feature article

Science and the Islamic world—The quest for rapprochement

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Internal causes led to the decline of Islam's scientific greatness long before the era of mercantile imperialism. To contribute once again, Muslims must be introspective and ask what went wrong.

This article grew out of the Max von Laue Lecture that I delivered earlier this year to celebrate that eminent physicist and man of strong social conscience. When Adolf Hitler was on the ascendancy, Laue was one of the very few German physicists of stature who dared to defend Albert Einstein and the theory of relativity. It therefore seems appropriate that a matter concerning science and civilization should be my concern here.

The question I want to pose—perhaps as much to myself as to anyone else—is this: With well over a billion Muslims and extensive material resources, why is the Islamic world disengaged from science and the process of creating new knowledge? To be definite, I am here using the 57 countries of the Organization of the Islamic Conference (OIC) as a proxy for the Islamic world.

It was not always this way. Islam's magnificent Golden Age in the 9th–13th centuries brought about major advances in mathematics, science, and medicine. 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. But with the end of that period, science in the Islamic world essentially collapsed. No major invention or discovery has emerged from the Muslim world for well over seven centuries now. That arrested scientific development is one important element—although by no means the only one—that contributes to the present marginalization of Muslims and a growing sense of injustice and victimhood.

Such negative feelings must be checked before the gulf widens further. A bloody clash of civilizations, should it actually transpire, will surely rank along with the two other most dangerous challenges to life on our planet—climate change and nuclear proliferation.

First encounters

Islam's encounter with science has had happy and unhappy periods. There was no science in Arab culture in the initial period of Islam, around 610 AD. 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 Asharites. A generally tolerant and pluralistic Islamic culture allowed Muslims, Christians, and Jews to create new works of art and science together. But 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 Islam.[1]

A long period of darkness followed, punctuated by occasional brilliant spots. In the 16th century, the Turkish Ottomans established an extensive empire with the help of military technology. But there was little enthusiasm for science and new knowledge (see figure 1). In the 19th century, the European Enlightenment inspired a wave of modernist Islamic reformers: Mohammed Abduh of Egypt, his follower Rashid Rida from Syria, and their counterparts on the Indian subcontinent, such as Sayyid Ahmad Khan and Jamaluddin Afghani, exhorted their fellow Muslims to accept ideas of the Enlightenment and the scientific revolution. Their theological position can be roughly paraphrased as, "The Qur'an tells us how to go to heaven, not how the heavens go." That echoed Galileo earlier in Europe.

The 20th century witnessed the end of European colonial rule and the emergence of several new independent Muslim states, all initially under secular national leaderships. A spurt toward modernization and the acquisition of technology followed. Many expected that a Muslim scientific renaissance would ensue. Clearly, it did not.

What ails science in the Muslim world?

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 (see figure 2 and the news story on page 33). No Muslim leader has publicly called for separating science from religion.

Is boosting resource allocations enough to energize science, or are more fundamental changes required? Scholars of

Figure 1. Ottoman Empire astronomers working in 1577 at an observatory in Istanbul. This painting accompanied an epic poem that honored Sultan Murad III, who ruled from 1574 to 1595. The observatory was demolished in 1580 after astronomers sighted a comet and predicted a military victory that failed to materialize. The poem was published a year later. (For more on ancient Islamic astronomy, see the American Institute of Physics online cosmology exhibit, http://www.aip.org/history/cosmology/tools/tools-nakedeyes.htm#astrolabe.)

the 19th century, such as the pioneering sociologist Max Weber, claimed that Islam lacks an "idea system" critical for sustaining a scientific culture based on innovation, new experiences, quantification, and empirical verification. Fatalism and an orientation toward the past, they said, makes progress difficult and even undesirable.

In the current epoch of growing antagonism between the Islamic and the Western worlds, most Muslims reject such charges with angry indignation. They feel those accusations add yet another excuse for the West to justify its ongoing cultural and military assaults on Muslim populations. Muslims bristle at any hint that Islam and science may be at odds, or that some underlying conflict between Islam and science may account for the slowness of progress. The Qur'an, being the unaltered word of God, cannot be at fault: Muslims believe that if there is a problem, it must come from their inability to properly interpret and implement the Qur'an's divine instructions.

