

# Essay summary of lupain ng taglamig



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Arabic mathematics: forgotten brilliance? Indian mathematics reached Baghdad, a major early center of Islam, about ad 800. Supported by the ruling caliphs and wealthy individuals, translators in Baghdad produced Arabic versions of Greek and Indian mathematical works. The need for translations was stimulated by mathematical research in the Islamic world. Islamic mathematics also served religion in that it proved useful in dividing inheritances according to Islamic law; in predicting the time of the new moon, when the next month began; and in determining the direction to Mecca for the orientation of mosques and of daily prayers, which were delivered facing Mecca. Recent research paints a new picture of the debt that we owe to Arabic/Islamic mathematics.

Certainly many of the ideas which were previously thought to have been brilliant new conceptions due to European mathematicians of the sixteenth, seventeenth and eighteenth centuries are now known to have been developed by Arabic/Islamic mathematicians around four centuries earlier. In many respects the mathematics studied today is far closer in style to that of the Arabic/Islamic contribution than to that of the Greeks.

There is a widely held view that, after a brilliant period for mathematics when the Greeks laid the foundations for modern mathematics, there was a period of stagnation before the Europeans took over where the Greeks left off at the beginning of the sixteenth century. The common perception of the period of 1000 years or so between the ancient Greeks and the European Renaissance is that little happened in the world of mathematics except that

some Arabic translations of Greek texts were made which preserved the Greek learning so that it was available to the Europeans at the beginning of the sixteenth century.

That such views should be generally held is of no surprise. Many leading historians of mathematics have contributed to the perception by either omitting any mention of Arabic/Islamic mathematics in the historical development of the subject or with statements such as that made by Duhem in :- ... Arabicscienceonly reproduced the teachings received from Greek science. Before we proceed it is worth trying to define the period that this article covers and give an overall description to cover the mathematicians who contributed.

The period we cover is easy to describe: it stretches from the end of the eighth century to about the middle of the fifteenth century. Giving a description to cover the mathematicians who contributed, however, is much harder. The works and are on " Islamic mathematics", similar to which uses the title the " Muslim contribution to mathematics". Other authors try the description " Arabic mathematics". However, certainly not all the mathematicians we wish to include were Muslims; some were Jews, some Christians, some of other faiths.

Nor were all these mathematicians Arabs, but for convenience we will call our topic " Arab mathematics". We should emphasize that the translations into Arabic at this time were made by scientists and mathematicians such as those named above, not by language experts ignorant of mathematics, and the need for the translations was stimulated by the most advanced research

of the time. It is important to realize that the translating was not done for its own sake, but was done as part of the current research effort.

Of Euclid's works, the Elements, the Data, the Optics, the Phaenomena, and On Divisions were translated. Of Archimedes' works only two - Sphere and Cylinder and Measurement of the Circle - are known to have been translated, but these were sufficient to stimulate independent researches from the 9th to the 15th century. On the other hand, virtually all of Apollonius's works were translated, and of Diophantus and Menelaus one book each, the Arithmetica and the Sphaerica, respectively, were translated into Arabic.

Finally, the translation of Ptolemy's Almagest furnished important astronomical material. ... Diocles' treatise on mirrors, Theodosius's Spherics, Pappus's work on mechanics, Ptolemy's Planisphaerium, and Hypsicles' treatises on regular polyhedra (the so-called Books XIV and XV of Euclid's Elements) ... Perhaps one of the most significant advances made by Arabic mathematics began at this time with the work of al-Khwarizmi, namely the beginnings of algebra. It is important to understand just how significant this new idea was. It was a revolutionary move away from the Greek concept of mathematics which was essentially geometry. Algebra was a unifying theory which allowed rational numbers, irrational numbers, geometrical magnitudes, etc. , to all be treated as " algebraic objects". It gave mathematics a whole new development path so much broader in concept than that which had existed before, and provided a vehicle for future development of the subject. Another important aspect of the introduction of algebraic ideas was that it allowed mathematics to be applied to itself in a way which had not happened before.

Al-Khwarizmi's successors undertook a systematic application of arithmetic to algebra, algebra to arithmetic, both to trigonometry, algebra to the Euclidean theory of numbers, algebra to geometry, and geometry to algebra. This was how the creation of polynomial algebra, combinatorial analysis, and numerical analysis, the numerical solution of equations, the new elementary theory of numbers, and the geometric construction of equations arose. Let us follow the development of algebra for a moment and look at al-Khwarizmi's successors.

