

PHYSICS IN THE MODERN MUSLIM WORLD

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MAIN TEXT: Physics is taught as a subject in schools, colleges, and universities in all 48 Muslim-majority countries. The content is, for the most part, fairly standard. In some countries there is often an extended attempt to show the consistency of science with Islamic principles, and to stress the achievements of ancient Muslim scientists. Specific Muslim responses to major scientific developments such as Einstein's theory of relativity, quantum mechanics, big-bang cosmology, or chaos are hard to find. Only a few little-known Muslim writers have argued that these major ideas of science are in conflict with Quranic teachings. They have essentially echoed criticisms common in the last century in the West wherein, for example, Einsteinian Relativity was taken to imply moral relativism and quantum mechanical uncertainty was criticized for limiting God's power to know. However, these are isolated examples and the majority attitude has been to essentially ignore such philosophical issues and to passively accept the results of physics research without critical examination of its theological implications.

The research productivity of Muslim physicists residing in their own countries is low. This will be evident from statistics quoted later in this essay. Muslims living abroad in scientifically advanced countries are relatively much more productive. Several have been credited with important scientific discoveries. Mohammed Abdus Salam is by far the most significant. Together with Steven Weinberg and Sheldon Glashow, he received the Nobel Prize for physics in 1979 for work that unified the weak and electromagnetic interactions. Salam was also the most articulate and effective proponent of Muslim scientific development. As founder-director of the International Centre for Theoretical Physics, he created an organization that played an important role in stimulating scientific research in developing countries by inviting thousands of researchers to participate in research conferences and workshops in Trieste, Italy. The Third World Academy of Sciences, an offshoot of the ICTP, was also headed by Salam and received some financial support by Muslim countries. It should be noted, however, that Salam's Ahmeddiya sect, while it continues to claim adherence to Islam, was officially declared non-Muslim by an act of the Pakistani parliament in 1974.

Academic research in physics appears to be strongest in Turkey and Iran, both of which are considered the most secular among Muslim countries. In applied nuclear physics, also considered as the domain of medium-high technology, Pakistan has relatively the most advanced programme among Muslim countries. It has one Canadian supplied power reactor as well as two Chinese supplied ones and a third one currently (2010) in the

process of installation. It also has an extensive uranium enrichment programme using centrifuge technology derived from Holland and Belgium. It is the only Muslim country which currently has nuclear weapons capability with an estimated 80-100 nuclear warheads. Iran is investing heavily in nuclear technology and has developed advanced centrifuges that, when cascaded together, can provide enriched uranium for a number of nuclear power plants or for warheads.

A HISTORICAL OVERVIEW

In a nutshell, the Muslim experience of science consists of a golden age extending from the 9th through 13th centuries, subsequent collapse, modest rebirth in the 19th century, and a marked reversal away from science and modernity beginning in the last decades of the 20th century.

There was no science in Arab culture in the initial period of Islam, around 610 AD¹. But as Islam established itself politically and militarily, its territory expanded. In the mid-eighth century, Muslim conquerors came upon the ancient treasures of Greek learning. Translations from Greek into Arabic were ordered by liberal and enlightened caliphs, who filled their courts in Baghdad with visiting scholars from near and far. Politics was dominated by the rationalist *Mutazilites*, who sought to combine faith and reason in opposition to their rivals, the dogmatic anti-reason Asharites. A generally tolerant and pluralistic Islamic culture allowed Muslims, Christians, and Jews to create new works of art and science together. The Arabic language held sway in an age that created algebra, elucidated principles of optics, established the body's circulation of blood, named stars, and created universities. In addition, Greek learning was transmitted to Europe through a major translation effort by Muslim rulers.

Over time the theological tensions between liberal and fundamentalist interpretations of Islam—such as on the issue of free will versus predestination—became intense and turned bloody. A resurgent religious orthodoxy eventually inflicted a crushing defeat on the *Mutazilites*. Thereafter, the open-minded pursuits of philosophy, mathematics, and science were increasingly relegated to the margins of Islam².

Centuries later the introduction into Islamic societies of European post-renaissance science, technology, and thought was pioneered by several outstanding Muslim leaders. In 19th century Egypt, following the Napoleonic occupation, Muhammad Ali seized state power and ruled from 1805 through 1848. During this period he made bold attempts to transfer French and British technology into the country, relying principally on European expatriates³. He introduced the first printing press – a device initially condemned by some of the *ulema* as having a belt of pigs skin. But this resistance was overcome, and the Bulaq press in Cairo published 81 Arabic books on science between 1821 and 1850. Technology for irrigation, textile manufacturing, surveying, prospecting and mining for coal and iron, and military hardware received high priority. Major earth moving and civil engineering projects were embarked upon. Even more significantly, technical schools with foreign teachers were established with the aim of generating manpower. More than

400 students were sent to Europe to study various branches of science, including military tactics.

