

Returning science to Islam – the rocky road ahead

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On the morning of the first Gulf War in 1991, having just heard the news of the US attack on Baghdad, I walked into my office in the physics department in a state of numbness and depression. Mass death and devastation would surely follow. I was dismayed, but not surprised, to discover my PhD student, a militant activist of the Jamaat-i-Islami's student wing in Islamabad, in a state of euphoria. Islam's victory, he said, is inevitable because God is on our side and the Americans cannot survive without alcohol and women. He reasoned that neither would be available in Iraq, and happily concluded that the Americans were doomed. Two weeks later, after the rout of Saddam's army and 70,000 dead Iraqis, I reminded him of his words. He had nothing to say.

But years later, soon after earning a reasonably good doctorate in quantum field theory and elementary particles, he quit academia and put his considerable physics skills to use in a very different direction. Today he heads a department that deals with missile guidance systems inside a liberally funded, massively sized defence organisation employing thousands to make nuclear weapons and missiles. Serving Pakistan and Islam, as he sees it, gives him a feeling of pride. Plus it pays about three times as much as a university job.

Technology is very welcome

In modern times every form of intellectual endeavour in Islam stands in poor health. Science, in particular, is almost nowhere to be seen. Nonetheless, several Muslim countries have aimed for nuclear

weapons and the highest kinds of technology. As the little episode above illustrates, defence technology is accorded top priority and has been more successful than science. The emphasis is reflected not just in salaries but also in research funding and social status. The nexus between technology and defence is made at a student's early stages of development. For example, freshmen at the elite Lahore University of Management Sciences are introduced to the fundamentals of computer science with the following textbook preface: 'It is military prowess that bestows technical and economic superiority to nations, and it is not otherwise. The association of science and technology with ruling empires is, therefore, natural.'

Technological nationalism – the association of power and national greatness with technology – finds its expression in the yearly celebration of Pakistan's nuclear achievements. While Iraq, Iran, and Libya have actively sought to make nuclear weapons, Pakistan is the only Muslim country to have achieved this goal. Since May 1998 the Pakistani state has flaunted its nuclear potency publicly, proudly, and provocatively. Nuclear shrines, erected with government funds, dot the country. One – a fibre glass model of the nuclear-blasted Chaghi Mountain – stands at the entrance to Islamabad, bathed at night in a garish, orange light. Officialdom has vigorously promoted nuclearisation as the symbol of Pakistan's high scientific achievement, national determination, self-respect, and the harbinger of a new Muslim era. Pakistan's Islamic parties rushed to claim ownership after the nuclear tests, seeing in the Bomb a sure sign of a reversal of fortunes, and a panacea for the ills that have plagued Muslims since the end of the Golden Age of Islam many centuries ago. Their hero was (and largely remains) Dr Abdul Qadeer Khan, a metallurgist with intimate knowledge of uranium enrichment technology acquired during his stint in Holland with URENCO, a European uranium enrichment consortium. Abdus Salam, the Nobel prize-winner of theoretical physics, remains largely unknown.

Technology was surrounded by religious taboos in earlier times.

But it is rapidly gaining acceptance in Muslim societies and earlier restrictions seem virtually incomprehensible to Muslims today. Public clocks had been banned in 16th-century Turkey under the Ottomans; the printing press was roundly condemned by the orthodox *ulema* in Muhammad Ali's Egypt; loudspeakers (even for the call to prayers) were once disallowed on religious grounds on the Indian subcontinent; and so forth. Some prohibitions still stand, but are rapidly weakening. Today prohibitions on blood transfusions and organ transplants are generally disregarded everywhere in the Muslim world in spite of orthodox restrictions. Television under the Taliban was severely restricted but has made its way into Muslim homes almost everywhere. In fact, technological innovation – even in matters relating to religious practices and rituals – is now welcomed by a growing consumerist middle class. Commercially available devices include Islamic screen savers and computerised holy texts, cell phones with GPS indicators indicating the direction towards *qibla*, prayer mats with sensors that keep count of the number of kneel-downs and head-downs for the forgetful; and electronically recorded voices that help in remembering the 99 names of Allah.

