

When Baghdad was centre of the scientific world

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The Bab al-Sharqi district of Baghdad as it is today (above). Photograph: Wikipedia

Islamic science had its heyday in the ninth century, thanks to Abū Ja'far al-Ma'mūn's House of Wisdom

The Bab al-Sharqi district in the centre of Baghdad derives its name, which means east gate, from the medieval fortifications of the city. These walls were probably built around the first half of the 10th century. During the brief British stay at the end of the first world war, its gatehouse was used as a garrison church. Nothing of those medieval walls, or the east gate, remains today; I remember Bab al-Sharqi as a sprawling, noisy and bustling square, with its food stalls and secondhand record shops scattered around the busy bus depot and taxi ranks. But its name is a reminder of the expansion and transformation of this proud city over the years since its foundation in AD762 as the new seat of power of the mighty Abbasid empire. Indeed, no other city on Earth has had to put up with the levels of death and destruction that Baghdad has endured over the centuries. And yet, as the capital of one of the world's great empires, this was the richest, proudest, most supercilious city on the planet for half a millennium.

Pathfinders: The Golden Age of Arabic Science by Jim Al-Khalili Buy it from the Guardian bookshop Search the Guardian bookshop Exactly 1,200 years after its foundation, I was born in Karradat Mariam, a Shia district of Baghdad with a large Christian community, a stone's throw away from today's Green Zone and a few miles south of the spot where one of Baghdad's most famous rulers was born in 786. His name was Abū Ja'far al-Ma'mūn. Half Arab, half Persian, this enigmatic caliph was destined to become the greatest patron of science in the cavalcade of Islamic rulers, and the person responsible for initiating the world's most impressive period of scholarship and learning since Ancient Greece.

By the eighth century, with western Europe languishing in its dark ages, the Islamic empire covered an area larger in expanse than either the Roman empire at its height or all the lands conquered and ruled by Alexander the Great. So powerful and influential was this empire that, for a period stretching over 700 years, the international language of science was Arabic.

The teenage prince Ma'mūn would have known Baghdad at the height of its glory: a vast, beautiful city characterised by the domes and archways of its famously intricate Abbasid architecture. It had grown to become the world's largest city just 50 years after the first brick was laid, with some estimates putting its population at more than 1 million.

Ma'mūn was not the only caliph to support scholarship and science, but he was certainly the most cultured, passionate and enthusiastic. As a young man, he memorised the Qur'an,

studied the history of early Islam, recited poetry and mastered the newly maturing discipline of Arabic grammar. He also studied arithmetic and its applications in the calculation of taxes. Most importantly, he was a brilliant student of philosophy and theology, or more specifically what is referred to in Arabic as *kalam*, which is a form of dialectic debate and argument. The early Muslim theologians found that the techniques of *kalam* enabled them to hold their own in theological discussions with the Christian and Jewish scholars who lived alongside them, and who had had a head start of several centuries to hone their debating skills by studying the writings of philosophers such as Socrates, Plato and Aristotle – historical figures from ancient Greece whose names would certainly have been known to the young Ma'mūn. It is even quite likely that by the early 9th century, some of their work had already been translated into Arabic.

Under Ma'mūn's patronage, and the spirit of openness towards other religions and cultures that he fostered, many scholars from all over the empire gravitated towards Baghdad, drawn by a vibrant sense of optimism and freedom of expression. Every week, guests would be invited to the palace, wined and dined, and then begin to discuss with the caliph all manner of scholarly subjects, from theology to mathematics. He would send emissaries great distances to get hold of ancient scientific texts: one, Salman, visited Constantinople to obtain Greek texts from the Emperor Leo V (Leo the Armenian). Often, defeated foreign rulers would be required to settle the terms of surrender to him with books from their libraries rather than in gold.