About forty years after al-Khwarizmi is the work of al-Mahani (born 820), who conceived the idea of reducing geometrical problems such as duplicating the cube to problems in algebra. Abu Kamil (born 850) forms an important link in the development of algebra between al-Khwarizmi and al-Karaji. Despite not using symbols, but writing powers of  $x$  in words, he had begun to understand what we would write in symbols as  $x^n$ .  $x^m = x^{m+n}$ . Let us remark that symbols did not appear in Arabic mathematics until much later.

Ibn al-Banna and al-Qalasadi used symbols in the 15th century and, although we do not know exactly when their use began, we know that symbols were used at least a century before this. Al-Karaji (born 953) is seen by many as the first person to completely free algebra from geometrical operations and to replace them with the arithmetical type of operations which are at the core of algebra today. He was first to define the monomials  $x$ ,  $x^2$ ,  $x^3$ , ... and  $1/x$ ,  $1/x^2$ ,  $1/x^3$ , ... and to give rules for products of any two of these. He started a school of algebra which flourished for several hundreds of years.

Al-Samawal, nearly 200 years later, was an important member of al-Karaji's school. Al-Samawal (born 1130) was the first to give the new topic of algebra a precise description when he wrote that it was concerned:- ... with operating on unknowns using all the arithmetical tools, in the same way as the arithmetician operates on the known. Omar Khayyam (born 1048) gave a complete classification of cubic equations with geometric solutions found by means of intersecting conic sections. Khayyam also wrote that he hoped to give a full description of the algebraic solution of cubic equations in a later work .

If the opportunity arises and I can succeed, I shall give all these fourteen forms with all their branches and cases, and how to distinguish whatever is possible or impossible so that a paper, containing elements which are greatly useful in this art will be prepared. Sharaf al-Din al-Tusi (born 1135), although almost exactly the same age as al-Samawal, does not follow the general development that came through al-Karaji's school of algebra but rather follows Khayyam's application of algebra to geometry. He wrote a treatise on cubic equations. .. represents an essential contribution to another algebra which aimed to study curves by means of equations, thus inaugurating the beginning of algebraic geometry. Let us give other examples of the development of Arabic mathematics. Returning to the House of Wisdom in Baghdad in the 9th century, one mathematician who was educated there by the Banu Musa brothers was Thabit ibn Qurra (born 836). He made many contributions to mathematics, but let us consider for the moment consider his contributions to number theory.

He discovered a beautiful theorem which allowed pairs of amicable numbers to be found, that is two numbers such that each is the sum of the proper divisors of the other. Al-Baghdadi (born 980) looked at a slight variant of Thabit ibn Qurra's theorem, while al-Haytham (born 965) seems to have been the first to attempt to classify all even perfect numbers (numbers equal to the sum of their proper divisors) as those of the form  $2^{k-1}(2^k - 1)$  where  $2^k - 1$  is prime. Al-Haytham, is also the first person that we know to state Wilson's theorem, namely that if  $p$  is prime then  $1 + (p-1)!$  is divisible by  $p$ .

It is unclear whether he knew how to prove this result. It is called Wilson's theorem because of a comment made by Waring in 1770 that John Wilson had noticed the result. There is no evidence that John Wilson knew how to prove it and most certainly Waring did not. Lagrange gave the first proof in 1771 and it should be noticed that it is more than 750 years after al-Haytham before number theory surpasses this achievement of Arabic mathematics. Continuing the story of amicable numbers, from which we have taken a diversion, it is worth noting that they play a large role in Arabic mathematics.

Al-Farisi (born 1260) gave a new proof of Thabit ibn Qurra's theorem, introducing important new ideas concerning factorisation and combinatorial methods. He also gave the pair of amicable numbers 17296, 18416 which have been attributed to Euler, but we know that these were known earlier than al-Farisi, perhaps even by Thabit ibn Qurra himself. Although outside our time range for Arabic mathematics in this article, it is worth noting that in the 17th century the Arabic mathematician Mohammed Baqir Yazdi gave

the pair of amicable number 9, 363, 584 and 9, 437, 056 still many years before Euler's contribution.