Science remains problematic

Islam's relationship with science, on the other hand, is less comfortable. To remove possible ambiguities, let me define 'science': it is the process wherein knowledge about the physical world is acquired in a systematic and logically self-consistent manner by observation, experimentation, testing of hypotheses, and observer-independent verification.

Some Muslims bristle at the very suggestion that there might be a disjuncture between Islam and science. A common reaction is to point towards the debt owed by modern science to the achievements of their ancestors. Indeed, Muslim intellectual giants such as Omar Khayyam, Jabir Ibn Hayyan, and Alhazen, are rightly remembered for their front-ranking intellectual achievements. But

this does not solve the compatibility issue: it is a mistake to think that modern science is simply a more advanced form of ancient science. The two are separated by fundamentally different goals and world views.

In ancient times, science was a matter of discovering curious and interesting new phenomena and facts. These would sometimes tickle the fancy of kings and caliphs, and make the scholar rich or famous. The relation of science with technology was a distant one – a scientific discovery would only rarely result in the creation of new implements or tools, weapons of war, or new architectural methods and designs. Most importantly, given the state of knowledge in pre-modern times, it was simply not possible to have today's view of the universe wherein every physical phenomenon is traceable to physical principles. Modern science insists that these laws are rationally comprehensible, and have validity far beyond the situation from which they were deduced. For example, the laws of physics governing the motion of a falling stone are identical to those that determine the motion of a spacecraft travelling to Venus. These very laws also determine the manner in which DNA replicates, cells divide, or electric signals communicate information inside a computer. In this modern view, the human body is undoubtedly an immensely complex mechanical and electrical system. However, every part can be fully understood in terms of biological, chemical, and physical processes.

Modern scientific thought clearly comes with a high price tag. Before the Lutheran Reformation, this provoked a bitter battle between its adherents and the Church. In contemporary Islam, where there is no formal centre of religious authority, the reactions have been more varied.

Fortunately, the dominant Muslim response to the issue of the compatibility of science with Islam is a rather sensible one – that of indifference. Most Muslims are quite content with a vague belief that there is consistency rather than conflict. This is helped by the generally held view that science is a conglomeration of techniques,

formulae, equipment, and machines. At best, science creates new gadgets and even jobs. At worst, it is something technical, which is dreadfully boring and difficult to learn. In any case, the reasoning goes, it is better not to worry excessively over arcane matters.

But others will not let sleeping dogs lie. In recent years the applications, methodology and epistemology of modern science have been severely criticised by growing numbers of Muslim academics. At one level, these are familiar postmodernist arguments: the development and application of a science that claims to be value-free is held to be the prime cause of the myriad problems facing the world today – weapons of mass destruction, environmental degradation, global inequities in the distribution of wealth and power, alienation of the individual, and so forth.

At another level, many orthodox Muslims reject the scientific method as well as the notion of science as knowledge. Knowledge for the sake of knowledge is declared to be dangerous and illegitimate; the only form of legitimate knowledge is that which leads to a greater understanding of the Divine. Daily television broadcasts, and hugely popular Muslim websites and books, resound with claims that exegesis of the Qur'an and a 'proper understanding' of the Arabic language can lead to every scientific discovery from human embryology and cerebral physiology to black holes and the expanding universe.

American universities are host to countless speakers who condemn modern science on Islamic grounds. Iranian-born scholar Seyyed Hossein Nasr, who commands \$5,000 speaking fees, is often invited by campus Islamic groups. In a speech given at MIT that I found on the web, he argued that the Arabic word *ilm*, whose pursuit is a religious duty, has been wilfully applied to science and secular learning by Muslim modernists in an effort to make them more acceptable in Islamic societies. But science is subversion, he announces, 'because ever since children began to learn Lavoisier's Law that water is composed of oxygen and hydrogen, in many

Islamic countries they came home that evening and stopped saying their prayers'. In 1983, Nasr advised the Saudi government not to build a science museum because 'it could be a time bomb' and destroy faith in Islam.

