CONCEPTION OF COSMOS IN MEDIEVAL ISLAM

Cultural and historical background

Medieval Islamic astronomy is intrinsically bonded to astrology and often these two "sciences" were used in connection with Quran .
Early Islamic scholars relied their studies mainly upon books written by Greek, Babylonian and Iranian precursors. Specially under the Abbasid and Omayyad caliphates the translation of Greek "science" books was strongly encouraged. Both Shiite and Sunnite scholars gave tremendous contribution to the development of art, science and a new conception of cosmos.
But there was a big difference between how the Shiite and the Sunnite had a different approach toward the Greek heritage and in particular its philosophy. Sunnite gave more importance to Quranic and shari'a law studies, considering science, logic and philosophy as tools to improve the quality of daily life. On the other side the Shia embraced greek logic and science as a mean to deepen the comprehension of Quran.
This vision is particularly stressed from S. H. Nasr (George Washington University), while other scholars like M. Salama (San Francisco State University) believe that the contribution to science in the first 4-500 years of Islam was also due to other culture coexisting with Muslim Arabs like Jews and Christians. In fact the first 4-500 years of Islam were a period of great ferment and cultural development, where both Sunnite and Shiite scholars contributed greatly to the development of Islamic thought. Definitely it can't be said that during the period of time commonly known as "middle age" the culture and thinking in the Arab world (and in the east in general) was so obscured as in Europe: in fact they were living what was later called the "golden age of Islam".
Muslim medieval scientists inherited and developed cosmological ideas that were accepted for a long time. One of these was the belief that the world was divided into seven climate stripes and that the stripe where Islamic world had developed was considered the most liveable one.
We will now see three of the main vision of cosmos that were formulated around the 10th century.

Rasa' il Ikhwan al-safa'

One of the most influential work about science and cosmology in this period in the Arab world is Rasa' il Ikhwan al-safa' (Encyclopaedia of the Brethren of Purity). This is a collection of writings about almost any topic (including astronomy,astrology,mathematics and logic) and it was written by a esoteric brotherhood existing in Basra (a city in nowadays Iraq) during the 10th century (we don't know anything about their members).
This book is one of the first historical encyclopaedia and is strongly influenced by platonic philosophy. They use rhetorical figures and above all

mathematical similarities. As S.H. Nasr states that " Ikhwan considered numbers as the cause of all things and the key to understand the harmony pervading the Universe", in fact they considered the being (in this case matter=4) represented by the number 4 caused by the efficient cause 1 (God), 2 (Intellect) and 3(Soul); the Ikhwan considered matter as a spiritual being and it manifested in many phases, the last of which is the common objects we daily encounter.
Also the scholar F. Schuon observes that Ikhwan considered a divine relation between numbers and geometrical figures and that they inherited this qualitative and universal (more than quantitative) view from Pythagoras.
Ikhwan compared God relation to the world as that of One to the other numbers, and every number had a deep significance in the history of universe creation, building in this way a hierarchy of the universe where all the beings and the whole universe itself seek the Creator.
Moreover they adopted the thinking of the Pythagorean philosopher Nichomacus who believed that the most important subject to study among the *Quadrivium* (arithmetic, geometry, music and astronomy) was arithmetic because "it existed before all others in the mind of the creating God and because it is naturally prior in birth than other sciences".
Definitely they considered numbers as a projection of the Unity, and with geometrical figures they were considered tools to reach the world of archetypes; numbers are also used as a bridge from the language of the revelation to the language of Nature.
Ikhwan called Nature (which manifested itself only under the spheres) the way the Soul (2) expressed itself in the bodies (simple and complex). Similarly to Aristotle the simple bodies are fire air water and earth and the three complex bodies are made of them: minerals plants and animals.
Their spheres conception was strongly influenced by Aristotle and Ptolomy: they believed Earth being at the centre of the Universe with Moon, Sun and the planet of the Solar system (until Saturn) rotating around it. Beyond Saturn there were the fixed stars and then the outer sphere. All of them had circular orbits and are made by the fifth element, which unlike Aristotle and Avicenna doesn't create two separate worlds because the fifth elements included all the other four (from this starting point they built their own astrology).
Ikhwan adopted Ptolomy astronomy and justified the precession of the equinox through a spherical epicycle. Their conception of matter denied the existence of the void and so their Universe was finite and "neither void nor plenum".
As we already said Ikhwan took into great consideration numbers and so they attributed numbers to the celestial spheres and gave interpretation to object in space using mathematics. They managed to calculate the precession of the equinox and estimated it to be of 36000 years; they could forsee the occurrence of the planets conjunction and give astrological explanations.