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.

Such arguments have been and will continue to be much debated, but they will not be pursued further here. Instead, let us seek to understand the state of science in the contemporary Islamic world. First, to the degree that available data allows, I will quantitatively assess the current state of science in Muslim countries. Then I will look at prevalent Muslim attitudes toward science, technology, and modernity, with an eye toward identifying specific cultural and social practices that work against progress. Finally, we can turn to the fundamental question: What will it take to bring science back into the Islamic world?

Measuring Muslim scientific progress

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.

I will use the following reasonable set of four metrics:

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

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 Malaysia[2] 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 OIC.[3]

The situation may be even grimmer than the publication numbers or perhaps even the citation counts suggest. Assess-

NASSER HAMDAN/AUS

Figure 2. A student working with a scanning electron microscope at the American University of Sharjah, United Arab Emirates. The Emirate's ruler recently created the Sharjah Academy of Scientific Research, where a nanotechnology center and central lab facility is being established. Scientific researchers require financial resources and equipment. But can they also exercise the intellectual freedom and questioning skepticism that they need even more?

ing 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 example,[4] 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.

The situation regarding patents is also discouraging: The OIC countries produce negligibly few. According to official statistics, Pakistan has produced only eight patents in the past 43 years.

Islamic countries show a great diversity of cultures and levels of modernization 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.

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 (figure 3) 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 exceed $150 million yearly. 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.

Higher education

According to a recent survey, among the 57 member states of the OIC, there are approximately 1800 universities.[5] Of those, only 312 publish journal articles. A ranking of the 50 most published among them yields these numbers: 26 are in Turkey, 9 in Iran, 3 each in Malaysia and Egypt, 2 in Pakistan, and 1 in each of Uganda, the UAE, Saudi Arabia, Lebanon, Kuwait, Jordan, and Azerbaijan. For the top 20 universities, the average yearly production of journal articles was about 1500, a small but reasonable number. However, the average citation per article is less than 1.0 (the survey report does not state whether self-citations were excluded). There are fewer

data available for comparing against universities worldwide. Two Malaysian undergraduate institutions were in the top-200 list of the *Times Higher Education Supplement* in 2006 (available at http://www.thes.co.uk). No OIC university made the top-500 "Academic Ranking of World Universities" compiled by Shanghai Jiao Tong University (see http://ed.sjtu.edu.cn/en). This state of affairs led the director general of the OIC to issue an appeal for at least 20 OIC universities to be sufficiently elevated in quality to make the top-500 list. No action plan was specified, nor was the term "quality" defined.

An institution's quality is fundamental, but how is it to be defined? Providing more infrastructure and facilities is important but not key. Most universities in Islamic countries have a starkly inferior quality of teaching and learning, a tenuous connection to job skills, and research that is low in both quality and quantity. Poor teaching owes more to inappropriate attitudes than to material resources. Generally, obedience and rote learning are stressed, and the authority of the teacher is rarely challenged. Debate, analysis, and class discussions are infrequent.

Academic and cultural freedoms on campuses are highly restricted in most Muslim countries. At Quaid-i-Azam University in Islamabad, where I teach, the constraints are similar to those existing in most other Pakistani public-sector institutions. This university serves the typical middle-class Pakistani student and, according to the survey referred to earlier,[5] ranks number two among OIC universities. Here, as in other Pakistani public universities, films, drama, and music are frowned on, and sometimes even physical attacks by student vigilantes who believe that such pursuits violate Islamic norms take place. The campus has three mosques with a fourth one planned, but no bookstore. No Pakistani university, including QAU, allowed Abdus Salam to set foot on its campus, although he had received the Nobel Prize in 1979 for his role in formulating the standard model of particle physics. The Ahmedi sect to which he belonged, and which had earlier been considered to be Muslim, was officially declared heretical in 1974 by the Pakistani government.