A widening divide

My last Google keyword search on 'Islam and science' yielded 165,143 entries. These included hundreds of elaborately designed Islamic websites, some with counter hits running into tens of thousands. The one most frequently visited has a banner: 'Recently discovered astounding scientific facts, accurately described in the Muslim Holy Book and by the Prophet Muhammad (PBUH) 14 centuries ago.' Many seek to show that the birth of modern science would have been impossible but for Islam and Muslims. On the anti-science front there are familiar 19th-century arguments against Darwinism, with Harun Yahya of Turkey as the new Bishop Wilberforce.

I could not, however, find any websites dealing with the philosophical implications of the theory of relativity, quantum mechanics, chaos theory, strings or stem cells. Antiquity alone seems to matter. A visitor exits with the feeling that history's clock broke down somewhere during the 14th century and that plans for repair, at best, are vague.

In lieu of actual science, bizarre theories under the rubric of 'Islamic science' abound. Sometimes these are proposed by men with considerable technical skill. For example, Sultan Bashiruddin Mahmood, the first director of Pakistan's famous uranium enrichment plant, the Kahuta Research Laboratory (KRL) near Islamabad, the principal facility in the nuclear weapons complex, was given a major national honour for his contribution. This includes having several nuclear technology patents to his name. In addition, he was one of the chief designers of Pakistan's nuclear weapons plutonium production reactor at Khushab. For many years, Mahmood also ran the Holy Qur'an Research Foundation in Islamabad and drew up

theories that he claimed to be founded in Islamic wisdom. He argued, for example, that capturing heavenly genies (said to be made out of fire by God) would provide the ideal fuel for solving Pakistan's energy problems. Mahmood and I had an acrimonious public debate in 1988 after he published his book *Mechanics of Doomsday and Life after Death*, in which he discussed the physics of souls and their electromagnetic properties. After 9/11, he shot into worldwide prominence upon the discovery of his contacts with the Taliban and Osama bin Laden.

It is not just science that stands in such poor health today. In a stunning indictment of the state of the Arab world, the *Arab Human Development Report 2002*, written by Arab intellectuals and released in Cairo, concluded that Arab societies are crippled by a lack of political freedom and knowledge. High-quality, mind-opening education is virtually non-existent. Half of all Arab women cannot read or write. The facts point to a bleak situation: 'The entire Arab world translates about 330 books annually, one-fifth the number that Greece translates,' says the survey. It adds that in the 1,000 years since the reign of the Caliph Maa'moun the Arabs have translated as many books as Spain translates in just one year.

The 2003 report was no less scathing: 'Almost all Arab countries have relinquished important knowledge-intensive aspects of oil production to foreign firms,' say the authors. 'The consequences of this abdication are severe.' They note that the divide between Arab countries and knowledge-based societies continues to widen.

Closer to home: in Pakistan, the commonly referred to 'crisis' of higher education understates the situation. Pakistan's public (and all but a handful of private) universities are intellectual rubble; their degrees of little consequence. With a population of 150 million, Pakistan has fewer than 20 computer scientists of sufficient calibre even to have a chance of getting tenure-track faculty positions at some B-grade US university. In physics, even if one roped in every good physicist in the country, it would still not be possible to staff

one single proper department of physics. Mathematics is yet more impoverished: to claim that there are even five able mathematicians in Pakistan would be exaggerating their numbers. According to the Pakistan Council for Science and Technology, Pakistanis have succeeded in registering only eight patents internationally in 57 years. The state of the social sciences is scarcely better.