They took into account the distances and the volumes (adopting mostly the calculations of their predecessors) to measure celestial objects in our solar system; we observe that few data were similar to nowadays calculations (e.g. the sizes of the Moon and Mercury).

Al Biruni

Abu Rayhan al-Biruni was one of the most influential scholars in the Islam golden age. He was born in central Asia and was a courtier of the Ghaznavid Sultan Mahmud. He had contributed to most of the sciences of his time and rebutted many points of Aristotles' philosophy.
Biruni conception of cosmos always refers to God as the Creator and as a consequences he refuses the idea of eternity of time; influenced by Hinduism cosmology he gives a qualitative interpretation of time by which "far from being under a uniform condition, the cosmic environment as well as human society, which is closely wed to it, possesses certain characteristics and modes of existence belonging to the particular period in which it has come into existence" (Nasr page 118).
His religious belief brought him to claim that according to the economy of nature nothing is useless neither wasted (but it is not necessary a simple or logic economy because it derives from the wisdom of the Creator).
Al-Biruni took into great consideration measurements and experiments. For instance he managed to measure the radius of Earth by standing on the top of a mountain near the sea: if we suppose Earth to be a perfect sphere we see that the result he obtained is very close to recent measurements.
Consistently to the spread beliefs of his time he claimed that Earth was at the centre of the Universe and the Cosmos was spherical. Abu Rayhan believed there were 8 heavens: fixed stars, Saturn, Jupiter, Mars, Sun, Venus, Mercury and the Moon; below these there is the region of generation and corruption where Earth is. This vision is in contrast to Cosmos models of Greek scholars because it doesn't included a ninth heaven, which was introduced in order to explain the precession of the equinox.
As he was very concerned with measurements he estimated the size and the distance from Earth of the 7 nearest heavens; unfortunately he relied on Ptolomy data and results, therefore his calculations may differ from nowadays measurements up to two order of magnitude. He was aware of the need for experiments in order to establish correct results and therefore he did not claim to be right.
Al-Biruni came in touch with the Heliocentric theory during his permanence in India, and for almost all of his life he did not prefer the one more than the other because he believed that both models were not contradicting astronomy and that the correct answer should be given by physics. But then when he calculated the velocity of the Earth in the hypothesis of the Heliocentric

model he couldn't explain all the physics on the Earth with such a huge speed and so he rejected this hypothesis.
Another interesting element of his cosmological model is about the source of light. The Ikhwan had a strong view about it and believed that the Sun carried order and harmony through light in all the Universe and similar view was shared in all the Islamic world. On the contrary al-Biruni believed that the Sun and also the other planets emitted light. He supported this idea in the concern that nor his hypothesis nor the other one were neither proved to be correct nor to be wrong by physics. He explained the fact that we saw most of the light from the Sun because every planet had a different and lower brightness. He could explain and give proofs of this hypothesis by assuming the Earth-centric model: in fact he stated that we could see planets like Venus and Mercury (which are nearer to the Earth than the Sun) just because of the light they emit. But he believed that the Moon was not emitting light otherwise we would have seen a permanent full Moon.
Al Biruni was an incredibly eclectic observer: he studied deeply the conformation of the Earth and was one of the founder of geology. He, like many other Muslim scientists, were aware of the fact that the surface of the Earth was transforming: they (and more than everybody else Al Biruni) studied the stratification of rock: " We have to rely upon the records of the rocks and vestiges of the past to infer that all these changes should have taken place in very very long times and under unknown condition of cold and heat: for even now it takes a long time for water and wind to do their work". Moreover he was able to correctly interpret the reason of the existence of fossils and the sedimentation of deposit due by the fluxes of the rivers: while studying with coring the banks of Gange river at different points (at the source and near the mouth) he could infer a relation between the size of rocks and the position of the rock respectively to the river. Conversely to European medieval science the study of geology (and natural sciences in general) was common to Muslim scientists of this time because of two main reason:

i) Quran affirm that "all perishes save the face of Allah", which was interpreted for the continuous transformation of nature and so as an encouragement to deepen this comprehension;

ii) the possibility for Muslim scientists to travel for huge distances and so study very different environments.

