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Seeking Seamless Celestial Globes: An Interview with Emilie Savage-Smith.

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SEEKING SEAMLESS CELESTIAL GLOBES: AN INTERVIEW WITH EMILIE SAVAGE-SMITH.

We marvel at the legacy of the ancient Egyptians who left us their awesome pyramids not to mention their colossal temples and obelisks. We do not credit them with scientific know-how, though we speculate on how they erected such mathematically exact and stupendous structures, long before the Greeks - lauded as the first scientists – made their impact on the world stage. The great pyramid of Giza was already a relic of antiquity when Greek and Roman invaders encountered them and both were as awe-struck by these astonishing stone sky-scrapers, as we are today - a feat all the more remarkable when we consider that until the 19th century these sole surviving wonders of the ancient world flaunted their supremacy as the tallest buildings to grace the earth's skyline.

In 1993 the BBC's flagship science strand, Horizon, screened a documentary[1], which attempted to answer the quandary of how the pyramids were built, by getting local labour, using traditional tools, to erect a pilot replica – a feasibility study if you like that might offer clues as to how the Egyptians designed and built their soaring tombs, that have stood the test of time over several millennia and never fail to astound and inspire by their sheer scale and pure geometry. It's hard to say if such tests, applied to feats of the past, that scientists today find hard to explain, make us wiser. In part, the flaw with applying such a test to outstanding landmarks of antiquity is that not only must we make assumptions about the technological know how of that era and the ways in which it was put to use, but we cannot conjure up the mindset and the inspiration unique to that cultural milieu that was surely integral to the successful completion of such massive construction projects. The pyramids continue to command admiration and awe, so much so that some find it inconceivable that they can represent the product of human imagination, ingenuity and toil of an era long gone, resorting instead to whacky and outlandish pseudo-scientific conjecture to explain them away, such as, the idea that they were built by aliens, because the Egyptians, it is argued, could not have possessed the know-how to achieve such lofty and audacious feats. They stand in brazen defiance to the assumptions of our scientific age and what we imagine to be the limits set by the rudimentary technology and tools of the era in which they were built. But what of those achievements of the past that today's experts tell us are technically impossible even in our hi-tech age?

CELESTIAL GLOBES

Such was the conundrum faced by historian of science, Emilie Savage-Smith, when she began her investigation, applying the most cutting edge tools of 20th century science to determine how celestial globes were made in the Muslim World. Savage-Smith is an internationally acclaimed authority on 'Islamic' Medicine. Happily, a chance encounter coupled with her forensic eye, set her on course towards a world wide quest which uncovered the unique construction of celestial globes made in parts of the Muslim World and led to a new understanding of the evolution of these instruments. More importantly her approach in this as in other areas of scholarship highlighted the diversity of techniques that were being innovated and put into practice long after the official decline of science and technology in the Muslim World had set in. Judging by her work it is apparent that in order to get a handle on a more realistic picture of the state of scientific advance in the Muslim World it is vital that today's scholars and historians of science do not confine their focus to those Arabic texts that were translated into Latin in the medieval period but that they also begin to look at the vast body of Arabic texts that escaped the attention of the European Arabic-to-Latin translation movement of the middle ages, thus were not translated and did not reach Europe. At a time when many deride the very notion of science and Islam co-existing, Savage-Smith's discoveries and her pioneering and on-going work in recovering and re-documenting the achievements in science and technology of Muslim civilisation, has led to a shift in reassessing the place of the medieval Islamic phase in the history of science. The thousands of Arabic manuscripts on a range of scientific subjects that languish in the basements of the world's leading museums and private collections, are testament to the diversity of sciences practiced after the rise of Islam and challenge the received view that science went into hibernation as the world entered the so called 'dark ages' after the collapse of the Greek and Roman empires.

Her discovery that the hollow metal globe she was asked to identify was an outstanding technical 'miracle', it being cast seamlessly in one piece and produced by a workshop of precision instrument makers in 16th and 17th century Mughal India, shocked the world's leading metallurgical experts. Prior to her investigation no one imagined that there might be anything extraordinary about the construction of some of these globes with their origins in classical antiquity. The very idea that they could be cast in one piece with no seam was dismissed, as being an impossible feat. As she says "When I first discovered these I was told by the museum as well as historians of metal work that that was physically not possible. You cannot cast a hollow sphere with no seam."