Ma'mūn was almost fanatical in his desire to collect all the world's books under one roof, translate them into Arabic and have his scholars study them. The institution he created to realise his dream epitomises more than anything else the blossoming of the scientific golden age. It became known throughout the world as the House of Wisdom (*Bayt al-Hikma*).

No physical trace remains of this academy today, so we cannot be sure exactly where it was located or what it looked like. Some historians even argue against exaggerated claims about its scope and purpose and the role of Ma'mūn in setting it up. But whatever its function – and many of Baghdad's scholars may not have been based physically within it – there is no doubt that the House of Wisdom has acquired a mythical status symbolising this golden age, on a par with the Library of Alexandria, 1,000 years earlier.

The House of Wisdom grew rapidly with the acquisition of texts from Greece, Persia and India, swelling with the addition of the Arabic translations of these texts, a process that was already becoming an industry in Baghdad. This growth would have gathered pace with the use of paper, the production of which the Arabs had learnt from Chinese prisoners of war, as a new and cheaper writing material replacing papyrus and parchment. The translators would have had scribes recording their work and producing multiple copies of each text. By the middle of the ninth century, Baghdad had become the centre of the civilised world, attracting the very best of Arab and Persian philosophers and scientists for several centuries to come.

The most famous of all the Baghdad translators, Hunayn ibn Ishāq, was born in the ancient Christian city of Hira and never converted to Islam. He would spend many years travelling around the world in his search for Greek manuscripts. It is the medical work of the physician Galen that is his most important legacy, for not only did it open up the Islamic world to this great treasure, in many cases it is only via these Arabic translations that much of Galen's work reaches us today.

The precocious young Hunayn had been introduced to Ma'mūn by the Banū Mūsa brothers, three colourful characters also associated with the House of Wisdom. The eldest, Mohammad, is said to have been the first person to suggest that celestial bodies such as the moon and planets were subject to the same laws of physics as on Earth - which marked a clear break from the received Aristotelian picture of the universe. Indeed his book, *Astral Motion and the Force of Attraction*, shows clear signs that he had a crude qualitative notion of such a force, albeit a far cry from Newton's universal law of gravity. The brothers are probably best known for their wonderful inventions and engineering projects. Most famous of all was their *Book of Ingenious Devices* (*Kitab al-Hiyal*), published in 850. This was a large illustrated work on mechanical devices that included automata, puzzles and magic tricks, as well as what we would today refer to as "executive toys". One of the most impressive is also possibly the earliest example of a programmable machine: a robotic flute player. Another person employed in the House of Wisdom by Ma'mūn is known to this day simply as "The Philosopher of the Arabs". His name was al-Kindi (801-873) (Latinised as Alkindus) and he is regarded as the first of the Abbasid polymaths. Born in Basra, an Arab from the powerful Kinda tribe, Kindi is thought to have moved to Baghdad early in life and received his education there. A great mathematician, he studied cryptanalysis and was the first great theoretician of music in the Islamic empire. But he is mostly famous for being the first to introduce the philosophy of Aristotle to the Arabic-speaking world, making it both accessible and acceptable to a Muslim audience. Central to Kindi's work was the way his writing fused Aristotelian philosophy with Islamic theology, thereby creating an intellectual platform for a debate between philosophers and theologians that would run for hundreds of years.

Another giant of Ma'mūn's Baghdad was mathematician Muhammad ibn Mūsa al-Khwārizmi. One of the 20th century's most famous historians of science, George Sarton, wrote a multi-volume reference book called *Introduction to the History of Science*, in which he divides up world history, going back to the sixth century BC, into half-century chapters, each named after the most important scientist of that age, anywhere in the world. The period between 800 and 850 is referred to as *The Time of al-Khwārizmi*.

Khwārizmi was born around 780 and died around 850. His name suggests that he was originally from Khorezm, a province of Uzbekistan. He worked in the House of Wisdom as a mathematician, geographer and astronomer. Together with Kindi, he was instrumental in introducing the Arabs to the Hindu decimal numerals that we use today. But his greatest legacy is his extraordinary book on algebra. Indeed, the word "algebra" is derived from the title of this book: *Kitab al-Jabr* (*The Book of Completion*) in which he lays out for the first time the rules and steps of solving algebraic equations.

