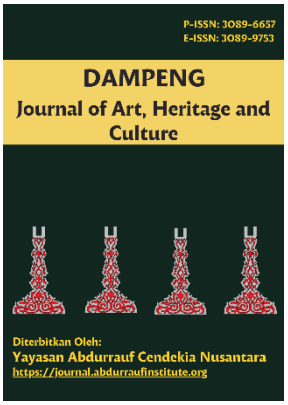

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RESEARCH ARTICLE

The Umayyad Dynasty in Andalusia: Contributions to the Development of Science

Yan Nurcahya*, Deri Sugiarto, Teddiansyah Nata Negara, Dandie Hambaliana, Rian Ananda Putra

Abstract: The Umayyad Dynasty was an Islamic government regime under the rule of the Umayyad family which lasted from 661 AD-750 AD. The Umayyad Caliphate or Umayyad Dynasty was the second Islamic caliphate after the dissolution of the Rashidun Caliphate in the Arabian Peninsula, the Umayyad Dynasty in Al-Andalus was an important period in Spanish history which began in 756 AD when Abdul ar-Rahman I fled from Constantinople after the defeat of Umayyad troops in the Middle East. The dynasty ended in 1031 AD when political collapse and rebellion divided Al-Andalus into various small taifa kingdoms. The city of Cordoba became an important cultural and economic center, with Al-Andalus being one of the intellectual centers of the Islamic world. The steps in this research were carried out in three stages, namely the source collection stage and the analysis results presentation stage. The collection of sources in this research used library research techniques. The Umayyad dynasty in Andalusia was a golden period in the history of the development of science and culture. Policies of tolerance and support for education and research allowed for innovations that not only enriched the Islamic world, but also had a profound and lasting influence throughout the world.

Keywords: Development, Islam, Science, Umayyad Dynasty

Abstrak: *Dinasti Umayyah merupakan rezim pemerintahan Islam di bawah kekuasaan keluarga Umayyah yang berlangsung dari tahun 661 M hingga 750 M. Kekhalifahan Umayyah atau Dinasti Umayyah adalah kekhalifahan Islam kedua setelah runtuhnya Kekhalifahan Rasyidun di Jazirah Arab. Dinasti Umayyah di Al-Andalus menjadi periode penting dalam sejarah Spanyol yang dimulai pada tahun 756 M ketika Abdul ar-Rahman I melarikan diri dari Konstantinopel setelah kekalahan pasukan Umayyah di Timur Tengah. Dinasti ini berakhir pada tahun 1031 M ketika terjadi keruntuhan politik dan pemberontakan yang memecah Al-Andalus menjadi berbagai kerajaan kecil (*taifa*). Kota Cordoba berkembang menjadi pusat kebudayaan dan perekonomian yang penting, dengan Al-Andalus sebagai salah satu pusat intelektual dunia Islam. Langkah-langkah penelitian ini dilaksanakan melalui tiga tahapan, yaitu tahap pengumpulan sumber dan tahap penyajian hasil analisis. Pengumpulan sumber dalam penelitian ini menggunakan teknik studi pustaka. Dinasti Umayyah di Andalusia merupakan masa keemasan dalam sejarah perkembangan ilmu pengetahuan dan kebudayaan. Kebijakan toleransi serta dukungan terhadap pendidikan dan penelitian memungkinkan lahirnya berbagai inovasi yang tidak hanya memperkaya dunia Islam, tetapi juga memberikan pengaruh mendalam dan bertahan lama di seluruh dunia.*

Kata Kunci: *Perkembangan, Islam, Ilmu Pengetahuan, Dinasti Umayyah*

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Introduction

Andalusia is one of Spain's autonomous communities of international significance. As the most populous and second-largest of Spain's 17 autonomous communities, Andalusia plays a crucial role in the country's economy, culture, and history. Its capital, Seville, is not only the administrative center but also one of Spain's largest and most iconic cities, renowned for its architectural and cultural heritage.

Strategically located in the southern part of the Iberian Peninsula, Andalusia borders several important regions. To the north, it borders Extremadura and Castilla-La Mancha, two regions that have contributed significantly to Spain's geographical and cultural diversity. Meanwhile, to the east, Andalusia borders the region of Murcia and the Mediterranean Sea, giving it direct access to strategic maritime trade routes. To the west, it borders Portugal, Spain's international neighbor, and the Atlantic Ocean, which has shaped the history of European seafaring and exploration. The southern part of Andalusia boasts an extensive coastline overlooking the Mediterranean Sea and encompasses the Strait of Gibraltar, the narrow strip separating Europe from Africa. It also encompasses Gibraltar, a British overseas territory, which is a crucial geopolitical point in the region.