However, the success of Muhammad Ali's industrialization policies was mixed⁴. The quality of domestically produced products, such as textiles, was poor. Technical schools provided insufficient exposure to theoretical science, and did not succeed in creating a base of technicians or engineers of sufficiently high calibre. The reasons for this have been debated⁵. After Mohammed Ali's death in 1849, these schools were closed down under the rule of Khedive Abbas and Khedive Sa'id, and the scientific momentum ground to a halt. Among other Arab rulers, Sultan Sa'id bin Sultan of Oman (1806-1856) is notable for his interest in acquiring European technology. He made numerous attempts to have sugar refineries installed in Zanzibar, an Omani possession. He also made unsuccessful attempts at ship building. Emir Abdel Kader of Algeria, whose rule extended from 1832 to 1847, engaged various experts to build small ordnance factories and appears to have understood the importance of technology for progress.

The Turkish Ottomans had established an extensive and magnificent empire in the 16th century and had recognized the utility of military technology, particularly cannons, which they readily borrowed from the West. But there were strong religious taboos which, for example, prevented the use of the printing press or of public clocks. Travelers to Turkey in this period remarked on the lack of interest in matters of science and learning. Sweeping changes in civil administration and education came with Sultan Selim III (1761-1808), who was the last and the most radical of the Ottoman reformers. Selim established a new military corps armed and organized in the most modern techniques of warfare in Europe. Gun founding was introduced, printing presses were set up, and the works of Western authors were translated into Turkish. To sustain the modern army the subjects of algebra, trigonometry, mechanics, ballistics, and metallurgy were introduced into the teaching curriculum.

Like Muhammad Ali, Selim III had no choice but to import teachers from Europe for these subjects. The importance of theoretical science as a basis for continued development appears not to have been recognized. The major impetus to scientific and industrial development came after the revolution brought about by Mustafa Kemal Ataturk (1881-1938) in 1924. Prior to this, education had been limited to the cities and controlled by religious authorities⁶. But after the secularization of Turkey, the control was taken over by the state and the curricula revised to include modern science, mathematics, world history, etc. Among Muslim countries, Turkey is today among the most advanced in scientific research and in terms of the quality of its universities.

On the Indian subcontinent modern scientific ideas and techniques came in the wake of the English conquest. In the decades preceding this, the rule of the Moghuls had produced a civilization known for impressive architecture, literature, and poetry but with few achievements in the realm of knowledge. The Moghuls did not set up any universities or centres of learning. Some transmission of Western technology had taken place in the reign of Emperor Akbar (1542-1605), when Europeans had come as traders⁷. Notably,

ships of large tonnage and shapes similar to English ones were built. But these lacked compasses, gimbals, navigational charts, etc. Reading glasses were greatly admired by Akbar, but they appear to have been imported from France. After the banishment of the last Moghul emperor Bahadur Shah Zafar in 1857, the English consolidated their rule and later introduced modern education. A combination of hurt, pride, defiance, and conservatism led Muslims to resist Western learning. Consequently, Muslims were at a substantial disadvantage relative to Hindus; it is recorded, for example, that between 1876-7 and 1885-6, 51 Muslims and 1,338 Hindus took the B.A degree at Calcutta. In 1870 only 2 Muslims, both of whom failed, sat for the B.A while, in the same year, 151 Hindus took the examination of whom 56 received the degree.

The resistance of Muslims of the subcontinent to modern ideas motivated Syed Ahmad Khan (1817-1898) into becoming a forceful proponent of modern science and thought⁸. He was convinced that the subjugation of Muslims to the West was a result of their scientific backwardness, and that this in turn was a consequence of the dominance of superstitious beliefs and rejection of *maaqulat* (reason) in favour of blind obedience to *manqulat* (tradition). He therefore set about the monumental task of reinterpreting Muslim theology, making it compatible with post-Renaissance Western humanistic and scientific ideas. Syed Ahmad Khan founded the Aligarh Muslim University, which provided Muslims of the subcontinent a unique opportunity for higher education. His articles in the periodical *Tahzib-ul-Akhlaq*, which included translations and explanations of scientific tracts as well as his interpretations of religious issues, were highly influential among upper class Muslims. To maintain consistency with science, he argued that miracles – such as Noah's Flood – must be understood in allegorical rather than literal terms. This innovative position brought Syed Ahmad Khan widespread condemnation and numerous *fatwas* against his life.