And the reign of Ma'mūn was notable for more than just the scholarly writings of these individual geniuses. Not satisfied with setting up his seat of learning, Ma'mūn ordered the building of the first astronomical observatory in Baghdad around the second decade of the ninth century. This was the only way his astronomers could check the accuracy of the various, often conflicting, Greek, Persian and Indian astronomical texts at their disposal, most notably Ptolemy's *Almagest*.

The observatory was probably the world's first state-funded large-scale science project. We have only to look at current multinational, multibillion-dollar projects such as the Large Hadron Collider at Cern in Geneva to get a sense of what Ma'mūn managed to achieve on a much more modest scale, but with such spectacular results. He also put together an impressive team of mathematicians, astronomers and geographers to collaborate on the drawing of a new map of the world, and then charged them with devising a new way of

measuring the circumference of the Earth. In this sense, Ma'mūn's true legacy is that he was the first to fund "big science".

As for the philosopher Kindi, who outlived Ma'mūn, he seems to have fallen victim to a conspiracy led by the Banū Mūsa brothers, who had grown jealous of his extensive personal library and plotted against him until they persuaded the then caliph, al-Mutawakkil (847-861), to expel him from the House of Wisdom. He lived his remaining years a lonely man and after his death his philosophical work fell into obscurity.

His ideas were revived in the 10th century by Turkish philosopher al-Farābi, who continued Kindi's mission of the Islamicisation of Greek philosophy and would himself pass the baton to two men who achieved great prominence in Europe and would deeply influence many Renaissance thinkers. They were Ibn Sīna (980-1037) and Ibn Rushd (1126-98), both of whom are more familiar in the west by their Latinised names: Avicenna and Averroës. The former is best known as a physician and is by far the most famous scholar in Islam. His Canon of Medicine was required reading in Renaissance Europe right up to the 17th century – a remarkable shelf-life. Meanwhile Ibn Rushd, who was born in Cordobá, is thought of as the last of the great Muslim philosophers.

There are many other great men whose contributions are forgotten in the west, such as Iraqi genius Ibn al-Haytham, the greatest physicist in the 2,000-year span between Archimedes and Newton, al-Bīrūni, the Persian polymath regarded as the Da Vinci of Islam, al-Tūsi, a mathematician and astronomer who would influence Copernicus, and Ibn Khaldūn, the acknowledged father of social science and economic theory. All these men are no less worthy of mention in the history of science than Aristotle, Galileo, Newton or Einstein.

Of course, we will never really know what life was like within the House of Wisdom. But it is well established and uncontroversial that the much earlier academy in Alexandria was likewise more than just a library, for it not only brought together under one roof much of the world's accumulated knowledge, but acted as a magnet for many of the world's greatest thinkers and scholars. The patronage of the Egyptian Ptolemaic dynasty, which provided travel, lodging and stipends to those men, is not so different from the government research grants that university academics worldwide receive today to carry out their research.

If this backward projection of our idea of a research institution works for the Library of Alexandria, then it is just as valid in the case of Baghdad's House of Wisdom. It became the seed from which sprouted all the subsequent achievements of this golden age of science, from Uzbekistan in the east to Spain in the west.

I recall, as a boy growing up in Iraq, only hearing about the likes of al-Kindi and al-Khwārizmi during history lessons, rather than science lessons. Not only are their stories so rich to western ears, I hope that in reminding those in the Muslim world today of their rich scientific heritage, and how our current understanding of the natural world has been due in no small part to the contributions of these great scholars, that it might instil in many a sense of pride that can propel the importance of rational scientific enquiry back to where it belongs: at the very heart of what defines civilised and enlightened society.

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