Beyond its defining geographical boundaries, Andalusia holds profound historical significance. It is known as a meeting place for many great civilizations throughout history, including the Romans, Visigoths, and Muslims during the Umayyad Caliphate in Andalusia. With its rich historical heritage, warm climate, and diverse landscapes, from the Sierra Nevada mountains to the beautiful beaches of the Costa del Sol, Andalusia has become one of the wor The origins of the name "Andalusia" can be traced to the Arabic term "Al-Andalus," which refers to the region of the Iberian Peninsula that was once under Muslim domination. This region served as an important entry point for Islamic history in Spain, reflecting a complex and rich cultural heritage. Before the Islamic era, the region was also home to Tartessos, the capital of the Tartessos Civilization, known as one of the great civilizations of antiquity.

In the Bible, this civilization is referred to as Tarshish, a name that emphasizes the region's historical and religious significance. During the Roman period, the region became part of the province of Hispania Baetica, a key hub in the Roman Empire's economic and administrative network. During the Umayyad Dynasty of Al-Andalus, which lasted from the 8th to the 11th century CE, the region became a crucial center for the development of scholarship in the Islamic world. The Umayyads not only developed the region politically and economically but also created an environment conducive to extraordinary intellectual growth. One of the most striking features of this period was the relatively high level of religious tolerance, with Muslims, Christians, and Jews living side by side and interacting peacefully.

This created an environment that promoted the exchange of knowledge and ideas between cultures, which in turn laid the foundation for the development of diverse scientific knowledge. Centers of learning such as Cordoba, Seville, and Granada became magnets for scholars from across the Islamic world, where they not only deepened their understanding of the classical Greek and Roman scientific heritage but also made new breakthroughs in various fields of knowledge. This period also saw a large-scale translation of classical Greek, Persian, and Indian works into Arabic, allowing wider access to knowledge that had previously been limited to specific regions.ld's most attractive destinations for tourism and cultural exploration.

Specifically, medicine, mathematics, astronomy, and the sciences of alchemy and chemistry experienced significant development in Al-Andalus during the Umayyad Dynasty. The seminal works of scholars such as Ibn Sina (Avicenna), Al-Zarqali, and Jabir ibn Hayyan marked important milestones in the development of science during that period. Studying the development of science during the Umayyad Dynasty in Al-Andalus is significant not only for understanding the history of Islamic science but also for uncovering its influence on scientific

advancement in Europe and the modern world. Therefore, this research is expected to make a significant contribution to understanding the intellectual and cultural history of the region. In addition to its intellectual contributions, Andalusia also boasts a unique cultural history, thanks to the influence of Muslim rule that lasted for nearly eight centuries. This influence encompassed not only everyday life but was also reflected in language, art, and architecture. Muslim rule in the region ended in 1492 when the Catholic monarchy conquered Granada in an event known as the Reconquista, marking the beginning of a new era in Spanish history.

The Spanish language that developed in the Americas is largely derived from the Andalusian dialect of Castilian Spanish. This is closely related to Seville's strategic role as a trading center and a major gateway to the Spanish colonies in the Americas during the 16th and 17th centuries. Therefore, Andalusian cultural influence was not limited to the Iberian Peninsula but also spread widely into the New World.

The architectural legacy of the Muslim era in Andalusia remains a major attraction for tourists and researchers. Historical monuments such as the Alhambra in Granada, a magnificent palace that symbolizes the glory of Moorish architecture; the Mezquita in Córdoba, known for its blend of Islamic and Christian architecture; and the Torre del Oro and Giralda in Seville, which reflect the era's distinctive architectural styles, all stand as clear evidence of the artistic and engineering excellence of the time. Furthermore, the Reales Alcázares in Seville, still used as the official residence of the Spanish royal family, is one of the finest examples of Islamic architecture fused with European influences.

Archaeological sites in Andalusia also hold great historical value. Medina Azahara, a palace city near Córdoba, and Itálica, a Roman city located near Seville, provide important insights into the historical and cultural evolution of the region. Together, these monuments and sites not only reflect Andalusia's diverse history but also affirm its position as one of the most influential centers of civilization in human history.

The peak of Islamic expansion into the west reached during the reign of Al-Walid ibn Abdul-Malik, one of the most influential caliphs in the history of the Umayyad Dynasty. His reign, from 705 to 715 CE, is known as the Golden Age, marked by political stability, economic prosperity, and social harmony among Muslim communities. This orderly and peaceful environment allowed for significant growth in various aspects of life, including administration, trade, and culture. Al-Walid's success in expanding his empire not only strengthened the Umayyad Dynasty's position as a global power but also reflected his strategic vision and brilliant management.