Astronomy is the oldest of all sciences, as early human communities became aware of the influence of stars and heavenly phenomena to life on earth. The early empirical observations and identification of star groupings or constellations and their positions and movements relative to terrestrial latitudes were used to devise ways of measuring time, the seasons and the calendar, all of which provided vital know-how - the best time to sow and harvest crops, as well as being indispensable for terrestrial and marine navigation and for mapping the earth. Every culture on earth evolved its own system of identifying and naming constellations. The Sumerian and Babylonian cultures of the Middle East developed a mathematical system that proved the most enduring and has been adopted, modified and augmented by Greek, Roman, Islamic and in our time, European astronomers to evolve into today's internationally recognised system of 88 constellations.

The celestial globe, known as al-kurah in the Muslim world, though in the 9th and 10th centuries it was also known as al-baydah (egg-shaped), is the culmination of the earliest attempts to map the sky, by the philosopher/ scientists of antiquity and was designed to track the position and movement of constellations and other celestial bodies relative to given terrestrial latitudes. The earth was regarded as the centre of the universe and surrounded by stars and other heavenly bodies. The Chaldeans and ancient Egyptians are thought to be the first to depict the sky and its stars on a sphere and the Greeks the first to construct celestial globes. Greek civilisation was contemporaneous with and overlapped that of the Middle East after Alexander the Great's eastern conquests ensured that the new centre of gravity of the Greek universe was no longer Athens but Alexandria, at the mouth of the Nile in Egypt. The consequent amalgam of Greek, ancient Egyptian and Babylonian gave rise to a flowering of science, in particular the science of astronomy, in the Hellenistic era, and it was this heritage that the Arabs became the new guardians of when they in turn conquered Alexandria in 641. No precision pre-Islamic celestial globes are known to exist but references to them abound in Greek, Roman, Sanskrit and of course Arabic writings on astronomy. Decorative globes were also in demand as were copies of older globes as evidenced by three globes that have survived the Egyptian and Graeco-Roman period. The oldest surviving is the metal Kugel globe, and a copy of an even older globe, clearly not made by a professional instrument maker since he replicated the evidence of repairs on the original, thinking they depicted celestial detail. The Mainz globe, also of metal is Roman/Egyptian and originally part of a sundial. The Farnese globe is a 2nd century AD Roman copy in marble of an older Greek globe.

Greek astronomy reached its apogee in Alexandria with the great Ptolemy (100 – 178 AD), the first to give a detailed description of a celestial globe. He modified the design to allow it to be used in more than one terrestrial latitude. After the Arab conquest, Baghdad, the seat of the Caliphate, became the new centre of astronomy, as major projects were undertaken to translate Greek, Sanskrit and other texts into Arabic. In 815 AD Ptolemy's major work on astronomy was translated in Baghdad by al-Hajjaj ibn Yusuf ibn Matar and became known the world over by its Arabic title – the *Almagest*. For many centuries it was the most important treatise on astronomy in Muslim lands and in Europe. From Ptolemy's star catalogue of 1025, stars in 48 constellations were updated by the leading astronomers of the Muslim World and indeed by modern astronomers. The 10th century Persian astronomer Abd al-Rahman al-Sufi (known as Azophi in Europe) translated, expanded on, challenged certain ideas in the Almagest (as did other Muslim astronomers) and also began the work of integrating the Greek and Arabic systems of naming stars and constellations, though remember, both had their origins in the Sumerian system. Al-Sufi observed that the star co-ordinates of many of the celestial globes that he came across were inaccurate when compared with actual observations and dismissed such globes as decorative rather than precision instruments. In 964 he published his Kitab Suwar al-Kawakab al-Thabithah (Book of Fixed Stars), which included his revised star catalogue giving corrections to Ptolemy's data. He omitted stars he believed did not exist, and in his accompanying text Al-Sufi detailed stars not included in Ptolemy's catalogue. Also, for each of the 48 constellations he drafted two illustrations, one as seen in the sky by an observer on earth and the other as it should look on the celestial globe. Al-Sufi's star catalogue was in turn revised by Ulugh Beg, the 15th century emperor/astronomer and grandson of Tamerlane. Along with precision instrument makers of the Muslim World, one or other of these two catalogues were used to arrive at the star co-ordinates depicted on their celestial globes and astrolabes. Thus the celestial globes that evolved in the Muslim World were rooted in their Hellenistic precursor which itself had evolved from Egyptian and Babylonian beginnings.