As intolerance and militancy sweep across the Muslim world, personal and academic freedoms diminish with the rising pressure to conform. In Pakistani universities, the veil is now ubiquitous, and the last few unveiled women students are under intense pressure to cover up. The head of the government-funded mosque-cum-seminary (figure 4) in the heart of Islamabad, the nation's capital, issued the following chilling warning to my university's female students and faculty on his FM radio channel on 12 April 2007:

> The government should abolish co-education. Quaid-i-Azam University has become a brothel. Its female professors and students roam in objectionable dresses. . . . Sportswomen are spreading nudity. I warn the sportswomen of Islamabad to stop participating in sports. . . . Our female students have not issued the threat of throwing acid on the uncovered faces of women. However, such a threat could be used for creating the fear of Islam among sinful women. There is no harm in it. There are far more horrible punishments in the hereafter for such women.[6]

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 imposition of the veil makes a difference. My colleagues and I share a common observation that over time most students—particularly veiled females—have largely lapsed into becoming silent note-takers, are increasingly timid, and are less inclined to ask questions or take part in discussions. This lack of self-expression and confidence leads to most Pakistani university students, including those in their mid- or late-twenties, referring to themselves as boys and girls rather than as men and women.

Science and religion still at odds

Science is under pressure globally, and from every religion. As science becomes an increasingly dominant part of human culture, its achievements inspire both awe and fear. Creationism and intelligent design, curbs on genetic research, pseudoscience, parapsychology, belief in UFOs, and so on are some of its manifestations in the West. Religious conservatives in the US have rallied against the teaching of Darwinian evolution. Extreme Hindu groups such as the Vishnu Hindu Parishad, which has called for ethnic cleansing of Christians and Muslims, have promoted various "temple miracles," including one in which an elephant-like God miraculously came alive and started drinking milk. Some extremist Jewish groups also derive additional political strength from antiscience movements. For example, certain American cattle tycoons have for years been working with Israeli counterparts to try to breed a pure red heifer in Israel, which, by their interpretation of chapter 19 of the Book of Numbers, will signal the coming of the building of the Third Temple,[7] an event that would ignite the Middle East.

In the Islamic world, opposition to science in the public arena takes additional forms. Antiscience materials have an

FEDERATION OF AMERICAN SCIENTISTS

Figure 3. One of Pakistan's missile launchers. Military technology is an area of investment in a few Muslim countries as in other developing countries. But such arms are more often a triumph of reverse engineering than of original research and development.

immense presence on the internet, with thousands of elaborately designed Islamic websites, some with view counters running into the hundreds of thousands. A typical and frequently visited one has the following banner: "Recently discovered astounding scientific facts, accurately described in the Muslim Holy Book and by the Prophet Muhammad (PBUH) 14 centuries ago." Here one will find that everything from quantum mechanics to black holes and genes was anticipated 1400 years ago.

Science, in the view of fundamentalists, is principally seen as valuable for establishing yet more proofs of God, proving the truth of Islam and the Qur'an, and showing that modern science would have been impossible but for Muslim discoveries. Antiquity alone seems to matter. One gets the impression that history's clock broke down somewhere during the 14th century and that plans for repair are, at best, vague. In that all-too-prevalent view, science is not about critical thought and awareness, creative uncertainties, or ceaseless explorations. Missing are websites or discussion groups dealing with the philosophical implications from the Islamic point of view of the theory of relativity, quantum mechanics, chaos theory, superstrings, stem cells, and other contemporary science issues.

Similarly, in the mass media of Muslim countries, discussions on "Islam and science" are common and welcomed only to the extent that belief in the status quo is reaffirmed rather than challenged. When the 2005 earthquake struck Pakistan, killing more than 90 000 people, no major scientist in the country publicly challenged the belief, freely propagated through the mass media, that the quake was God's punishment for sinful behavior. Mullahs ridiculed the notion that science could provide an explanation; they incited their followers into smashing television sets, which had provoked Allah's anger and hence the earthquake. As several class discussions showed, an overwhelming majority of my university's science students accepted various divine-wrath explanations.

Why the slow development?

Although the relatively slow pace of scientific development in Muslim countries cannot be disputed, many explanations can and some common ones are plain wrong.

For example, it is a myth that women in Muslim countries are largely excluded from higher education. In fact, the numbers are similar to those in many Western countries: The percentage of women in the university student body is 35% in Egypt, 67% in Kuwait, 27% in Saudi Arabia, and 41% in Pakistan, for just a few examples. In the physical sciences and engineering, the proportion of women enrolled is roughly similar to that in the US. However, restrictions on the freedom of women leave them with far fewer choices, both in their personal lives and for professional advancement after graduation, relative to their male counterparts.