In terms of territorial expansion, Al-Walid's reign witnessed extraordinary achievements in both the eastern and western parts of the Caliphate. In the west, the conquest of Spain (Al-Andalus) through military expeditions led by Tariq ibn Ziyad and Musa ibn Nusayr was a significant milestone. North Africa, previously under Islamic rule, was further strengthened, enabling direct connections between Al-Andalus and Umayyad centers of government in the Middle East. In the east, territorial expansion encompassed areas now known as Persia, Afghanistan, and Pakistan, with conquests strengthening trade routes and expanding Islamic cultural influence.

Further east, the Caliphate reached Central Asia, including modern-day Turkmenistan, Uzbekistan, and Kyrgyzstan. This expansion not only had strategic value in controlling trade routes such as the Silk Road, but also brought significant cultural and intellectual influence. The interaction between local communities and Islamic traditions created a synthesis that

enriched the region's cultural heritage, making it a crucial center for the subsequent development of Islamic civilization.

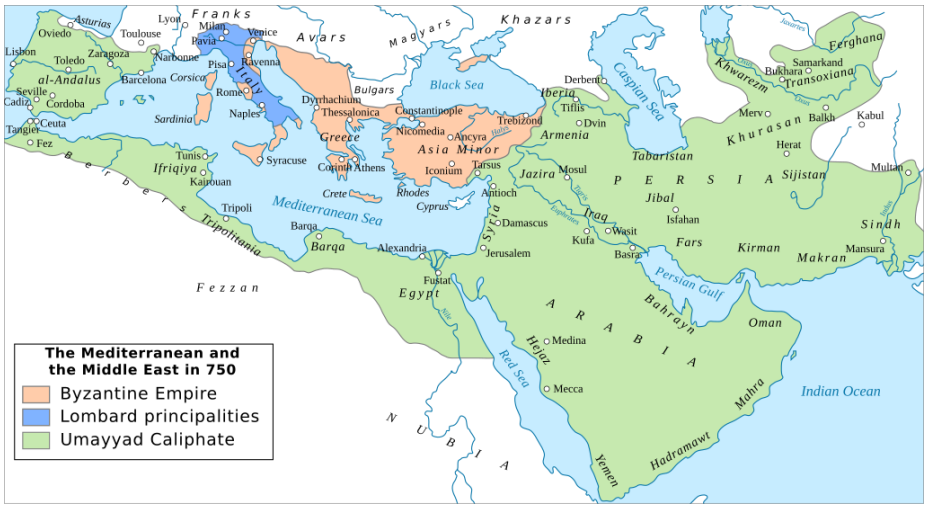

Figure 1. Umayyad Caliphate in 740 AD (Source: Constantine Plakidas)

Geographically, the Umayyad dynasty's reach during the reign of Al-Walid was one of the most extensive in world history. The caliphate encompassed most of the then-known world, from the western Atlantic coast of Spain to the border with China in Central Asia. This success reflected the Umayyad dynasty's administrative ability to manage a diverse region, both culturally and ethnically, as well as their military prowess in meeting the challenges of expansion.

Beyond mere territorial conquest, this expansion also had significant cultural impact. Islamic influence spread across various regions, introducing religious values, legal systems, and innovations in science and technology. At the same time, interactions with local cultures enriched Islamic intellectual traditions, creating a solid foundation for the development of Islamic civilization in subsequent periods. The era of Al-Walid was not only a historical milestone for the Umayyad Dynasty, but also a symbol of the dynamics of early globalization, involving an unprecedented exchange of cultures, ideas, and technologies.

Method

This research process is carried out through three main stages, namely source collection and presentation of analytical results. In the first stage, namely source collection, this research utilizes library research methods, which focus on collecting relevant data and information from various written references. These references include books, scientific journals, articles, archival documents, and other sources available in libraries and digital databases. Historical sources include records and other facts that provide a comprehensive picture of an event. Historians with integrity present data with transparency, including explaining its origins. Therefore, while subjectivity in historiography is acknowledged, efforts to avoid it remain a priority.

The initial step in historical research is heuristics, namely the process of collecting various historical sources that serve as the main foundation for conducting research. Interpretation is then a step or activity that involves interpreting facts and determining the meaning and context of the facts obtained. Interpretation is often referred to as subjectivity. There are two types of interpretation: analysis, which means to explain.

Historiography is the final stage in historical research, achieved after going through the processes of heuristics, source criticism, and interpretation. Historiography is the process of

compiling facts from various selected sources and presenting them in historical writing. After reviewing the available data, a historian must consider the structure and narrative style used. At this stage, historians are also responsible for explaining the reasoning behind their interpretations so that they can be understood by readers. The final stage of historiography involves writing the results of interpretations of past events or occurrences, namely an attempt to reconstruct the past based on critically analyzed facts. This reconstruction involves imaginative thinking but remains based on data that has been thoroughly tested and analyzed to answer the previously formulated questions.