Syed Jamaluddin Afghani (1838-1897), also a supporter of Western science and modern ideas, but an implacable opponent of Syed Ahmad Khan, was a determined anti-imperialist who inspired Muslims in Turkey, Egypt, Iran, and India⁹. Like his mentor Mohammad Abduh (1849-1905), Afghani held that there was no contradiction between Islam and science, and that Islam encouraged rational thought and discouraged blind imitation. In 1870, because of pressure from the clergy, Afghani was expelled from Istanbul for advocating the setting up of a *Darul-Funun*, a new university devoted to the teaching of modern science. He is known for his vitriolic criticism of those *ulema* who opposed modern ideas and science.

Modernization and the introduction of science have inevitably brought about the issue of having to choose between traditional and modern education for Muslims, or perhaps devising an acceptable synthesis. Traditional Islamic education, with its emphasis on teaching of the *Quran* and *Sunnah* and on perfect memorization, had remained essentially unchanged since the Nizammiyah curriculum was devised under the rule of the Sultan Nizam-ul-Mulk in the 11'th century¹⁰. Ibn Khaldun, in a comparative study of education in Muslim lands of the 14'th century, pointed out that only in Muslim Spain and Persia were were subjects such as poetry, grammar, and arithmetic included in the syllabi.

Elsewhere, subjects unrelated to the Qu'ran were regarded as too secular to teach to children. The Nizammiyah curriculum was faithfully passed on to subsequent generations and also adopted in unchanged form in Mughal India, until somewhat modified by Shah Waliullah (1703-?) to include arithmetic and logic. However, al-Azhar University in Cairo did have some scientific subjects in its teaching syllabus, including mathematics and astronomy, even prior to the Napoleonic invasion. These largely reflected knowledge which had long since been superseded. The astronomy taught, for example, was based on a Ptolemaic model requiring the sun to go around the earth. Thus, it was a prime goal of Muslim modernists to effect the transfer of Western models of universities and schools into their societies. The spread of science teaching in several Arab countries, such as Egypt, Syria, Iraq, and Lebanon, and on the Indian subcontinent, was greatly aided by Christian missionary efforts. Although their purpose was primarily evangelical, they brought considerable intellectual stimulus coming from new developments in the West. The first Western scientific institutions in the Arab world were the Syrian Protestant College and the Jesuit St. Joseph's College, both in Beirut.

CURRENT MUSLIM SCIENTIFIC ACHIEVEMENTS

The metrics of scientific progress are neither precise nor unique. Science permeates our lives in myriad ways, means different things to different people, and has changed its content and scope drastically over the course of history. In addition, the paucity of reliable and current data makes the task of assessing scientific progress in Muslim countries still harder.

The following four metrics appear to be reasonable:

1. The quantity of scientific output, weighted by some reasonable measure of relevance and importance.
2. The role played by science and technology in the national economies, funding for S&T, and the size of the national scientific enterprises.
3. The extent and quality of higher education.
4. The degree to which science is present or absent in popular culture.

Only the first two shall be commented upon here. The reader may find additional details in reference¹¹.

Scientific output: A useful, if imperfect, indicator of scientific output is the number of published scientific research papers, together with the citations to them. Table 1 shows the output of the seven most scientifically productive Muslim countries for physics papers, over the period from 1 January 1997 to 28 February 2007, together with the total number of publications in all scientific fields. A comparison with Brazil, India, China, and the US reveals significantly smaller numbers. A study by academics at the International Islamic University Malaysia¹² showed that OIC countries have 8.5 scientists, engineers, and technicians per 1000 population, compared with a world average of 40.7, and 139.3 for countries of the Organisation for Economic Co-operation and Development. (For

more on the OECD, see <http://www.oecd.org>.) Forty-six Muslim countries contributed 1.17% of the world's science literature, whereas 1.66% came from India alone and 1.48% from Spain. Twenty Arab countries contributed 0.55%, compared with 0.89% by Israel alone. The US NSF records that of the 28 lowest producers of scientific articles in 2003, half belong to the OIC¹³.