Decorative globes were no doubt as much in vogue in the Muslim World as in more ancient times. Even now Emily Winterburn, Curator of Astronomy at Greenwich Maritime Museum observes that, until recently most museums regarded even the precision made Islamic celestial globes as works of art rather than as scientific instruments. Celestial globes are still made and as in the past serve a dual function as decoration and teaching aids. However, the methodology of casting seamless metal spheres was lost as they became obsolete with the dawn of a new age of astronomy, in which Europe took centre stage as the new scientific power and pushed technological breakthroughs to stellar heights only dreamed of by Islamic and Greek astronomers of the past.

Savage-Smith's ground breaking study began in a somewhat impromptu fashion with a casual encounter, "I was with the Smithsonian in the division of medical sciences. At the time it was the National Museum of History and Technology" she recaps. One day the director of the Institution approached her. The museum had just acquired a celestial globe, inscribed in Arabic. Would she take a look at it and identify where, when and by whom it was made? On examining the globe she found it to be undated and unsigned whereupon the director suggested that she embark on a trawl of the museums of Europe and the Middle East to see if she could find any more. She set off on her expedition with her husband in tow. "You can take the pictures," she told him, mindful of how difficult it is to photograph spheres. Little did she realize that the assignment she had embarked on so casually would morph into a decade long quest, as it dawned on her that these globes were not just beautiful and superlatively crafted examples of metal work but were technical feats in themselves. Every museum had one or two of these globes and "I started to see signatures and dates," she says. Gradually she built up a picture of their construction and history. On her return to Washington, the Conservation and Analytical Laboratory of the Smithsonian Institution agreed to conduct a full range of tests using x-rays and cameras in order to identify the faintest trace of a join anywhere on the inside and the outside surface of the spheres, anything that might give a clue as to how the spheres were cast. By tracking down and studying a large number of the globes she was finally able to put together the pieces of the jig-saw puzzle and identify the maker of the anonymous Smithsonian globe that had set her off on her quest to solve the mystery of why such a fine instrument was left unsigned and undated. More crucially her detective work led her to identify the unique way the globe was constructed - something that had hitherto gone unnoticed. The anonymous Smithsonian instrument belonged to a remarkable family of globes that were seamlessly cast and made by one workshop in the city of Lahore, in present day Pakistan. As she discovered, this family of precision instrument makers, were the most prolific producers of seamlessly cast celestial globes and masters of the technique, establishing this as their particular area of expertise.

Savage-Smith's investigation found that celestial globes from the Muslim world fall into two categories: those made by casting two metal hemispheres and soldering these to produce a seamed globe, on which astronomical data is then inscribed. This was by far the easiest and the most common method of constructing metal globes. Most existing celestial globes are seamed and tend to originate in the Western parts of the Islamic world. The earliest surviving example of a celestial globe is a seamed globe and was made in Muslim Spain in Valencia in 473H/AD1080 by Ibrahim ibn Sa'id al-Sahli al-Wazzan and his son Muhammad. Until Savage-Smith's work it was assumed by historians of science and all metallurgical experts that all surviving metal globes made anywhere in the world are unquestionably seamed.