Result and Discussion

Religious Science and Philosophy of the Umayyad Dynasty in Andalusia

During the Umayyad Dynasty in Andalusia, religious studies developed rapidly and became the basis of intellectual civilization, with the following focus studies:

1. Jurisprudence

The most basic progress in scientific fields is deep In the field of jurisprudence, Andalusia is known as the center of followers of the Maliki school of thought. The person who introduced this school of thought in Andalusia was Ziyad bin Abdurrahman. Further developments were determined by Ibn Yahya who became Qadhi during the time of Hisham Ibn Abdurrahman. Fiqh experts others are Abu Bakr bin al Quthiyah, Muniz bin Sa'id Al Baluthi, Ibnu Rusyd, author of the book Bidayah al Mujtahid wa Nihayah al Muqtasid, AsySyatibi, author of the book Al Muwaffaqat fi Ushul Asy Syari'ah (Ushul Fiqh), and Ibn Hazm.

In the history of the development of the world of jurisprudence, this science has experienced The golden age was around the 2nd century H, when the khulafa' Bani Abbas approach the Fuqaha and carry out more in-depth studies and truly until fiqh reaches its point of brilliance. This concern about fiqh was seen when the caliph Harun Ar Rasyid summoned Imam Malik to teach the book Muwatta' to the two his sons, Al Amin and Al Makmun. Imam Mailik firmly refused in his letter sent to Ar Rasyid, which read:

“The noble Amirul Mukminin, to obtain that knowledge effort is required. Knowledge will be honorable if you respect it, but if you devalue it, then knowledge will be meaningless. Therefore, I emphasize that knowledge is visited, not not arrived by itself”.

Ar Rasyid was not angry with that, but instead ordered his two children to study the Koran with Imam Malik and many people in Medina. Essentially, all the old legal schools shared the same attitude toward the practices and administrative regulations of the Umayyad government. Despite their common fundamental stance, in the earliest period of Islamic justice, there was a common doctrine among these legal schools. However, over time, differences in opinion among them increased. This was supported by the increasing ability to think and the advancement of intellectual development, resulting in a growing number of views that could serve as legal foundations.

Abu Muhammad Yahya ibn Yahya ibn Kathir ibn Wislasen ibn Shammal ibn Mangaya al-Laythi (b. 769 / d. 848), better known as Yahya ibn Yahya, was a prominent Muslim scholar from Andalusia. Yahya was born in the region of Algeciras to the Banu Abi Isa family. His grandfather, Abu Isa Kathir, the family name, was a Berber warrior of Masmuda and a mawla of the Banu Layth of Kinana, thus having the nisba al-Laythi. Abdurrahman I rewarded Kathir by giving him the governorship of Algeciras, then Sidonia, and then Algeciras again, where he died and was buried.

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becoming his ardent follower. Al-Andalus during his time was dominated by the followers of Imam al-Awza'i, who was the reason why most of the Arab Muslim conquerors came from Syria, in addition to various other schools of jurisprudence, according to Imam al-Dhahabi in his Tarikh al-Islam al-Kabir when mentioning the teacher Yayha Shabtun (Zaid ibn Abdarrahman al-Lakhmi). Returning to Al-Andalus, he focused on his scholarly work. As a member of the shura (an advisory council that emirs and judges were required to consult), he wielded considerable influence over nominations to legal positions. However, he himself never accepted a legal position. In his role as a member of the shura, he became close to the rulers of Al-Andalus, who were apparently impressed by his intelligence and authority on Islamic matters. Thus, he grew to be the most influential member of the shura, giving him the opportunity to nominate judges who also supported the Maliki school. By the end of his life, the Maliki school had become the most important in Al-Andalus.

2. Science of Interpretation and Hadith

Cordoba produced scholars, particularly for Muslims and the entire world, not only in specific fields but also in many fields, including the surgeon Az-Zahrawi, who was the most renowned physician and expert in medicine and its preparation. Ibn Bajah, an astronomer, physician, physicist, botanist, psychologist, and writer, was an expert in medicine and literature. Muhammad Al-Ghaffah was one of the founders of ophthalmology. Ibn Abdilbar, one of the most renowned scholars in Cordoba, an expert in hadith and jurisprudence, as well as in medicine, astronomy, and physics, was a Muslim scientist who pioneered modern geography, including the creation of a globe by King Roger II of Sicily in 1954 AD.

Imam al-Qurtuni was an Imam, an expert in hadith, an experienced scholar, and a renowned commentator on the Quran, among other scholars and scholars. When the Christians reconquered Spain, the mosque was converted into a church and cathedral. Unfortunately, Queen Isabella of Castile and Ferdinand of Aragon successfully conquered Granada, the last Muslim stronghold in Andalusia, in 1492.