Avicenna

Abu Ali al-Husayn ibn Abd Allah ibn Sina (in latin Avicenna) was a Persian polymath. He lived across X and XI century. His father cared a lot about his education: since he was very young he knew grammar, theology, literature and the Quran. Just as a teenager he was already a famous physician and during his life he travelled a lot through courts of Muslim kingdoms in order

to gain patronage. He wrote a lot of books and the topics he studied were almost all those known at his time.
Like Al-Biruni, Avicenna didn't prefer Sunna or Scia; during his lifetime he faced many criticism accusing the unorthodoxy of his theories. Despite this he was one of the most influential philosophers of middle age scholastic and Islamic culture. He was inspired by many writings from other cultures (Greek, European, Indian..) and he was always wondering how to fit his philosophy and these other philosophies to the Muslim perspective.
Nasr observes that Avicenna believed that "all knowledge involves the analogy of the beings of particular things with Being itself which stands above and anterior to the Universe. The highest form of knowledge, in fact, is the knowledge of Being itself, to which the knowledge of mathematics and physical world are subordinated "(page 197). From this conception of knowledge follows that Avicenna believed that the principles of the natural philosophies (sciences) couldn't be proofed within science; he believed that this question was concerned to the Theological and Metaphysical fields.
Avicenna imagined the universe (Geocentric, of course) to be made of nine celestial spheres and below them the world of corruption and transformation. He conjectured spheres to be nine: eight of them were the Ptolemaic, while to the last one he gave a Theological meaning (rather than an astronomical meaning as Greeks did); this conception of the celestial spheres was the most common among Muslim astronomer.
He adversed a lot the common attitude of astrology (which he considered anyway a fundamental topic) to formulate exact previsions for the future; he argued in particularly using the "fact" that Celestial bodies (which are incorruptible because made of Ether) cannot influence events happening on Earth because they are not made of the other four elements (which are corruptible).
Avicenna cosmological model was influenced a lot by Aristotle ideas: he believed that everything in the world of corruptions was made of the four elements (which had their natural places) and developed Aristotle conception of matter and form: these two factors melt together create life.
One of Avicenna several studies was about metereology. He divided air in four layers and considered this assumption the basis for his explanations of meteorological events; he hypothesized seven different causes for the thunder and 4 different causes for the lightning, which he considered as two independent events.
Similarly to Al-Biruni also Avicenna undertook the study of the soil and in particular of rocks. He studied riverbeds, pieces of asteroids (which he compared to Earth's rocks), fossils and mountains. His account about the formation of a rock is really vanguard, in fact he states that stones are being created from two different processes:

1) the hardening of clay,

2) freezing of water

Avicenna was also able to explain the existence of fossils by assuming inundations.
Studying mountains he interpreted their formation through earthquake, which he believed to be caused by a violent release of gases residing under the soil.
Concerning life, Avicenna believed that the lowest domain of being on Earth was the reign of minerals. He believed that all the minerals were a combination of mercury and sulphur (and just few of them a combination of mercury and gold). Thanks to this conception he became famous in Europe also as an alchemist, but he rejected transmutation (turning metals in gold) because he believed that it couldn't solve humanity problems.
Plants are considered as the following step after minerals. They have a higher amount pureness and are more equilibrate. After the plants come the animals which are still more "perfect" and pure than plants, but animals differ from plants because they have a soul attached to their form and their matter. After animals there are human beings, which are characterized by the possibility to purify their soul and consequently reach the Angels in the celestial spheres.

At this point it can't be said anything about Ulugh Beg and his scientific work even if he lived 400 years after the period we just studied.

Ulugh Beg

Ulugh Beg was a Mongolian ruler who lived in XV century; the capital of his domain was in Samarcanda. He was a grandson of Tamerlane and he had the chance to visit the Maragha observatory when he was young; it is thought that this experience made him interested in astronomy and mathematics.
When Beg ascent the throne he built an observatory in Samarcanda with the largest meridian ever; having a big meridian means that the distance between the grades is bigger and so the measurement of the apparent precision is higher (Ulugh Beg didn't have a telescope, so he needed a huge sextant in order to get the highest precision possible).
With this observatory he, with the help of many employees, was able to calculate the coordinates of Samarcanda with a relatively small error of (0;3;14) south.
He collected all his data in a manuscript where there is also a table with some values of co-sinus and sinus with a very high precision. Among all the scientific measurements he made there is the 16 digit correct calculation of π.
One of his greatest work was a catalogue of more than one thousand stars;

this work was made in order to adjust astronomical data collected by Ptolomy.

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