The second category is that of seamlessly cast metal globes. In her weighty monograph[2] in which she details the outcome of her decade long quest, Savage-Smith reveals that the process of seamlessly casting hollow metal spheres became well established in North Western India by the end of the 16th century. Though the Lahore workshop was the most prolific, she discovered other workshops were also making precision seamlessly cast globes. One example she found was made in Kashmir by Ali Kashmiri ibn Luqman in 998H/AD1589-90, in the reign of the Mughal Emperor Akbar. Another was made by Muhammad Salih Tahtawi in 1074H/AD1663-64 and is of interest for being inscribed in both Arabic and Sanskrit. Savage-Smith comments that seamlessly cast globes continued to be made in Lahore up to the mid 19th century. In 1842 Lala Balhumal Lahuri, a Hindu maker of precision instruments made such a globe, inscribed in Arabic and Persian for his Sikh patron. Savage-Smith adds that no workshop today, anywhere in the world, knows how to do this and indeed the casting of seamless metal spheres is regarded as technically impossible.

But how and where did the process originate? Savage-Smith speculates that the process may have been developed by the metal workers of Persia as early as the 13th century, since she also tracked down three apparently older seamlessly cast, hollow globes. However she expresses doubts as to the authenticity of these earlier examples. Are they genuine or later copies of older globes? Though skillfully cast seamless spheres, not only are they astronomically incorrect but the information inscribed on them is inconsistent with known historical detail.

Savage-Smith suggests that the technique for casting seamless metal spheres evolved from the ancient *cire perdue* or lost wax process. In his Book of Knowledge of Ingenious Devices, published in AD1206, Ibn al-Razzaz al-Jazari describes and discusses this technique, but as Savage-Smith points out he does not allude to the methods or potential problems associated with casting seamless metal spheres. As in the case of the pyramids, though the hieroglyphs on the internal walls depict the life of Egyptians and their religious beliefs (which inspired the building of the pyramids) there is no manual telling us how the pyramids were constructed. Similarly though there is considerable literature on celestial globes and their usage, however, with no methodology as to how seamlessly cast metal globes were made.

The Lahore workshop was founded by Ustadh Allahdad Asturlabi Lahuri, meaning master craftsman and maker of astrolabes from Lahore. Savage-Smith speculates that he may have enjoyed royal patronage at the court of Humayun the son of Babar, the founder of the Mughal dynasty, since his sons and grandsons designate him Shaikh Allahdad Asturlabi Humayuni Lahuri. By royal patronage or not, Allahdad's working life spanned the reigns of Humayun and Akbar. Allahdad's son, Mulla Isa ibn Allahdad continued the family business as did his grandsons Muhammad Muqim and Qai'm Muhammad. Having identified the Lahore workshop and the output of each generation of the family, it became clear to Savage-Smith that the anonymous Smithsonian globe was in all probability made by Qai'm Muhammad. But why did the maker leave such a fine instrument undated and unsigned? On closer examination Savage-Smith identified a factual error in the surface engraving and surmises that this caused him to cease work on this almost finished globe, leaving the unfinished instrument undated and unsigned. The same conclusion was arrived at independently by art historian, Andrea Belloli[3], making this a particularly satisfying instance of the fruitful collaboration that can be achieved by historians of science and art, using their different knowledge and methodologies.

Qai'm Muhammad's son Diya al-Din Muhammad was the most prolific maker of seamlessly cast globes and it is thought that in the course of his 44 year working life, spanning the reigns of emperors Shah Jahan and Aurangzeb, he moved the family workshop to Delhi which was then the seat of the Mughal court. "It's a four generation family," says Savage-Smith and the last of this family probably lived in the 1680s. The globes they made are magnificent pieces of metal work she says and adds: "One should see them. You can almost identify them across a room because their sphericity is so perfect."

It was by any standards a spectacular breakthrough, the stuff historians of science must dream of. It was, she says, one of her most enjoyable projects. Describing her work on the globes as inspiring, as it was "entirely new and absolutely creative," she says that aside from the sheer joy of highlighting such original and innovative craftsmanship, the celestial spheres sparked her interest in the history of astronomy. More importantly as she emphasises the project convinced her of the need to look beyond the confines of what was already known to Europe through the Arabic-to-Latin translation movement of the Middle Ages, which tended to restrict it's focus to the early period of the Islamic 'golden' age of science and also to works that achieved fame outside the Muslim World.