Andalusia gave birth to prominent hadith scholars such as Ibn 'Abd al-Barr. Ibn 'Abd al-Barr was born in 978 and died in 1071 in Xàtiva in Al-Andalus. According to Ibn Khallikan, Ibn Abd al-Barr sprung from the Arabian tribe of Namr ibn Qasit. While initially having been an adherent of the Zahiri school of Muslim jurisprudence, Ibn Abd al-Barr later switched to the Maliki school, which was the officially recognized legal code of the Umayyad dynasty, under which he lived. His book on the three great Sunni jurists Malik ibn Anas, Al-Shafi'i and Abu Hanifa noticeably excluded both his former patron Dawud al-Zahiri and Ahmad ibn Hanbal, Ibn 'Abd al-Barr represented the traditionalist strand of the Maliki school. He is often referred to as the "Bukhari of the West. Ibn Abd al-Barr was a supporter of taqlid, or following an Islamic school of jurisprudence. Ibn Abd al-Barr wrote in his book, Jami' Bayan al-'Ilm wa Fadlihi: "The scholars do not differ on the point that the laymen must make Taqlid their respective Imams.

3. Theology

Theological discourse also entered, particularly through the influence of the Mu'tazilah, although officially the government tended to uphold Sunni orthodoxy. This statement refers to a historical situation in which, despite the government's official support and adherence to Sunni orthodoxy, the influence of Mu'tazilah theological thought infiltrated theological discourse at that time. This Mu'tazilah influence stemmed from the use of a rationalist approach to explaining religious issues, which then interacted and dialogued with the dominant Sunni ideology.

The Mu'tazilah is a school of Islamic theology known for its emphasis on the use of reason and reason (rational thinking) in understanding and explaining God's teachings. These

teachings are often influenced by philosophical thought from outside Islam. The majority religious understanding in Islam became the basis and official view in many Islamic governments, including during this period (Sunni orthodoxy). Although the government tended to maintain Sunni orthodoxy, the rational thought of the Mu'tazilah continued to enter and influence theological discussions and debates. This created an interaction between the two different schools of thought, where the rational thought of the Mu'tazilah was used to understand and explain theological issues, even though it contradicted the majority Sunni view which was more based on texts and traditions.

4. Discourse in Andalusia did not rigidly separate religion and philosophy.

Islam views knowledge as a vital part of life. From the beginning, Islamic teachings have emphasized the importance of seeking, understanding, and practicing knowledge. This is clearly evident in numerous verses of the Quran that instruct humans to read, think, and use reason. The first verse revealed to the Prophet Muhammad (peace be upon him) was the command to read (Iqra'), indicating that the process of seeking knowledge is a highly noble form of worship in Islam.

In the Islamic perspective, the sources of knowledge come from two main sources: revelation and reason. Revelation is guidance from Allah SWT conveyed through the prophets, while reason is a gift given to humans to think and understand the world. The two are not contradictory, but rather complementary. Revelation provides direction and values, while reason helps humans understand and develop knowledge in various areas of life.

During the classical era, Islamic civilization experienced a period of extraordinary prosperity in the field of science. The development of science and culture during the classical Islamic civilization testifies to the glory of Muslims in the past. This period lasted from approximately the 8th to the 13th century CE, when the Islamic world became a global intellectual center. In major cities such as Baghdad, Cordoba, Cairo, and Damascus, advanced centers of learning emerged that were open to various scientific traditions, including those from Greece, Persia, and India.

One of the most famous centers of learning was the House of Wisdom in Baghdad, built during the reign of Caliph Harun al-Rashid and reaching its peak under al-Ma'mun.This institution was not only a library, but also a center for translation and scientific research. There, the works of Greek philosophers and scientists such as Aristotle and Galen were translated into Arabic, and then further developed by Muslim scholars. In the western Islamic region, Córdoba became a center of learning and culture in Andalusia (Islamic Spain), with a large library, university, and highly developed hospitals.

5. Philosophy is seen as a means of understanding the essence of truth, while religious knowledge serves as a normative guideline.

The emergence of philosophy cannot be separated from the various problems faced by humans in their lives. All of these fundamental problems faced by humans are sought for answers and solutions by philosophy, armed with reason. These range from questions related to the existence of God, the reality of the universe, to the essence of humanity itself as a being existing in this world. Philosophy is not alone in responding to these fundamental questions. Religion and science are two other tools that humans can use to address these issues. In this context, all three; philosophy, science, and religion can be used by humans to address the problems of their lives.

6. A debate arose between the orthodox group of fuqaha (who feared that philosophy interfered with faith) and the philosophers (who saw reason as a way of understanding revelation).