Not surprisingly, the teaching of modern science in schools and universities in Muslim countries (Iran, Turkey and Malaysia are exceptions) is generally very different from that in Western countries. Students are brought up to uncritically respect authority, and efficiently memorise and reproduce formulae and facts. Many of my department's graduate students write the magical inscription '786' on their exam sheets; others spend long hours praying before examinations. The general ambience in educational institutions has becoming progressively more conservative. A first-time visitor to my university's physics department in Islamabad (reputedly the best in Pakistan) innocently asked me if this was the Islamic Studies department. He had good reason to be confused: young burqa-clad women students were chanting something (actually, formulae for a physics test) with only their eyes visible from behind all-enveloping black shrouds. Brought up to respect authority uncritically, the only skill some of the students have is to efficiently memorise and reproduce formulae and facts, as if they were scripture. Instructions posted on the walls specify the proper prayer to use while ascending and descending the stairs; sayings of the Prophet have been posted all around; and there is scarcely anything related to physics on the noticeboards.

Iran and Turkey offer some relief in an otherwise bleak situation. Their universities and schools appear to be qualitatively better, and scientific research more fruitful and advanced. Nevertheless, flipping through scientific journals one seldom encounters a Muslim name. Muslims are conspicuous by their absence from the world of ideas and scholarship. An exception was Professor Abdus Salam who, together with Americans Steven Weinberg and Sheldon Glashow, won

the Nobel Prize for physics in 1979. Salam was a remarkable man, in love with his country and religion. But although he was born a Muslim, he died a non-Muslim because the Ahmadi sect to which he belonged was expelled from Islam by an act of the Pakistani parliament in 1974.

Is a Muslim renaissance around the corner?

'Now Muslim leaders are planning [science's] revival and hope to restore a golden age', says Ziauddin Sardar, writer on Islam and contemporary cultural and scientific issues, in an optimistic article published recently in the *New Statesman*. Brave words, but I can see no visible evidence of significant collective activity, much less steps towards a 'golden age'. Visiting the websites of the Islamic Academy of Sciences (IAS), the Islamic Education, Scientific and Cultural Organisation (ISESCO) and the Organisation of Islamic Conference Standing Committee on Scientific and Technological Co-operation (COMSTECH), one learns that the sum of their combined activities over the last decade amount to sporadic conferences on disparate subjects, a handful of research and travel grants, and pitifully small sums for repair of equipment and spare parts. Lavish conferences have become an annual feature in Islamabad, with routine exhortations to develop science and technology for the *ummah*.

At the level of individual countries, there is more promise. An extraordinarily dynamic individual, Dr Atta-ur-Rahman, who is Pakistan's Minister for Science and Technology, was able to persuade the government to increase his ministry's budget over a three-year period, by a whopping factor of 60 (6,000 per cent) and the higher education budget by 12 (1,200 per cent). In consequence, a large human resource development plan for training teachers and researchers has been launched; internet connectivity in Pakistan has been substantially expanded; infrastructural improvements in universities and research institutions have been made; and a huge increase in faculty salaries is in the pipeline. Pakistan may well be

unique: when I asked Dr Rahman, who also heads COMSTECH, if any of his ministerial counterparts in other Muslim countries felt a similar sense of urgency, he sadly shook his head.

The frequent exhortations and unprecedented attention to science and technology in Pakistan, as well as some parts of the Muslim world, are welcome. But will they work?

Noticeably absent is the call for critical thinking, scepticism, and the scientific method. But here lies the crux of the problem: science is about ideas, the flight of the imagination, and the unsparing rigour of logic and empirical testing. It is not primarily about resources for laboratories and equipment. The most powerful engines of science - mathematics and theoretical physics - are also the most parsimonious and undemanding of resources. Yet, with only modest exceptions, theoretical and foundational science is all but gone from Islamic lands. It is already evident that the huge science budget increase in Pakistan is also leading to massive wastage. Clearly money and resources are a relatively small part of the solution. We need to probe deeper.

A brilliant past that vanished

Taking refuge in the past is sad but understandable. Unlike the native peoples of South America or Africa, Muslims have a rich history of contributing to science and, to an extent, technology as well. Martians visiting Earth in the Golden Age of Islam, between the 9th and 13th-centuries would surely have reported back to headquarters that the only people doing decent work in science, philosophy or medicine were Muslims. Muslims not only preserved the ancient learning of the Greeks, they also made substantial innovations.