THE JOURNEY OF MEDICINE

The fortuitous opportunity to learn Arabic was the key that she says "gave me a window" to look more closely, initially at the connection between the Greek and the Islamic - how the newly emerging Islamic Caliphate picked up the torch for science after the demise of Greek science and how it diverged and followed independent pathways, in short how Arabic succeeded Greek as the new language of science. However, to begin with, Savage-Smith was far from making a decision to commit her career to 'Islamic' science. As she recaps: "I've always been interested even as a young person in the history of science (and) of medicine. It was my intention to work in that area."

In line with the traditional view that to get a handle on the history of science you had to trace it to its Greek roots; she combined her undergraduate degree in mathematics with the study of classical Greek. For her post-graduate studies she switched focus from mathematics to Late Greek medicine and commenced her doctorate at the University of Wisconsin, which had the world's largest and oldest department of the History of Science. It was at this time that the University appointed a Harvard academic to teach classical Arabic. She seized the chance because as she put it, "I had always been interested particularly in Egypt, not ancient Egypt, but the history of medieval Egypt …… so I enrolled in a course on Arabic."

This was the turning point. Amidst her growing awareness of the link between classical Greek and Arabic, she modified her original focus and decided to work with Classical Arabic and incorporate it in her doctoral thesis, choosing to edit an Arabic translation of a Greek medical text by Galen, a renowned second-century physician. Claudius Galen or Jalinus al-Hakim as he was known to Arabs was the master physician of the Roman Empire and perhaps the most influential physician in the history of medicine. He wrote prodigiously in Greek and almost all of his works were translated into Arabic in 9th century Baghdad. He was the major influence especially on medieval Muslim physicians though as we now know, not all of his pronouncements went unchallenged by later Arab physicians. However, as Savage-Smith's work highlights, this was something the medieval Arabic-to-Latin translation movement did not pick up on.

Explaining that in the United States a doctorate takes an average of 9 years, Savage-Smith's reading list encompassed a range in order to pass muster in related fields such as Islamic history, literature as well as science and the history of science. "In the course of all that I became aware of how incredibly rich and important the material was that was composed in Arabic," and "I knew then that it was the Arabic material I wanted to work with" she says.

If most people know anything about the history of early science and medicine and the link between classical Greek and Arabic, it is that the Arabs translated Classical Greek treatises be they mathematical such as Euclid or medical, into Arabic and that these were available in the Islamic world for several centuries before the push began in Europe to translate these back into Latin from the Arabic. Few make the connection that this link actually tracks the progress of science and technology from the Greek to the Renaissance period. But, Savage-Smith recalls that "when I started looking more at the Arabic material I realised that that is only one aspect of it." Beyond the link and far more exciting was the consolidation and reorganisation of existing knowledge and the addition of new knowledge and ideas. This transformation and strengthening of existing scientific literature, applied not only to medicine but also to mathematics, astronomy, cartography and other areas. "Once you realize that, it's much richer," there is no need then to view the Islamic phase in the history of science as "only a conduit by which Europe regained it's knowledge of Greece."

One end result of such a major cross border survey and reorganisation of the world's existing literature – and remember this venture was not confined to the Greek heritage but also took in the Persian and the Indian, was that medical encyclopaedias started to become commonplace. Savage-Smith points out that they were a rarity in Greek medical literature, an exception being a 7th century encyclopaedia compiled in Alexandria by Paul of Aegina. It is said that he was in Alexandria when the city fell to the Arabs in 641.

More significant changes were afoot as new material was added to the existing body of knowledge. In Baghdad "as early as the 9th century they were describing some entirely new diseases, diseases that were not known to Galen" says Savage-Smith. Smallpox was identified and described in detail for the first time and "a treatise was written on smallpox and measles and how to distinguish the two in the 10th century," she adds. This was written by al-Razi, who headed a hospital in Baghdad and died in 925. His treatise, she says, turned out to be very influential right up to the 18th century. By the early 10th century Arab physicians were naming and describing trachoma and its complications. "It's an eye disease. The major cause of blindness at the time was trachoma and its series of complications," she explains. One complication of trachoma is Pannus, and is a form of vascularisation of the cornea. Arab physicians realised that this, along with trachoma, was infectious and that it could be spread from person to person, something that had never been expressed by earlier physicians.