The near-absence of democracy in Muslim countries is also not an especially important reason for slow scientific development. It is certainly true that authoritarian regimes generally deny freedom of inquiry or dissent, cripple professional societies, intimidate universities, and limit contacts with the outside world. But no Muslim government today, even if dictatorial or imperfectly democratic, remotely approximates the terror of Hitler or Joseph Stalin—regimes in which science survived and could even advance.

Another myth is that the Muslim world rejects new technology. It does not. 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. For example, while driving in Islamabad, it would occasion no surprise if you were to receive an urgent SMS (short message service) requesting immediate prayers for helping Pakistan's cricket team win a match. 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.

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.

Some relatively more plausible reasons for the slow scientific development of Muslim countries have been offered. First, even though a handful of rich oil-producing Muslim countries have extravagant incomes, most are fairly poor and in the same boat as other developing countries. Indeed, the OIC average for per capita income is significantly less than the global average. Second, the inadequacy of traditional Islamic languages—Arabic, Persian, Urdu—is an important contributory reason. About 80% of the world's scientific literature appears first in English, and few traditional languages in the developing world have adequately adapted to new linguistic demands. With the exceptions of Iran and Turkey, translation rates are small. According to a 2002 United Nations report written by Arab intellectuals and released in Cairo, Egypt, "The entire Arab world translates about 330 books annually, one-fifth the number that Greece translates." The report adds that in the 1000 years since the reign of the caliph Maa'moun, the Arabs have translated as many books as Spain translates in just one year.[8]

It's the thought that counts

But the still deeper reasons are attitudinal, not material. At the base lies the yet unresolved tension between traditional and modern modes of thought and social behavior.

That assertion needs explanation. No grand dispute, such as between Galileo and Pope Urban VIII, is holding back the clock. Bread-and-butter science and technology requires learning complicated but mundane rules and procedures that place no strain on any reasonable individual's belief system. A bridge engineer, robotics expert, or microbiologist can certainly be a perfectly successful professional without pondering profound mysteries of the universe. Truly fundamental and ideology-laden issues confront only that tiny minority of scientists who grapple with cosmology, indeterminacy in quantum mechanical and chaotic systems, neuroscience, human evolution, and other such deep topics. Therefore, one could conclude that developing science is only a matter of setting up enough schools, universities, libraries, and laboratories, and purchasing the latest scientific tools and equipment.

But the above reasoning is superficial and misleading. Science is fundamentally an idea-system that has grown around a sort of skeleton wire frame—the scientific method. The deliberately cultivated scientific habit of mind is mandatory for successful work in all science and related fields where critical judgment is essential. Scientific progress

ISHAQUE CHOUDHRY

Figure 4. Students of a seminary, Jamia Hafsa, in Islamabad, demonstrating for the enforcement of Islamic law, March 2007. The seminary's head, a government employee, issued a threat to all female students in Islamabad to be similarly veiled or else face consequences. Is this a climate that is conducive to scientific inquiry?

constantly demands that facts and hypotheses be checked and rechecked, and is unmindful of authority. But there lies the problem: The scientific method is alien to traditional, unreformed religious thought. Only the exceptional individual is able to exercise such a mindset in a society in which absolute authority comes from above, questions are asked only with difficulty, the penalties for disbelief are severe, the intellect is denigrated, and a certainty exists that all answers are already known and must only be discovered.

Science finds every soil barren in which miracles are taken literally and seriously and revelation is considered to provide authentic knowledge of the physical world. If the scientific method is trashed, no amount of resources or loud declarations of intent to develop science can compensate. In those circumstances, scientific research becomes, at best, a kind of cataloging or "butterfly-collecting" activity. It cannot be a creative process of genuine inquiry in which bold hypotheses are made and checked.