C. Arabian Mathematics/ Islamic Mathematics In the 9th century Arab mathematician al-Khwarizmi wrote a systematic introduction to algebra, *Kitab al-jabr w'al Muqabalah* (Book of Restoring and Balancing). The English word algebra comes from al-jabr in the treatise's title. Al-Khwarizmi's algebra was founded on Brahmagupta's work, which he duly credited, and showed the influence of Babylonian and Greek mathematics as well. A 12th-century Latin translation of al-Khwarizmi's treatise was crucial for the later development of algebra in Europe. Al-Khwarizmi's name is the source of the word algorithm.

By the year 900 the acquisition of past mathematics was complete, and Muslim scholars began to build on what they had acquired. Alhazen, an outstanding Arab scientist of the late 900s and early 1000s, produced algebraic solutions of quadratic and cubic equations. Al-Karaji in the 10th and early 11th century completed the algebra of polynomials (mathematical expressions that are the sum of a number of terms) of al-Khwarizmi. He included polynomials with an infinite number of terms.

Later scholars, including 12th-century Persian mathematician Omar Khayyam, solved certain cubic equations geometrically by using conic sections.

Arab astronomers contributed the tangent and cotangent to trigonometry. Geometers such as Ibrahim ibn Sinan in the 10th century continued Archimedes's investigations of areas and volumes, and Kamal al-Din and



others applied the theory of conic sections to solve problems in optics.

Astronomer Nasir al-Din al-Tusi created the mathematical disciplines of plane and spherical trigonometry in the 13th century and was the first to treat trigonometry separately from astronomy. Finally, a number of Muslim mathematicians made important discoveries in the theory of numbers, while others explained a variety of numerical methods for solving equations.

Many of the ancient Greek works on mathematics were preserved during the middle Ages through Arabic translations and commentaries. Europe acquired much of this learning during the 12th century, when Greek and Arabic works were translated into Latin, then the written language of educated Europeans. These Arabic works, together with the Greek classics, were responsible for the growth of mathematics in the West during the late middle Ages.

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All rights reserved. D. Origin of the Word Algebra The word algebra is a Latin variant of the Arabic word al-jabr. This came from the title of a book, *Hidab al-jabr wal-muqubala*, written in Baghdad about 825 A. D. by the Arab mathematician Mohammed ibn-Musa al-Khowarizmi. The words jabr (JAH-ber) and muqubalah (moo-KAH-ba-lah) were used by al-Khowarizmi to designate two basic operations in solving equations. Jabr was to transpose subtracted terms to the other side of the equation. Muqubalah was to cancel like terms on opposite sides of the equation.

In fact, the title has been translated to mean " science of restoration (or reunion) and opposition" or " science of transposition and cancellation" and " The Book of Completion and Cancellation" or " The Book of Restoration and Balancing. " Jabr is used in the step where  $x - 2 = 12$  becomes  $x = 14$ . The

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left-side of the first equation, where  $x$  is lessened by 2, is "restored" or "completed" back to  $x$  in the second equation. Muqabalah takes us from  $x + y = y + 7$  to  $x = 7$  by "cancelling" or "balancing" the two sides of the equation.

Eventually the muqabalah was left behind, and this type of math became known as algebra in many languages. It is interesting to note that the word al-jabr used non-mathematically made its way into Europe through the Moors of Spain. There an algebrista is a bonesetter, or "restorer" of bones. A barber of medieval times called himself an algebrista since barbers often did bone-setting and bloodletting on the side. Hence the red and white striped barber poles of today.

## II. Insights

The Arabian contributions to Mathematics are much used around the world.

Their Mathematics shows a perfect way to represent numbers and problems, in a way to make it clearer and easier to understand. They have discovered many things about mathematics and formulated many formulas that are widely used today. I learned from this research that Arabs mathematics started when Indian mathematics reached Baghdad and translated it into Arabic. They improved and studied Mathematics and formulated many things. They become more famous when they discovered Algebra and improved it.

Many Arabian mathematicians became famous because of their contributions on Mathematics. Many ancient Greeks works on mathematics were preserved through Arabic translations and commentaries. I am enlightened about the origin of what are we studying now in Mathematics. Now I know

that majority of our lessons in mathematics came from Arabians not from Greeks. I also learned that many mathematicians contributed on different branches and techniques on mathematics and it take so much time for them to explore and improve mathematics.