Table 1. The seven most scientifically productive Islamic countries as of early 2007, compared against a selection of other countries

| | Physics papers | Physics citations | All science papers | All science citations |
|--------------|----------------|-------------------|--------------------|-----------------------|
| Malaysia | 690 | 1 685 | 11 287 | 40 925 |
| Pakistan | 846 | 2 952 | 7 934 | 26 958 |
| Saudi Arabia | 836 | 2 220 | 14 538 | 49 654 |
| Morocco | 1 518 | 5 332 | 9 979 | 35 011 |
| Iran | 2 408 | 9 385 | 25 400 | 76 467 |
| Egypt | 3 064 | 11 211 | 26 276 | 90 056 |
| Turkey | 5 036 | 21 798 | 88 438 | 299 808 |
| Brazil | 18 571 | 104 245 | 128 687 | 642 745 |
| India | 26 241 | 136 993 | 202 727 | 793 946 |
| China | 75 318 | 298 227 | 431 859 | 1 637 287 |
| USA | 201 062 | 2 332 789 | 2 732 816 | 35 678 385 |

These data are from the Philadelphia-based science information specialist, Thomson Scientific.

The situation may be even less favorable than the publication numbers or perhaps even the citation counts suggest. Assessing the scientific worth of publications — never an easy task—is complicated further by the rapid appearance of new international scientific journals that publish low-quality work. Many have poor editorial policies and refereeing procedures. Scientists in many developing countries, who are under pressure to publish, or who are

attracted by strong government incentives, choose to follow the path of least resistance paved for them by the increasingly commercialized policies of journals. Prospective authors know that editors need to produce a journal of a certain thickness every month. In addition to considerable anecdotal evidence for these practices, there have been a few systematic studies. For example¹⁴, chemistry publications by Iranian scientists tripled in five years, from 1040 in 1998 to 3277 in 2003. Many scientific papers that were claimed as original by their Iranian chemist authors, and that had been published in internationally peer-reviewed journals, had actually been published twice and sometimes thrice with identical or nearly identical contents by the same authors. Others were plagiarized papers that could have been easily detected by any reasonably careful referee.

Islamic countries show a great diversity of cultures and levels of modernization¹⁵ and a correspondingly large spread in scientific productivity. Among the larger countries—in both population and political importance—Turkey, Iran, Egypt, and Pakistan are the most scientifically developed. Among the smaller countries, such as the central Asian republics, Uzbekistan and Kazakhstan rank considerably above Turkmenistan, Tajikistan, and Kyrgyzstan. Malaysia—a rather atypical Muslim country with a 40% non-Muslim minority—is much smaller than neighboring Indonesia but is nevertheless more productive. Kuwait, Saudi Arabia, Qatar, the UAE, and other states that have many foreign scientists are scientifically far ahead of other Arab states.

National scientific enterprises: Conventional wisdom suggests that bigger science budgets indicate, or will induce, greater scientific activity. On average, the 57 OIC states spend an estimated 0.3% of their gross national product on research and development, which is far below the global average of 2.4%. But the trend toward higher spending is unambiguous. Rulers in the UAE and Qatar are building several new universities with

manpower imported from the West for both construction and staffing. In June 2006, Nigeria's president Olusegun Obasanjo announced he will plow \$5 billion of oil money into R&D. Iran increased its R&D spending dramatically, from a pittance in 1988 at the end of the Iraq–Iran war, to a current level of 0.4% of its gross domestic product. Saudi Arabia announced that it spent 26% of its development budget on science and education in 2006, and sent 5000 students to US universities on full scholarships. Pakistan set a world record by increasing funding for higher education and science by an immense 800% over the past five years.

But bigger budgets by themselves are not a panacea. The capacity to put those funds to good use is crucial. One determining factor is the number of available scientists, engineers, and technicians. Those numbers are low for OIC countries, averaging around 400–500 per million people, while developed countries typically lie in the range of 3500–5000 per million. Even more important are the quality and level of professionalism, which are less easily quantifiable. But increasing funding without adequately addressing such crucial concerns can lead to a null correlation between scientific funding and performance.

The role played by science in creating high technology is an important science indicator. Comparing table 1 with table 2 shows there is little correlation between academic research papers and the role of S&T in the national economies of the seven listed countries. The anomalous position of Malaysia in table 2 has its explanation in the large direct investment made by multinational companies and in having trading partners that are overwhelmingly non-OIC countries.