The debate between orthodox fuqaha (Islamic legal scholars) and Muslim philosophers occurred because of fundamental differences in views regarding the relationship between reason (ratio) and revelation, where orthodox fuqaha feared that philosophy could damage faith, while philosophers, such as Al-Kindi and the Mu'tazilah, saw reason as a tool to understand the truth of revelation and integrate it with philosophy.

In the realm of philosophy, theology can be divided into two categories: revealed theology and naturalist theology. Revealed theology is the study of God, with basic arguments derived from scripture or revelation. Revealed theology is bottom-up. Naturalist theology, on the other hand, is top-down. Naturalist theology discovers God through human thought about the universe and God's existence itself. This type of theology was widely followed by Muslim philosophers, such as Alfarabī and Ibn Sinī, as well as Sufi philosophers like Ibn ‘Arabī and Suhrawardī. Naturalist theology has an intimate relationship with philosophy. Its ideas fall within the realm of metaphysics, which encompasses theology.

Orthodox theology perceives God through various personifications. These personifications take the form of names and attributes of perfection. In this position, God is depicted as a personal being, just like humans, who require attributes. These attributes are derived from His self-mention in the Quran, including His beautiful names (asma' al-husna) and His attributes, obligatory, impossible, and divinely permissible, which are adopted from the holy book.

As a personal God, humans are considered capable of knowing God. God is touchable by humans. Humans are also able to think about God based on transcendent analogies of something immanent (such as the words "hand," "face," "enthroned," "descended," and so on). God is assumed to have immanentized Himself in the form of attributes and actions toward His creatures (such as gentleness, compassion, anger, and so on). God is depicted as a person who reigns with compassion on one side and anger on the other.

Philosophy Astronomy and Mathematics, Umayyad Dynasty in Andalusia:

1. **Observatories were established in Toledo and Cordoba.**

Muslim scientists actively contributed to the preservation and development of knowledge. By translating classical texts from ancient civilizations, they successfully preserved the intellectual heritage. Furthermore, Muslim scientists innovated and developed new concepts and theories that later became the foundation for the development of science in Europe. The sciences they developed included not only Islamic theology but also general sciences such as mathematics, medicine, chemistry, philosophy, and astronomy. Astronomy studies the universe. Based on the discovery of astronomical artifacts from prehistoric times, astronomy is known to be one of the oldest scientific disciplines in the world.

Abu Ishaq Ibrahim Ibn Yahya al-Naqqash al-Zarqali, better known as Al-Zarqali, or in Latin Arzachel, was born in 1029 CE in Toledo, Islamic Spain. He came from a family of metalworkers, which enabled him to become an expert in astronomical instrument making. His expertise in celestial observation made him one of the most influential astronomers of his time. After the Christian conquest of Toledo in 1085 CE, he moved to Córdoba and continued working until his death in 1087 CE.

One of Al-Zarqali's major contributions was the compilation of the Zij al-Safiha, or what was known in Europe as the Toledan Tables. This work contained astronomical tables that accurately recorded the positions of celestial bodies and was used for centuries by astronomers in Europe and the Islamic world. Additionally, Al-Zarqali created a universal astrolabe, an astronomical instrument that could be used at all geographic latitudes, unlike earlier versions that could only be used in specific regions. His work also included corrections for the length of the Mediterranean Sea and the non-uniform movement of the solar apogee, which approximated the heliocentric understanding before Copernicus.

The transmission of knowledge from Islamic civilization to Europe took place through various intellectual activities, including translation, book trade, and direct interaction between scientists from various regions. One important figure who made a significant contribution to the development of astronomy was Al-Zarqali, a pioneer in the development of significant scientific concepts. His success in measuring time and distance between celestial objects demonstrated a high level of accuracy and a deep understanding of astronomical phenomena.

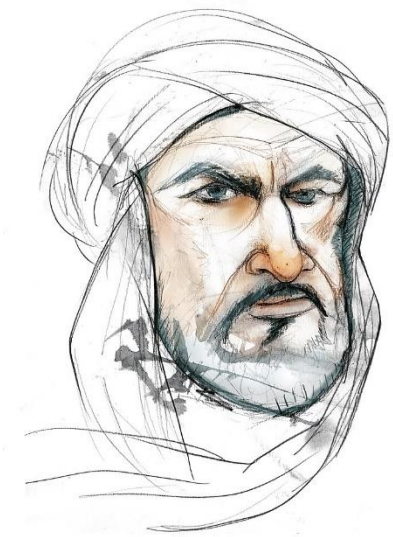

Figure 2. Abū Ishaq Ibrahim al-Zarqali (Source: Eulogia Merle - Fundación Española para la Ciencia y la Tecnología)

