traders” as mentioned in Tarih al-Rusul wa'l-Muluk by Tabari. It seems that the rulers of the young state were afraid that striking a new coin might lead to disturbance of commercial relations between the market of Arabia and international markets.

To wrap up, when talking of currency, we have to remember the following:

First: sources mention that some governors like Mu'awiya and Mus'ab bin al-Zubair struck dirhams in the Sassanian style, similar to the dirhams introduced by some of the Guided Caliphs. The sources mention the dirhams struck by Imam Ali in Basra in the year 40 AH, but these did not survive and they never reached the researchers. It is described as an imitation of Sassanian dirham but without the images of Persian Kings.

Second: Currency always reflected the state's political and economic sovereignty as well as weakness. Strong currency acted as a successful political weapon, as the Fatimid's used their strong gold dinar, supported by the great wealth of gold they compiled in Sudan when they ruled Morocco, in working to cause the fall of the Abbasid currency in Egypt after they moved to Cairo. In his book Shudur al 'Uday al-Sharaf al-Naqib, Al-Maqrizi states: “The Mu'izz dinar became so common that when al-Mu'izz came to Egypt in 362 AH and stayed in his palace in Cairo, he appointed Yaqub bin Kilis and 'Aslog bin al-Hassan to receive the tribute and they would accept nothing but Mu'izz dinar. At this point Al-Radi dinar was devalued by more than a quarter dinar, while the Mu'izz dinar was equivalent to fifteen and half dirhams”.

We have already referred to the Fatimid’s conflict with the Umayyads in Cordoba, during their reign of Morocco and against Bani Midjar and the Safarids in Sejlimana. It was not an ideological conflict, but it was rather over the control of gold-trade routes with Sudan. They assembled large quantities of gold ready to move the centre of Islamic caliphate to Egypt and hence they could rule the Islamic East. A strong gold dinar was struck as a successful tool to carry on that strategy.

In his book Itiz al-Hurafa, Al-Maqrizi talks of that wealth saying: “when Al-Mu’izz decided on departure to Egypt, Balkin bin Ziri brought him 2000 camels from the Zanata in order to carry the treasures of his palaces. He minted his dinars in the form of mills, putting 2 pieces on each camel, in the middle of each; a hole was pierced by which a piece was joined to the other. Soldiers as well as citizen were so impressed by such a view and they used to stand on the road watching that mobile treasury.”

It is well known that the scarcity of gold and silver currency led to the striking of fake dinars and dirhams which motivated some rebellions like that of Darahim, which took place in Qairawan during the Aghlabid reign. At that time of political and economic decline, people tended to transfer the gold they had into jewellery for women or stored at home, which deprived the local economy of its benefits.

Al Maqrizi in his book Al-Sulh I’marafat dual-Muluk, describes how economic crises prevailed in the Ayyubid era: “because gold and silver left and never came back. It almost disappeared and people complained of what they suffered as a result of that shortage”.

Third: Currency was commonly struck in the different centres of political sovereignty and commercial activity flourishing in these centres, especially during the time of good prosperity. This initiated two financial professions whose members enjoyed a special status in both economic and political fields. These were the money-exchangers and mint officials.

The work of the money-exchangers was not only to evaluate money as far as quality and weight were concerned or to transfer dinars into dirhams and vice versa. Their profession grew with the development of economic activity, so they worked in money-lending, accepting deposits, and also as mediators between citizens and the mint house. They used to take gold and silver from the people in order to be minted and take in return the equivalent money, making their profit from the difference in value. Money-exchangers, always appealed to the moderate and flexibility of some jurisprudents in order to find some legal solutions that enabled them to go beyond the strict rules set by extreme law scholars.

The 2nd profession was practiced by those working in mint houses established in capitals and big cities. It was accessible for all who wanted to change gold or silver into currency in return for a small fee.

As for official money, it was only struck with official permission. In this respect Imam Ahmed bin Hanbal said “striking of dirhams should only take place in the mint house with the Sultan’s permission, since people tend to go to extreme when given license”.