Table 2. High-technology exports as a percentage of total manufactured exports

| | | | |
|--------------|-----|--------|----|
| Malaysia | 58% | Iran | 2% |
| Pakistan | 1% | Egypt | 0% |
| Saudi Arabia | 0% | Turkey | 2% |
| Morocco | 11% | | |

These data are from the World Bank's World Development Report 2006.

Although not apparent in table 2, there are scientific areas in which research has paid off in the Islamic world. Agricultural research—which is relatively simple science—provides one case in point. Pakistan has good results, for example, with new varieties of cotton,

wheat, rice, and tea. Defense technology is another area in which many developing countries have invested, as they aim to both lessen their dependence on international arms suppliers and promote domestic capabilities. Pakistan manufactures nuclear weapons and intermediate-range missiles. There is now also a burgeoning, increasingly export-oriented Pakistani arms industry that turns out a large range of weapons from grenades to tanks, night-vision devices to laser-guided weapons, and small submarines to training aircraft. Export earnings exceeded \$300 million in 2009. Although much of the production is a triumph of reverse engineering rather than original research and development, there is clearly sufficient understanding of the requisite scientific principles and a capacity to exercise technical and managerial judgment as well. Iran has followed Pakistan's example.

The global diffusion of modern technology has profoundly altered life-styles in Muslim countries and has become an inseparable part of modern existence. It is not, however,

easy to decide on the status of a country in the field of science and technology in a simple quantitative manner. But one important indicator of the level of scientific-technological development of a country is the extent to which industry and manufacturing are part of its economy. This, in turn, is estimated by the "value added" in manufacturing, which includes machinery and transport equipment, chemicals, textiles, etc. Data on "value added" is published yearly in the Development Report of the World Bank, which the reader may consult for estimating the relative levels of progress of individual countries. Indonesia and Malaysia are among the fastest growing economies of the world, partly because of their success in attracting foreign investment, and partly because of high investments in human resource development. There has been a steady rise in "value added" for most Muslim countries but absolute levels are still low: In 1983, of 46 Muslim states, only 24 produced cement, 11 produced sugar, 5 had heavy engineering industries, 6 produced textiles, and 5 produced light armaments. By and large, Muslim states are consumers of technology and producers of raw materials, oil being the most important one of these.

Muslim Reactions To Modern Science

In defending the compatibility of science and Islam, Muslims argue that Islam had sustained a vibrant intellectual culture throughout the European Dark Ages and thus, by extension, is also capable of a modern scientific culture. The Pakistani physics Nobel Prize winner, Abdus Salam, would stress to audiences that one-eighth of the Qur'an is a call for Muslims to seek Allah's signs in the universe and hence that science is a spiritual as well as a temporal duty for Muslims. Perhaps the most widely used argument one hears is that the Prophet Muhammad had exhorted his followers to "seek knowledge even if it is in China," which implies that a Muslim is duty-bound to search for secular knowledge.

Generally, attitudes of Muslims towards technology are far friendlier than towards science. In earlier times, the orthodoxy had resisted new inventions such as the printing press, loudspeaker, and penicillin, but such rejection has all but vanished. The ubiquitous cell phone, that ultimate space-age device, epitomizes the surprisingly quick absorption of black-box technology into Islamic culture. Popular new Islamic cell-phone models now provide the exact GPS-based direction for Muslims to face while praying, certified translations of the Qur'an, and step-by-step instructions for performing the pilgrimages of Haj and Umrah. Digital Qur'ans are already popular, and prayer rugs with microchips (for counting bend-downs during prayers) have made their debut.

As an epistemological enterprise, science has elicited three principal types of response from Muslims.

The first response could be characterized as a pragmatic one – let science and religion go their own separate ways. Vagueness suffices. It is, from this point of view, inessential to look too closely at what Islam says about science. Most Muslims would probably be content to simply live with the thought that the two are not in conflict.

A second, diametrically opposed, reaction is articulated by Syed Qutb of Egypt and Syed Abul Ala Maudoodi of Pakistan¹⁶. They are overtly hostile to science, and do not see lack of Muslim scientific progress as particularly regrettable because, in their opinion, modern science is guided by no moral values but only naked materialism and arrogance. Science and modernity emphasize ceaseless change and are seen as working against the immutable and constant values of Islam. Claims to high achievement arising from the exercise of human reason are decried as amounting to man-worship. Therefore, according to this view, scientific development is not desirable in an Islamic society.