Science flourished in the Golden Age because of a strong rationalist and liberal tradition, carried on by a group of Muslim thinkers known as the Mutazilites. To the extent that they were able to dominate the traditionalists, progress was rapid. But in the 12th century, Muslim orthodoxy reawakened, spearheaded by the

Arab cleric Imam Al-Ghazali, who championed revelation over reason, and predestination over free will. Al-Ghazali damned mathematics as hostile to Islam; an intoxicant of the mind that weakened faith.

Caught in the iron grip of orthodoxy, Islam eventually choked. The bin Ladens and Mullah Omars of antiquity levelled the impressive edifice of Islamic cultural and scientific achievements. For petty doctrinal reasons, zealots persecuted and hounded those very Muslim scholars to whom Islamic civilisation owes much of its former brilliance and greatness. Al Kindi was whipped in public by a fanatical sultan and blinded; Al Razi and Ibn Sina escaped numerous charges of blasphemy and attempts upon their lives; and Ibn Rushd was exiled and had his books burned. It was also the end of tolerance, intellect and science in the Muslim world.

Meanwhile, the rest of the world moved on. The Renaissance brought an explosion of scientific enquiry in the West. This owed much to translations of Greek works carried out by Arabs, as well as original Muslim contributions in science, medicine, and philosophy. But the age of Arab cultural vitality and military dominance was on the way out. Mercantile capitalism and technological progress drove Western countries, in ways that were often brutal and at times genocidal, to colonise rapidly the Muslim world from Indonesia to Morocco.

The rise and fall of Muslim modernisation

The 19th-and early 20th-centuries saw a modest revival of efforts to bring science back into Islam. It had become clear, at least to a part of the Muslim elites in colonised countries, that they were paying a heavy price for not possessing the analytical tools of modern science and the associated social and political values of modern culture. Therefore, despite resistance from the orthodox, the logic of modernity found 19th-century Muslim adherents. Modernisers such as Mohammed Abduh and Rashid Rida of Egypt, Sayyed Ahmad Khan of India, and Jamaluddin Afghani (who belonged everywhere),

wished to adapt Islam to the times, interpret the Qur'an in ways consistent with modern science, and discard the Hadith (ways of the Prophet) in favour of the Qur'an. Others seized on the modern idea of the nation state.

When new nation states emerged in the 20th century, not a single leader was a fundamentalist. Turkey's Kemal Ataturk, Algeria's Ahmed Ben Bella, Indonesia's Sukarno, Pakistan's Muhammad Ali Jinnah, Egypt's Gamal Abdel Nasser, and Iran's Mohammed Mosaddeq all sought to organise their societies on the basis of secular values. However, Muslim and Arab nationalism, part of a larger anti-colonial nationalist current across the developing world, included the desire to control and deploy national resources for domestic benefit.

The conflict with Western greed was inevitable. Indeed, America's foes during the 1950s and 1960s were precisely these secular nationalists. Mossadeq, who opposed Standard Oil's grab at Iran's oil resources, was removed by a CIA coup. Sukarno, accused of being a communist, was overthrown by US intervention, with a resulting bloodbath that consumed about 800,000 lives. Nasser, who had Islamic fundamentalists like Saiyyid Qutb publicly executed, fell foul of the USA and Britain after the Suez Crisis. On the other hand, until 9/11, America's friends were the sheikhs of Saudi Arabia and the Gulf states, all of whom practised highly conservative forms of Islam, but were strongly favoured by Western oil interests.

Pressed from outside, corrupt and incompetent from within, secular Muslim governments proved unable to defend national interests or deliver social justice. Such failures left a vacuum that Islamic religious movements grew to fill – in Iran, Pakistan and Sudan, to name a few. The times had begun to change, but what was only a trot became a gallop in 1979 when Ronald Reagan's America entered a final stage of Cold War hostilities with the Soviet Union, aided by Pakistan and Saudi Arabia, who helped bring in some of the fiercest, most ideologically hardened, Islamic warriors from around

the Arab world.