Research has shown that although Copernicus (1473 - 1543) based his work namely on these Greek sources, he also utilised two theorems produced by astronomers working within the Arab world and writing mainly in Arabic. The first theorem is now called the Tusi Couple, after the famous astronomer and polymath, Nasir al-Din al-Tusi (d.1274) who first proposed it in 1247, and later formalized and proved it in 1259 (figure 1 and 2). This theorem appears again in the works of Copernicus, in the 16th century, and is deployed to solve the same problems that it was used to solve in the Arabic sources where it was first conceived. In the early seventies, the late German historian of science, Willy Hartner, drew attention to the fact that even the geometric points employed in the diagram preserved in the Copernican works were labelled identically to the geometric points used in the diagram of Tusi three centuries earlier. He noticed that where the Arabic diagram has a geometric point designated with the letter A, the Copernican diagram has the corresponding point marked with the equivalent letter A, where the Arabic has B the Copernican diagram has B, and so on.

The second theorem is slightly more subtle, but just as simple. I have dubbed it the ‘Urdi Lemma, after Mu'ayyad al-Din al-Urdu (d.1266), who first proposed it sometime before 1250. This theorem appears in the astronomical constructions of Copernicus, serving exactly the same purposes it had served in the works of Urdu three centuries earlier. The only difference is that in Urdu's work the theorem is consciously introduced as a new theorem and provided with a full formal mathematical proof, while in the works of Copernicus it was taken for granted and thus left without any such proof.

Because of its relative neglect in the works of Copernicus, it later became the subject of a correspondence between Kepler and his teacher Maestlin, where Kepler asked his teacher specifically about this theorem in Copernicus' astronomy. In 1973, Anthony Grafton of Princeton University demonstrated how Maestlin supplied the proof to the theorem in his answer to Kepler. The two theorems are organically embedded within Copernican astronomy, so much so, that it would be inconceivable to extract them and leave the mathematical edifice of Copernican
astronomy intact. It has also been demonstrated that these were the same as the ones first proposed and proven in the Arabic astronomical works some three centuries earlier, and had served the same astronomical, and mathematical functions. Furthermore, both were used in the context of creating alternatives to Greek astronomy.

There is no talk at this point of heliocentrism, the concept commonly stressed in Copernican astronomy. Copernican heliocentrism is itself stressed (with hindsight) at the expense of the mathematical foundations of Copernican astronomy, that he developed and used before taking the last step of displacing the centre of the universe from the earth to the sun. In mathematical terms, heliocentrism can be accomplished simply by reversing the direction of the last vector connecting the earth to the sun. The rest of the mathematics involved in both types of astronomical systems could then remain the same. That fact was well known to pre-Copernican astronomers, notably the polymath Biruni (d. 1049), and was dismissed as a philosophical problem and not an astronomical/mathematical one.

This shift in the Copernican system from the earth to the sun made no cosmological sense at the time of Copernicus, particularly because there was no theory of universal gravitation to account for the cosmological implications of a system with only one central mathematics, and similar observations, astronomers working within the Islamic world could account for the planetary positions just as well as Copernicus or even Ptolemy for that matter, despite the fact that the astronomers of the Islamic world continued to work within the earth-centred Aristotelian system which was perfectly defensible then. The central problem for them had nothing to do with the issue of heliocentrism, but with issues related to the lack of inner consistency within Greek astronomy. They were seeking mathematical constructions that did not exhibit a contradiction with the physical realities they were supposed to represent, as was clearly done in the defunct Ptolemaic astronomy.

Both Copernicus and his predecessors in the Islamic world were attempting to remove those inconsistencies, which included among other things such famous problems as the equant circles that became the subject of complaint by astronomers working on both sides of the Mediterranean. There is no clear evidential underpinning of the Copernician introduction to his Commentarius.

The discovery that such solutions to the Ptolemaic predicament were being vigorously pursued in the Islamic world first and then in the works of Copernicus has ignited some sparks over the last forty years or so and framed the question in terms of contacts between the world of Islam and Europe or in terms of the influence of one on the other.

From the perspective of blurred borders, the possibility of the mobility of ideas similar to those expressed in these two theorems becomes, itself, very intriguing. It clearly had serious implications for the autonomy of the Renaissance scientific tradition and the Arabic/Islamic scientific tradition, and has further implications for the concept of "local" versus "world" or "universal" science.