A third reaction, largely syncretic, was prominent among 19th century Muslim modernists. They worked to reinterpret the faith in order to reconcile the demands of modern science and civilization with the teachings and traditions of Islam. This school of thought has a historical tradition with roots going back to the rationalist Mutazilla movement of the 9th century, and the work of Ibn Rushd, particularly his book *Tahafut-al-Tahafut* in which he refuted the anti-rationalism of Imam al-Ghazali. In this "reconstructionist" tradition, it is argued that the word of God cannot be wrong, but also that the truths of science are manifest and real. Therefore the only issue is to arrive at suitable interpretations of the Qu'ran, through careful etymological examination, wherever there is an apparent conflict between the revealed truth and physical reality. It was held that Islam in the days of the Prophet and the *Khilafa-i-Rashida* was revolutionary, progressive, and rational and that the subsequent slide into stultifying rigidity was due to the triumph of *taqlid* (tradition) over *ijtihad* (innovation). Mohammed Abduh, Rashid Rida, and Syed Ahmad Khan were the leading proponents of this point of view.

It is interesting to examine Muslim attitudes towards major developments in science, of which Darwin's theory of evolution provides the most contentious example. The first major debate, which pitted traditionalist Muslim and Christian Arabs on the one side against rationalists and radicals on the other, was initiated in 1884 following the publication of a work in Arabic by Shibli Shumayyil (1853-1917) favouring Darwinism. Expectedly, religious conservatives denounced Darwin's theory as amounting to the denial of God and a refutation of the Quranic and biblical theories of creation. Even Jamaluddin Afghani, otherwise a powerful proponent of science, derided Darwinism – although it appears that he had not understood, or even read, any of Darwin's work. A few Muslims, such as the writer Ismail Mazhar (1891-1962), did make serious efforts to understand Darwinian evolution and asserted the need to reinterpret Islamic theology in the light of established facts. Others, such as the theologian Hussein al-Jisr (1845-1909), sought to reconcile elements of Darwin's work with Islam¹⁷. In the contemporary Muslim world, attitudes towards Darwinism are mixed. Teaching of the theory of evolution is allowed in Turkey, Egypt, Iraq, Iran, Indonesia, and several other countries. However, it was removed from the syllabus in Pakistan in the regime of General Zia-ul-Haq, and is expressly forbidden in Saudi Arabia and Sudan.

Unlike the vigorous science vs religion debates in post-scientific revolution Europe, there seems to be little discussion on the philosophical implications of modern scientific issues in Muslim countries, with Turkey and Iran being partial exceptions. The reason for this

relatively low level interest may be the increasing specialization of science and the difficulty of translating its ideas into ordinary language, as well as the reluctance of the ulema to be drawn into new fields. However, some time-honoured issues continue to be routinely debated and commented upon. One such issue is whether the new moon must be visually sighted, or whether its position can be predicted in advance with modern astronomical techniques. This becomes important and contentious especially around the time of *Eid-ul-Fitr*. In Pakistan, a *Ruet-i-Hilal* (moon-sighting) committee has been formed by the government to make final decisions on this matter. Weather prediction is an issue on which there has been a considerable softening of the traditionally hard position – that Allah alone knows and decides if and when it will rain, and that He has prescribed the *namaz-i-istisqa* (prayer for rain) so that believers may supplicate him. Presently all Muslim countries maintain some form of meteorological department and provide weather information. Whereas orthodox *ulema* continue to maintain their position against the dissection of cadavers for medical training, blood transfusions, and organ transplants, this is essentially disregarded almost everywhere in Muslim countries now.

In recent years, the applications, methodology and epistemology of modern science have been severely criticized by growing numbers of Muslim conservatives¹⁸. At one level, in close similarity with the radical critiques of science by the German "Greens" as well as European marxists and anarchists, it is argued that the development and application of a supposedly value-free science is the prime cause of the myriad problems faced by the world today - weapons of mass destruction, environmental degradation, global inequities in the distribution of wealth and power, alienation of the individual, etc. Others go a step beyond this and reject the validity of the scientific method as well as the notion of science as knowledge, believing that the goals and techniques of modern science – which are considered distinct from those of medieval age science – will inevitably damage the fabric of Islam. Knowledge for the sake of knowledge is declared to be a dangerous and illegitimate goal, and the only form of legitimate knowledge is that which leads to a greater understanding of the Divine. The most articulate representation of this point of view is by the Iranian born scholar Syed Hossein Nasr who also argues that the word *ilm*, whose pursuit is a religious duty, has been wilfully distorted into meaning science and secular learning by Muslim modernists in an effort to make science more acceptable in Islamic societies¹⁹.