After the Soviet Union collapsed, the United States walked away from an Afghanistan in shambles. The Taliban emerged; Osama bin Laden and his al-Qa'ida made Afghanistan their base. September 11 followed. The subsequent vengeance extracted by the USA against Afghanistan, Iraq, and Palestine, was radically to change the relationship of Islam with the West. The two Gulf Wars, televised in exultant detail, revealed the Arabs as a crippled, powerless mass. When Israeli bulldozers levelled entire neighbourhoods of Jenin and Rafah, and American soldiers tortured and sexually abused the inmates of Abu Ghraib, Arabs could do no more than impotently rail at their enemies. The lure of Islamic fundamentalism provided an escape from bitter realities and the promise of ultimate victory.

The modernisation and secularisation of Muslim countries that had seemed inevitable just a half-century ago, has been indefinitely postponed in the wake of 9/11, and particularly the latest conflict in Iraq. Many in the Muslim world ascribe these reversals solely to America's imperial actions (and, earlier, those of Europe). But this is only one contributing factor, albeit an important one. The extreme difficulty of adapting to a post-Renaissance, knowledge-based society is also due to a belief system that is remarkably resistant to change.

Will it rain if you pray?

Questions hovering over science and Islam will not go away. Take the issue of miracles: does God suspend the laws of physics in response to the actions of human beings? Following the lead of Renaissance thinkers, Muslim reformers of the 19th century, such as Syed Ahmad Khan, argued that miracles must be understood in broad allegorical terms rather than literally. Following the Mutazillite tradition, they insisted on an interpretation of the Qu'ran that was in conformity with the observed truths of science, thereby doing away with such commonly held beliefs as the Great Flood and Adam's descent from

heaven. It was a risky proposition, and one that has been wilfully forgotten in our times.

Miracles of all sorts continue to be sought. For example, whenever there is a drought in Pakistan, every head of state from General Zia-ul-Haq to General Pervez Musharraf, together with their governors and chief ministers, have joined with the *ulema* in asking the public to come out in large numbers and perform the prescribed *namaz-i-istisqa* (prayer for rain). Millions comply.

My allusion to this issue in a seminar where I described rain as a physical process uninfluenced by divine forces drew an angry reaction from a professor, who is also an influential religious authority at the elite Lahore University of Management Sciences, possibly the most liberal university in Pakistan. All students received an e-mail, part of which is reproduced below:

'The fact that rainfall sometimes is caused in response to prayers is a matter of human experience. Although I cannot narrate an incident directly, I know [this] from the observations of people who would not exaggerate. The problem is that Dr Hoodbhoy has narrowed down his mind to be influenced by only those facts that could be explained by the cause-and-effect relationship. That's a classic example of academic prejudice . . . our world is not running on the principle of a causal relationship. It is running the way it is being run by its Master. Man has discovered that, generally speaking, the physical phenomena of our world follow the principle of cause and effect. However, that may not always happen, because the One who is running it has never committed Himself to stick to that principle.

I responded with the following points:

- Dr Zaheer admits that he has never personally witnessed rainfall in consequence to prayers, but confidently states that this is 'a matter of human experience' because he thinks some

others have seen unusual things happen. Well, there are people who are willing to swear on oath that they have seen Elvis's ghost. Others claim that they have seen UFOs, horned beasts, apparitions and the dead arise. Without disputing that some of these people might be sincere and honest, I must emphasise that science cannot agree to this methodology. There is no limit to the power of people's imagination. Unless these mysterious events are recorded on camera, we cannot accept them as factual occurrences.