> *"Even more remarkably" says Savage-Smith, "they developed a surgical technique for actually removing it by using a series of small hooks to lift the cornea from the epithelium and cutting it with a small knife…. we have illustrations of the instruments they used. We have accounts of this technique being done for several centuries in the Islamic middle ages. The technique was translated into Latin and then into the vernacular in Europe and that very technique with virtually no change was used right through the First World War."*

One scientist /philosopher and physician who enjoyed overwhelming prestige and influence in Europe was Abu Ali al-Husayn Ibn Sina. Europeans, who knew him as Avicenna, regarded him as the world's foremost medical authority, on the basis of his famous book, The Canon of Medicine (Kitab al Qanun fi al-Tibb). Ibn Sina died in 1037 and at the end of the 12th century his Canon was translated into Latin by Gerard of Cremona, one of the most prolific translators of Arabic manuscripts. In 1527 a new Latin edition, translated by Andreo Alpago, who lived in Damascus for over 30 years, was published. Between 1500 and 1674, 60 editions of the canon were published in Europe. It held sway in Europe and dominated medical education through to the 17th century. This massive tome comprised 5 books, covering general medical principles, medicinal substances, and treatments for all known diseases from head to toe, systemic diseases such as fevers, and finally recipes for making remedies. Ibn Sina was the outstanding logician of his day, though it is thought by some that he may never have been a practicing physician, says Savage-Smith. He organised his canon "in a very logical way into sections, sub-sections and sub-sub-sections" she adds, producing the most highly detailed medical text book of it's time. The end result was so large that in Europe it was referred to as the ultimate authority - the magnum opus of the Islamic world in the field of medicine.

But the Canon of Medicine, though important in the Muslim world, was by no means the best the Islamic world had to offer, as Savage-Smith points out, and was certainly not unanimously regarded as the ultimate authority by Muslim physicians who came after Ibn Sina. Muslims continued to revere Ibn Sina after his death as the outstanding scientist/ philosopher and logician that he was, but in the field of medicine things moved on, as later Muslim physicians challenged Ibn Sina and indeed the master physician, Galen himself. The tremendous influence of Ibn Sina's Canon was in reality rather unfortunate for the development of medicine in Europe says Savage-Smith because it stultified Europe and closed it to other, newer influences from the Islamic world. "There were people, particularly in Egypt and Syria, in the 12th and 13th centuries who did very original monographs." Her own studies have drawn attention to "the work of the 12th and 13th century eye surgeons, surgical procedures and how really innovative that was." Sadly the work of these people "never gets incorporated into the larger medical view" as so much of this work remains in the Muslim World, untranslated.

One leading physician who wrote commentaries expressing criticisms of the way Ibn Sina organised his Canon, was Ibn al Nafis, who was born in Damascus in 1213 and died in 1288. He criticised the Canon for the way the human anatomy sections were organised and the descriptions scattered. So for instance the anatomy of one part of the body was described with the diseases of that part, instead of all anatomy being under one section. In the same critique and much more importantly Ibn Nafis made medical history by being the first physician in the world to challenge Galen in regard to the anatomy of the heart and the path of the pulmonary or lesser circulation of the blood. He stated that the blood in the right ventricle must reach the left ventricle via the lungs and not through passages or invisible holes connecting the two ventricles, as Galen believed.

> *"…..the blood from the right chamber of the heart must arrive at the left chamber, but there is no direct pathway between them. The thick septum of the heart is not perforated and does not have visible pores as some people thought or invisible pores as Galen thought. The blood from the right chamber must flow through the vena arteriosa (pulmonary artery) to the lungs, spread through it's substance, be mingled with air, pass through the arteria venosa (pulmonary vein) to reach the left chamber of the heart….."*

Ibn Nafis described his finding some three centuries before these same findings were described by Europeans, Michael Servelus and Realdo Colombo. His discovery was missed by Europe, in large measure, because Europeans thought that medical science had peaked in the Arab/Islamic world with the death of Ibn Sina. Hence, few if any Arabic medical treatises that were written after the death of Ibn Sina were translated into Latin.