The reaction of Muslim orthodoxy to the teaching of modern science in schools has been to demand basic changes. These include some or all of the following: introduction to all scientific facts by reference to Allah, dilution of the cause-and-effect relation to accommodate the Divine Will, rewriting of all science books by people of sound Islamic beliefs, highlighting of the former Muslim supremacy in science, and removal of names associated with specific physical laws (eg. Boyle's Law, Einstein's Theory, etc.). It should be noted, however, that the Iranian clergy has allowed science taught in Iranian schools to maintain its secular character.

ISLAMIC SCIENCE

Exponents of the so-called "Islamic Science" argue that it offers an Islamic alternative to the challenge of modern Western science, which they consider as reductionist and incapable of accommodating Islamic beliefs. Individual proposals for creating this alternative science have emerged in large numbers since the 1970's. However, given the absence of a centralized religious authority – an "Islamic Church" – the validity of these proposals cannot be clearly certified from the religious point of view. One fairly common definition of "Islamic science" is that every scientific fact and phenomena known today was anticipated 1,400 years ago and that all scientific predictions can and must be based upon study of the Qur'an. This has been the concern of dozens of conferences in numerous Muslim countries, including Egypt, Pakistan, Malaysia and Saudi Arabia. A popular author who advocates this version of Islamic science is Maurice Bucaille. A French surgeon who turned into a spiritualist, Bucaille's major book is "The Bible, The Qur'an, And Science". This book, which seeks to establish that the Qur'an correctly anticipated all major discoveries of science while the Bible was flawed in places, has been translated into several languages and read widely in Muslim countries.

Another opinion is that Islamic science is that which is based on Islamic values and beliefs such as *tawheed* (unity of God), *ibadah* (worship), *khilafah* (trusteeship), and which stands for the rejection of *zalim* (tyrannical) science as well as science for the sake of curiosity. Revelation rather than reason ought to be ultimate guide to valid knowledge. Syed Hossein Nasr demands that: "a truly Islamic science cannot but derive ultimately from the intellect which is Divine and not human reason.....the seat of the intellect is the heart rather than the head, and reason is no more than its reflection upon the mental plane". He provides no further clues of how the new science should be organized. Other Muslim authors insist that the study of natural disasters, which constitutes Islamic environmental science, must begin with trying to understand God's will because earthquakes, volcanic eruptions, floods, etc. are events under His direct control and part of a grand systems scheme. One of the most articulate advocates of the Islamization of knowledge, including science, was the late Isma'il Al Faruqi.

One should distinguish science practiced by Muslims – whether in the present epoch or in the "Golden Age" of Islamic civilization – from "Islamic science", which is supposed to reflect specifically Islamic characteristics. Whether an Islamic science of the physical world is a meaningful notion or concept can be challenged on at least three grounds. First, decades of efforts to create a specifically Islamic science have failed. The fact is that Islamic science has not led to the building of even a single new machine or instrument, the design of a new experiment, or the discovery of a new and testable fact. Only post-facto explanations have been provided, never a prediction. Second, specifying a set of moral and theological principles – no matter how elevated – does not permit one to build a new science from scratch. There are numerous examples of scientists subscribing to very different philosophical assumptions and having very different emotional and psychological dispositions, who have arrived at very similar results in their scientific investigations. Although a scientist may be inspired towards making a particular discovery as a consequence of his belief, his claims of discovery must be validated by a

system of science which relies on experimentation and testing as its basis. Third, there has never existed, and still does not exist, a definition of Islamic science which is acceptable to Muslims universally. Many of the great Muslim scholars of medieval times, including Al-Kindi, Al-Razi, Ibn-Sina, and Ibn-Rushd, suffered persecution at the hands of the orthodoxy on account of their non-traditional religious and spiritual beliefs. The sectarian divisions within Muslims today would be reflected in any endeavour to establish a common set of rules. It is also worthy of note that all suggestions of creating a new epistemology of science based on ideological or moral principles have failed to be of little value because they are far too vague and ill-defined.

Current Trends in Science Development

Muslim leaders today, realizing that military power and economic growth flow from technology, frequently call for speedy scientific development and a knowledge-based society. Often that call is rhetorical, but in some Muslim countries—Qatar, the United Arab Emirates (UAE), Pakistan, Malaysia, Saudi Arabia, Iran, and Nigeria among others—official patronage and funding for science and education have grown sharply in recent years. Enlightened individual rulers, including Sultan ibn Muhammad Al-Qasimi of Sharjah, Hamad bin Khalifa Al Thani of Qatar, and others have put aside some of their vast personal wealth for such causes. No Muslim leader has publicly called for separating science from religion.