In the 5th AH/11th century AD, Al-Zarqali built an observatory known as the Zij Toledo, better known in the West as the Toledan Tables. This work became a monumental work and played a major role in the development of the history of astronomy in Europe. These tables contained astronomical data with a high degree of accuracy at the time and were widely used by European astronomers for the next several centuries, providing a foundation for more precise calculations of the movements of celestial bodies and replacing systems that were considered inaccurate at the time. Al-Zarqali's works were translated into Latin in the 12th century through a translation center in Toledo. At a time when Greek and Roman cultural heritage was threatened with extinction, Muslim scholars played a crucial role in preserving, developing, and re-examining the works of earlier figures such as Galen, Aristotle, and Ptolemy. When Europe experienced a crisis due to the dominance of the Church in the Middle Ages, Muslims translated the works of Greek philosophers and other discoveries. This translation process not only preserved the classical scientific heritage but also served as a bridge for the spread of knowledge from the contributions of Islamic civilization in Europe.

2. Mathematics (algebra, geometry) was taught, including the great influence of the works of al-Khawarizmi.

Mathematics, including algebra and geometry, is taught to this day, with algebra being a branch heavily influenced by the works of Muhammad ibn Musa al-Khwarizmi. Al-Khwarizmi is known as the "Father of Algebra" because in his famous book, Al-Kitab al-mukhtaṣar fi ḥisab al-jabr wal-muqabala, he introduced and explained the systematic solution of linear and quadratic equations, which became the basis of modern algebra.

Beyond simply solving equations, al-Khwarizmi provided the conceptual foundation for algebra as a distinct branch of mathematics. He introduced notation and symbols that facilitated calculations and generalizations, laying the groundwork for the development of more complex mathematics that followed. In addition to algebra, al-Khwarizmi was also instrumental in introducing Hindu-Arabic numerals to the Islamic world, which later spread to Europe and replaced the cumbersome Roman numeral system. This decimal number system, including its use of the crucial zero, revolutionized computation and paved the way for the development of science and technology.

Figure 3. Abu Ja'far Muḥammad bin Musa al-Khwarizmi (Source: Akmal Ayyubi)

Al-Khwarizmi's contributions were not limited to mathematics. He also made important contributions to astronomy and geography. He wrote works on the astrolabe, an important astronomical instrument of the time, and contributed to the creation of more accurate world maps. His works were translated into Latin in the 12th century and became standard texts in European universities for centuries, influencing the development of science in the West.

Al-Khwarizmi's influence was profound and transcended his time. He not only provided practical solutions to mathematical problems but also laid the conceptual foundation for the development of modern science. The term "algorithm," which we use today in computer science, is named after al-Khwarizmi, honoring his contributions in developing step-by-step procedures for solving problems.

Al-Khwarizmi's legacy lives on today. The algebra he pioneered has become a crucial foundation for mathematics, physics, engineering, and many other fields. The algorithms he immortalizes are the backbone of information and computer technology. Through his work, al-Khwarizmi made invaluable contributions to human civilization, and his name will be remembered as one of the greatest scientists of all time. He is a living proof of how Muslim scholars of the past have made significant contributions to the development of modern science.

Al-Khwarizmi had also contributed to the science of geography. As the book of Geography of Claudius Ptolemy (2nd century CE) was translated several times into Arabic, he had a model for writing his book in this field of knowledge. His book on geography entitled

Kitâb Sûrat al-Ard (Book of the image of the earth) consists almost entirely of lists of longitudes as well as latitudes of localities and gives in a tabulated form the coordinates of the places such as cities, mountains, seas, rivers and islands. The book is arranged according to the Greek system of the seven climes (aqâlim) giving contemporary data but the knowledge acquired by other Muslims is also incorporated into it. The first section lists cities, the second, mountains (giving the coordinates of their extreme points and their orientation); the third, seas (giving the coordinates of salient point on their coastlines and a rough description of their outlines); the fourth, islands (giving the coordinates of their centres, and their length and breadth); the fifth, the central points of various geographical regions; the sixth, rivers (giving their salient points and towns on them). This book had served as a basis for later works and stimulated geographical studies and the composition of original treatises. It is said that his Kitab Surat al-Ard was also accompanied by regional maps of each of the climes and by a single world map called “al-Surat al-Ma’muniyya” but these have been lost. It is also said that his map of the world was the first map of the heavens and the earth drawn by Muslims. But the editor of the Kitâb Sûrat al-Ard, Hans von Mzik, has produced only four maps. These four maps, in the words of S. Maqbul Ahmad, seem to be later recessions of the original maps. But Ibrahim Shawkat argues that since Al-Khwarazmi wrote a brief work on geography, he did not draw a complete map of the world but confined himself to draw only the four maps as an illustration. His source of inspiration might possibly have been the mappa mundi constructed for Caliph Al-Ma’mun by a team of geographers in which Al-Khwarazmi him self would have been included.