The transmission of scientific ideas from the Islamic world to Europe raises certain problems. First, there is no concrete evidence that Copernicus himself could read Arabic in order to benefit directly from the research that was still going on in the Islamic civilization, or from the Arabic texts containing such theorems. Second, there is no concrete evidence that such Arabic works were ever translated into Latin, the language that Copernicus could read and write. It is known that Copernicus could read Greek, and it is well known that he lived and studied in northern Italy for a period of about ten years. The likelihood of his coming across the particular Greek manuscript uncovered by Neugebauer was thought to be plausible, first by Neugebauer and later more forcefully by Swerdlow in a side statement in their joint work that such Arabic theorems were indeed circulating in Italy around the year 1500, thus implying that Copernicus could have learned about them from his contacts in Italy.

Should this manuscript be thought of as part of the "Greek" science that contained no such theorem in its history or as part of "Islamic/Arabic" science that was "transplanted" back into Greek and copied in this manuscript, was first formulated? The author of the Byzantine Greek manuscript is supposed to have gone into the lands of Islam towards the beginning of the 14th century for the express purpose of learning the latest findings in the previous century, both went to Syria in order to learn Arabic and in the case of Andreas Alpagos, was mentioned above, and his predecessor Hieronimo Rammusso (d. 1486 in Beirut), the two Venetian physicians, who lived mostly in the 13th century, went to Syria in order to learn Arabic and the in the case of Andreas returned to teach Medicine in Padua, as was also stated above, just about the same time when Copernicus was obtaining his doctoral degree in law from the University of Ferrara. The results of this fact-finding mission. Among those results was the Tusi Couple. In this context, it is perfectly legitimate to ask whose science is the science contained in that late Greek Byzantine manuscript?

The discovery of the Tusi Couple in a Greek manuscript that could have been accessible to Copernicus accounts fairly well for the possible transmission of that theorem through the Greek route. The second theorem, however, has not yet had the similar fortune, as it has not yet been documented in a similar way by people like Postel and others. More importantly they could have incorporated what they learned of "Arabic" science into their "Latin/ Western" science as was done by Postel, or could have used their knowledge of "Arabic/Islamic" science to effect projects that were carried out by "Latin/Western" institutions as was done by the Patriarch Nifias siblings, for example. It is in those instances that it becomes difficult to classify such scientific production under one cultural rubric or the other.

The second issue concerns the intellectual environment in Italy during the Renaissance and the role played by Arabic manuscripts in that period. The evidence briefly illustrated here points to the distinct possibility that Arabic manuscripts were being studied in Italy during the time of Copernicus in the same fashion as they were still being studied by Postel and others at a slightly later date. One can legitimately argue that, if later scientists like Postel still felt they needed Arabic manuscripts in order to study astronomy, would not the earlier scientists like Alpagos, who went through the exercise of translating whole Arabic works into Latin instead of only annotating them, be available for Copernicus to consult regarding the latest in Arabic astronomy at the time? The latest in that astronomy was the production of full-size texts attempting to reformulate Greek astronomy and including the two theorems that were incorporated by Copernicus.

The thousands of Arabic scientific manuscripts that are still housed in European libraries, may have their own stories to tell, not only about the transmission of Arabic science, but also about the use made of such manuscripts by some Renaissance contemporaries of Copernicus like Andrea Alpagos, Postel, Raimondi, and many others whose stories we have not even begun to unravel.

The evidence illustrates very clearly the futility of designating science with a cultural, civilization, or linguistic adjective. There is the even more perplexing question of distinguishing linguistic adjectives to the scientists themselves when it is obvious that their work either knew no defined cultural, civilization or linguistic boundaries, or boundaries encountered that were at best blurred. Most tellingly, a name has still to be found for the production of the Tusi Couple, that was first encountered in an Arabic text, written by a man who spoke Persian at home, and used that term, like many other astronomers who followed him who were all working in the Arabic/Islamic world, in order to reform classical Arabic astronomy, translated into Byzantine Greek towards the beginning of the fourteenth century, only to be used later by Copernicus and others in Latin texts of Renaissance Europe. One could easily dream up for that kind of science, and whose science it was anyway?
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Dr. Yehiya Bin Jenaed
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