A pragmatic approach, which seeks promotion of regular science rather than Islamic science, is pursued by institutional bodies such as COMSTECH (Committee on Scientific and Technological Cooperation), which was established by the OIC's Islamic Summit in 1981. It joined the IAS (Islamic Academy of Sciences) and ISESCO (Islamic Educational, Scientific, and Cultural Organization) in serving the *ummah* (the global Muslim community). But a visit to the websites of those organizations reveals that over two decades, the combined sum of their activities amounts to sporadically held conferences on disparate subjects, a handful of research and travel grants, and small sums for repair of equipment and spare parts.

References

¹ A detailed account of Muslim scientific achievements can be found in George Sarton's monumental 5-volume work, *Introduction To the History Of Science*, Vol. I&II, New York, 1975.

² *Islam And Science - Religious Orthodoxy And The Battle For Rationality*, by Pervez Hoodbhoy, London, ZED Books 1991. A critical account of the relationship between the scientific spirit and Muslim orthodoxy, covering both present and medieval times.

³ *Science And Science Policy In The Arab World*, by A.B. Zahlan, London, 1980. A valuable, if somewhat dated, work on science and technological levels in Arab countries.

⁴ *The Muslim Discovery Of Europe*, Bernard Lewis, New York, 1982. Details the encounter of Muslims with the modern civilization of the West.

⁵ See, for example, A.B. Zahlan in "A History Of Technology In The Arab World, 1800-1977"

⁶ *The Economic History of The Middle East, 1800-1914*, Issawi, Charles (Ed.), Chicago, 1966.

⁷ *Science And Empire - Essays In The Indian Context*, Delhi, 1991. Kumar, Deepak (Ed.) A useful collection of essays detailing the introduction of science in British India.

⁸ *Sayyid Ahmad Khan - A Reinterpretation Of Muslim Theology*, by C.W. Troll, Karachi, 1978. This book traces the evolution of Sayyid Ahmad Khan from a staunch Muslim conservative into the most outstanding exponent of modernism in British India.

⁹ *An Islamic Response To Imperialism*, Nikkie Keddi, University of California Press, 1983. An authoritative account of Jamaluddin Afghani's life and thought, and his encounter with the anti-science orthodoxy of his times.

¹⁰ *Islamic Education*, A.L.Tibawi, London 1972.

¹¹ *Science and the Islamic world --- The quest for rapprochement*, Pervez Hoodbhoy, Physics Today, August 2007, pp 49-55.

¹² *Scientometrics*, M. A. Anwar, A. B. Abu Bakar, **40**, 23 (1997).

¹³ For additional statistics, see the special issue "Islam and Science," *Nature* **444**, 19 (2006).

¹⁴ *Chem. Biodivers*, M. Yalpani and A. Heydari., **2**, 730 (2005).

¹⁵ *Islamic Cultural Identity And Scientific-Technological Development*, Klaus Gottstein. This collection of papers deals with questions of cultural diversity and identity, and science and development in Muslim countries.

¹⁶ *Modern Technology And The Dehumanization Of Man*, Maryam Jameelah, Lahore, 1983. A scathing criticism of science and modernism from the Muslim orthodox perspective; *Taalimat* (Urdu) by Abul Ala Maudoodi, Lahore, Islamic Publishers, n.d. A critique of modern education and sketch of the Islamic alternative by one of the leading conservatives of the century.

¹⁷ A comprehensive account of this historical debate may be found in *Western Science In The Arab World - The Impact Of Darwinism, 1860-1930* by Adel A. Ziadat, London, 1986. The author concludes that an author's religion - whether Muslim or Christian - was of secondary importance in this debate. Rather, it was largely a debate between religious men on the one hand and secularists on the other.

¹⁸ *Knowledge For What?* Proceedings of the Seminar on the Islamization of Knowledge, Islamic University, Islamabad, 1982. A useful compendium of papers setting out the orthodox Islamic perspective on the nature and purpose of knowledge.

¹⁹ *Islam And Contemporary Society*, S.H. Nasr, London, 1982. An attack on the foundations of modern science and an appeal for a science based on Islam by one of the best known opponents of Western science.