Interestingly, as Savage-Smith points out, by the 18th century the Canon of Ibn Sina was not even known in Arabic, in some parts of the Muslim world, but was re-introduced from Europe through its Latin translations, rather the way Europe's classical Greek heritage was re-introduced back into Europe by Arab translations of the original Greek. It was this re-introduction that engendered a renewed interest in the Arab world in returning to the Canon.

To return to Ibn al Nafis, some of his work did get translated into Latin, but not until 1547 - by the same Andreo Alpago, who's translation of Ibn Sina's Canon was published 20 years earlier as a new edition in Europe. But his commentary disputing Galen's ideas on the anatomy of the heart and the path of the pulmonary circulation did not resurface until the 20th century.

As with many scientists of his time, Ibn Nafis as well as being a physician was also a philosopher and theologian, and was highly regarded as an expert in the Shafi'i school of jurisprudence. After training in a Damascus teaching hospital, Ibn Nafis moved to Cairo where he became prominent as the first head of the al-Mansuri hospital. It has been suggested that Ibn al Nafis based his description of pulmonary circulation and the anatomy of the heart upon dissection of the heart. Dissection of the human corpse is a somewhat controversial in Islam. Although seeking knowledge was and is regarded as a religious duty, was it permissible to dissect the human body in order to further medical knowledge?

"There was no real ban" says Savage-Smith and stresses that to her knowledge no ulema ever actually made a statement that it was inappropriate to carry out dissection. In fact, she adds "there are some treatises that actually call for dissection" and offer instructions on how the body should be prepared for dissection, as "it is only through dissection that you are going to properly understand anatomy." However she believes that dissections were never actually carried out, as there is no indisputable evidence to this effect. It is not clear she says if Ibn Nafis actually dissected a human corpse, in order to arrive at his conclusion of the pulmonary circulation. He was, she says, "indisputably a major legal scholar," and certainly he never states any restrictions against dissection. It is possible she thinks, that he may have dissected animals and extrapolated his observations to the human heart.

What of other medico-legal controversies? Were there situations where the ulema were called upon to intervene and issue *fatwas* or legal opinions – a yes or a no, for or against particular medical practices? Savage-Smith relates two instances she has come across. Both relate to whether it was permissible to cut open the abdomen of a pregnant woman who had died, in order to save her unborn child. In both cases she says, the ulema gave the green light and deemed it theologically permissible to do so.

What is interesting, she says, is that "in every medical encyclopaedia that has been written in Arabic in the medieval period as well as in the surgical treatises there is a very large section on treating diseases of women." All the treatises, certainly those that have been studied, have been written by men and they do contain some very interesting comments in relation to treating women's gynaecological problems. Instructions on treating certain conditions specify that in order to treat the condition you must get a midwife to follow directions. If you cannot find a qualified (meaning experienced) midwife find an educated woman who can follow instructions. If you cannot find an educated woman find any woman but make sure she follows the physician's directions. Which begs the question: how did the learned male physician know what to do in the first place?

Savage-Smith says a great deal came handed down from the Greeks. But how much of this transferred knowledge was modified and evolved, and on what basis, is hard to judge.

A substantial amount of the literature on women's diseases is devoted to problems such as how to remove a dead foetus from a pregnant woman safely, as if this is not done urgently after the foetus dies the mother's life is put at risk. The literature also contains techniques for childbirth and how to control bleeding after childbirth. It is not known she says if these procedures were performed by male or female physicians or by midwives under instructions of physicians, or otherwise.

There are however references to female physicians especially in Spain. We know of two members of the rather prominent Ibn Zuhr family of Spanish Muslim physicians and evidently they treated women, Savage-Smith states. Women certainly worked as attendants in the female wards of hospitals. There is anecdotal evidence of women employed in various health areas but the problem, she says is that no one has made attempts to look at this systematically. Women physicians undoubtedly practiced because there are diatribes male physicians have written lamenting that "most people prefer to go to an ignorant woman physician" rather than to a male physician (like me). But in most cases she says, all we know is the title of these treatises: “We haven’t actually read them and translated them to find out what the arguments are”. This takes us back to the point reiterated by historians of ‘Islamic’ science concerning the vast amount of work that remains to be done.