Medical and Pharmaceutical Sciences

1. Famous Andalusian physicians such as Abu al-Qasim al-Zahrawi (Albucasis) wrote al-Tasrif, a medical encyclopedia that was a reference in Europe until the 17th century.

Abu al-Qasim al-Zahrawi, also known as Albucasis, was a prominent Andalusian physician and surgeon of the 10th and 11th centuries. His encyclopedic medical work, the Kitab al-Tasrif (The Method), which included illustrated descriptions of surgical instruments and techniques, was translated into Latin and remained a leading surgical text in Europe until the Renaissance. Al-Zahrawi's pioneering contributions to the field of surgical procedures and instruments had an enormous impact in the East and West well into the modern period, where some of his discoveries are still applied in medicine to this day. He pioneered the use of catgut for internal stitches, and his surgical instruments are still used today to treat people.

He was the first physician to identify the hereditary nature of haemophilia and describe an abdominal pregnancy, a subtype of ectopic pregnancy that in those days was a fatal affliction, and was first to discover the root cause of paralysis. He also developed surgical devices for Caesarean sections and cataract surgeries

Al-Zahrawi specialized in curing disease by cauterization. He invented several devices used during surgery, for purposes such as inspection of the interior of the urethra and also inspection, applying and removing foreign bodies from the throat, the ear and other body organs. He was also the first to illustrate the various cannulae and the first to treat a wart with an iron tube and caustic metal as a boring instrument. Al-Zahrawi also pioneered neurosurgery and neurological diagnosis. He is known to have performed surgical treatments of head injuries, skull fractures, spinal injuries, hydrocephalus, subdural effusions and headache. The first clinical description of an operative procedure for hydrocephalus was given

by Al-Zahrawi who clearly describes the evacuation of superficial intracranial fluid in hydrocephalic children.

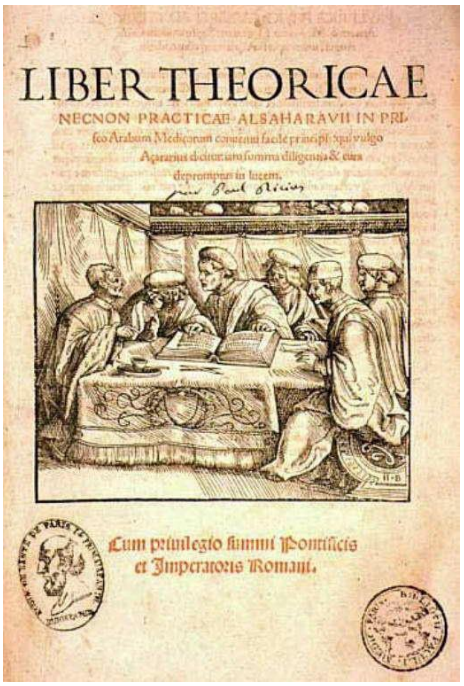

Figure 4. Frontispiece of the Latin translation of al-Zahrawi's Kitab al-Tasrif (Souce: Heinrich Petri)

Al-Zahrawi's thirty-volume medical encyclopedia, Kitāb al-Taṣrīf, completed in the year 1000, covered a broad range of medical topics, including on surgery, medicine, orthopaedics, ophthalmology, pharmacology, nutrition, dentistry, childbirth, and pathology.The first volume in the encyclopedia is concerned with general principles of medicine, the second with pathology, while much of the rest discuss topics regarding pharmacology and drugs. The last treatise and the most celebrated one is about surgery. Al-Zahrawi stated that he chose to discuss surgery in the last volume because surgery is the highest form of medicine, and one must not practice it until he becomes well-acquainted with all other branches of medicine.

Conclusion

The period of the Umayyad dynasty in Andalusia (756–1031 AD) marked a golden age of scientific and cultural flourishing in Europe. Under rulers such as Abd al-Rahman I, Abd al-Rahman III, and Al-Hakam II, Cordoba became one of the most advanced cities in the medieval world, renowned for its libraries, universities, and centers of learning. The Umayyad rulers strongly supported scholars, translating works of Greek, Persian, and Indian origin into Arabic, and integrating them into Islamic intellectual traditions. The establishment of libraries and madrasahs in Cordoba made Andalusia a hub for knowledge, attracting scholars from across the Muslim world and Europe. The interaction between Muslims, Christians, and Jews (convivencia) fostered an environment of intellectual exchange and tolerance that enhanced scientific progress. The Umayyad dynasty in Andalusia successfully combined Islamic intellectual traditions with classical knowledge, creating a vibrant scientific culture that not only advanced the Muslim world but also served as a bridge to Europe’s intellectual awakening.

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