- Rain is a physical process (evaporation, cloud formation, nucleation and condensation). It is complicated, because the atmospheric motion of gases needs many variables for a proper description. However, it obeys exactly the same physical laws as deduced by looking at gases in a cylinder, falling bodies, and so forth. Personally I would be most interested to know whether prayers can also cause the reversal of much simpler kinds of physical processes. For example, can a stone be made to fall upward instead of downward? Or can heat be made to flow from a cold body to a hot body by appropriate spiritual prompting? If prayers can cause rain to fall from a blue sky, then all physics and all science deserves to be trashed.
- I am afraid that the track record for Dr Zaheer's point of view on rain is not very good. Saudi Arabia remains a desert in spite of its evident holiness, and the poor peasants of Sind have a terrible time with drought in spite of their simplicity and piety. Geography, not earnestness of prayer, appears to be the determining factor.
- Confidence in the cause-and-effect relationship is indeed the very foundation of science and, as a scientist, I fully stand by it. Press the letter 'T' on your keyboard and the same letter appears on the screen; step on the accelerator and your car accelerates; jump out of a window and you get hurt; put your hand on a stove and you get burnt. Those who doubt cause and

effect do so at great personal peril.

- Dr Zaheer is correct in saying that many different people (not just Muslims alone) believe they can influence physical events by persuading a divine authority. Indeed, in the specific context of rain-making, we have several examples. Red Indians had their very elaborate dances to please the Rain God; people of the African bush tribes beat drums and chant; and orthodox Hindus plead with Ram through spectacular *yagas* with hundreds of thousands of the faithful. Their methods seem a little odd to me, but I wonder if Dr Zaheer wishes to accord them respect and legitimacy.

Can Islam and science live together again?

The reader who wishes to get to the bottom line will be disappointed. There is no universally accepted answer, and there cannot be one. Unlike Christianity, in Islam there is no Vatican and no Pope. In the absence of a central authority, Muslims have greater flexibility to decide on theological and doctrinal issues.

The questions posed above can be asked of any religion. For purposes of discussion, it is useful to split every religion into four components. Science has no problem with the first three – they are matters of faith and individual choice:

- **Metaphysical:** This relates to the particular beliefs of religion. Every faith has specific positions on issues as monotheism and polytheism, death and reincarnation, heaven and hell, prophets and holy men and rituals and relics.
- **Ethical and moral:** Religions have a specific prescription of how individuals are expected to order their lives and why they have been brought into being. Conversely, science offers no guidance in determining right from wrong, and does not provide a reason for the existence of individuals or the human race. It is silent on eugenics or cloning, and polygamy or polyandry.

- **Inspirational and emotional:** Marmaduke Pickthall, who translated the Qu'ran into English, wrote of how the melody of its verses could move men to tears. Abdus Salam, transfixed by the symmetry of Lahore's Badshahi Mosque, said that it inspired him to think of the famous $SU(2) \times U(1)$ symmetry that revolutionised the world of particle physics.
- **Beliefs about the physical world:** There is a definite problem here: taken literally, the texts of all religions lead to a description of physical reality that belongs to antiquity and is definitely at odds with modern science. The issues are well known: the origin of life, non-material beings such as spirits and djinns, geocentricity, the nature of comets and meteors, and miracles such as the Great Flood and the parting of the Red Sea.

Let us provisionally accept the argument that the religious impulse propelled science in Muslim civilisation in its Golden Age through requirements such as accurate determination of prayer times, sightings of the moon, directions of the *qibla* and of Mecca, quantitative application of Muslim inheritance laws, and so forth. But in the age of the globalised positioning system, atomic clocks, and computers, it is difficult to point to religious imperatives for scientific progress.

If Muslim societies are to escape their ice age then they must accept modernity – which should not be confused with Westernisation – as desirable, and welcome the role of science, reason, and universal principles of law and justice in the arbitration of human affairs. Scarcity of material resources is not the primary issue and cannot be used as an excuse for arrested development. It will be crucial to allow dogmas to be challenged without incurring the charges of heresy and blasphemy. Muslims must understand that there is no alternative now to respecting personal freedom of thought, encouraging artistic and scientific creativity, cultivating a compulsive urge to innovate and experiment, and making education a vehicle of change.