How were physicians able to fund the writing of these thousands of treatises with their labour intensive calligraphy, hand drawn or painted illustrations and illumination? The patronage of the courts was obviously key and as Savage-Smith says “court physicians would often write a treatise dedicated to a local ruler” and these rulers were sometimes very prominent. Similar systems of patronage prevailed in Europe for a long time. Court patronage or support for scholarship from wealthy and highly placed individuals was one way a learned physician got enough money together to write a treatise. We also have records of people indicating that it was considered both very prestigious and very lucrative to head a hospital. We know, Savage-Smith says that hospitals had staffs of physicians on various levels. Physicians did daily rounds much like they do today and there is clear evidence of bedside teaching as part of the function of the larger suburban hospitals in Baghdad for instance. Records show that the city of Baghdad alone had between 10-12 hospitals. The hospitals we know most about through documents that have survived are those built in Syria and Egypt in the 12th and 13th centuries. The large hospital of Damascus built in 1187 still stands and is used to this day, but as a medical history museum rather than a hospital. Cairo had 4-5 important hospitals as did the urban centres of India, Turkey and North Africa. Cairo was the adopted home city of Ibn Nafis, who on his death he donated his house, library and clinic to the al-Mansuri hospital, of which he was also head. Physicians also had consulting rooms in *souks* or markets. Wealthy people on the other hand got physicians to come to their home.

But why is it that when a search is done on Muslim scientists of the past the same 10 or 12 names result. Are these individuals all there is to represent the zenith of scientific achievement of a period that lasted several centuries? And what of the ones who came after, the authors of the thousands of treatises that still survive? Why do we not know their names?

But we do in fact know the names of these individual authors, counters Savage-Smith, and not just from the manuscripts they left behind but also from the many volumes of biographical dictionaries that have survived. Many biographical dictionaries were compiled on physicians alone in the 12th and the 13th centuries and these volumes contain a wealth of material. The compilers would do a history of all the physicians they knew up to their day. These are invaluable tools for researchers as they provide sources of information in which the user would be able to discover other writing by a particular physician. Such volumes cover thousands of names and titles. But, Savage-Smith concedes that only specialists know of this material.

However she stresses that a major problem of working in this field, whether it’s the history of medicine or astronomy or any other area, is the sheer number of manuscripts that remain to be read and translated. “These are tremendously large in number,” especially from the 10th to the 13th centuries and so far “we’ve only looked at a very few of these.” To give some idea of the numbers Savage-Smith cites the Bodleian Library collection, which happens to be very good in this area and has roughly five hundred Arabic treatises anywhere from the 9th century to the most recent from the late 18th century. As historians now appreciate a great deal of this work did not cross into Europe due to the fact that it was never translated into Latin.

What is becoming clear Savage-Smith states is that the push to translate Arabic manuscripts into Latin included very little in the way of treatises that were composed after the beginning of the 12th century. Increasingly, over the course of her work over the years Savage-Smith herself has become interested in untranslated Arabic works, as this work hosts "a community of great intellectual and practical curiosity and achievements."

Najma Kazi
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Based on an interview with Emilie Savage-Smith conducted on 12th October 2004 at the Oriental Institute in Oxford.
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3. Andrea Belloli contributed a chapter – The Constellation Figures on the Smithsonian Globe, to Savage-Smith's book on Islamicate Celestial Globes, detailing how she examined the anonymous Smithsonian globe as a art historical document, analyzing its style and iconography and arrived at the same conclusion as Savage-Smith in regard to the identity of the globe.
4. For eye diseases and the work of Ibn al-Nafis, see Emilie Savage-Smith, "Ibn al-Nafīs's *Perfected Book on Ophthalmology* and his treatment of trachoma and its sequelae," *Journal for the History of Arabic Science*, 1980, *4*:147-206.
5. For attitudes towards dissection, see Emilie Savage-Smith "Attitudes toward dissection in medieval Islam," *Journal of the History of Medicine and Allied Sciences*, vol. 50, 1995, pp. 68-111.