Religious fundamentalism is always bad news for science. But what explains its meteoric rise in Islam over the past half century? In the mid-1950s all Muslim leaders were secular, and secularism in Islam was growing. What changed? Here the West must accept its share of responsibility for reversing the trend. Iran under Mohammed Mossadeq, Indonesia under Ahmed Sukarno, and Egypt under Gamal Abdel Nasser are examples of secular but nationalist governments that wanted to protect their national wealth. Western imperial greed, however, subverted and overthrew them. At the same time, conservative oil-rich Arab states—such as Saudi Arabia—that exported extreme versions of Islam were US clients. The fundamentalist Hamas organization was helped by Israel in its fight against the secular Palestine Liberation Organization as part of a deliberate Israeli strategy in the 1980s. Perhaps most important, following the Soviet invasion of Afghanistan in 1979, the US Central Intelligence Agency armed the fiercest and most ideologically charged Islamic fighters and brought them from distant Muslim countries into Afghanistan, thus helping to create an extensive globalized jihad network. Today, as secularism continues to retreat, Islamic fundamentalism fills the vacuum.

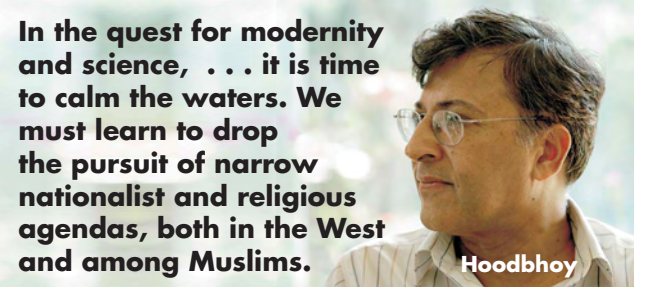
How science can return to the Islamic world

In the 1980s an imagined "Islamic science" was posed as an alternative to "Western science." The notion was widely propagated and received support from governments in Pakistan, Saudi Arabia, Egypt, and elsewhere. Muslim ideologues in the US, such as Ismail Faruqi and Syed Hossein Nasr, announced that a new science was about to be built on lofty moral principles such as tawheed (unity of God), ibadah (worship), khilafah (trusteeship), and rejection of zulm (tyranny), and that revelation rather than reason would be the ultimate guide to valid knowledge. Others took as literal statements of scientific fact verses from the Qur'an that related to descriptions of the physical world. Those attempts led to many elaborate and expensive Islamic science conferences around the world. Some scholars calculated the temperature of Hell, others the chemical composition of heavenly djinnis. None produced a new machine or instrument, conducted an experiment, or even formulated a single testable hypothesis.

A more 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.

One almost despairs. Will science never return to the Islamic world? Shall the world always be split between those who have science and those who do not, with all the attendant consequences?

Bleak as the present looks, that outcome does not have to prevail. History has no final word, and Muslims do have a



chance. One need only remember how the Anglo–American elite perceived the Jews as they entered the US at the opening of the 20th century. Academics such as Henry Herbert Goddard, the well-known eugenicist, described Jews in 1913 as "a hopelessly backward people, largely incapable of adjusting to the new demands of advanced capitalist societies." His research found that 83% of Jews were "morons"—a term he popularized to describe the feeble-minded—and he went on to suggest that they should be used for tasks requiring an "immense amount of drudgery." That ludicrous bigotry warrants no further discussion, beyond noting that the powerful have always created false images of the weak.

Progress will require behavioral changes. If Muslim societies are to develop technology instead of just using it, the ruthlessly competitive global marketplace will insist on not only high skill levels but also intense social work habits. The latter are not easily reconcilable with religious demands made on a fully observant Muslim's time, energy, and men-

tal concentration: The faithful must participate in five daily congregational prayers, endure a month of fasting that taxes the body, recite daily from the Qur'an, and more. Although such duties orient believers admirably well toward success in the life hereafter, they make worldly success less likely. A more balanced approach will be needed.

Science can prosper among Muslims once again, but only with a willingness to accept certain basic philosophical and attitudinal changes—a Weltanschauung that shrugs off the dead hand of tradition, rejects fatalism and absolute belief in authority, accepts the legitimacy of temporal laws, values intellectual rigor and scientific honesty, and respects cultural and personal freedoms. The struggle to usher in science will have to go side-by-side with a much wider campaign to elbow out rigid orthodoxy and bring in modern thought, arts, philosophy, democracy, and pluralism.

Respected voices among believing Muslims see no incompatibility between the above requirements and true Islam as they understand it. For example, Abdolkarim Soroush, described as Islam's Martin Luther, was handpicked by Ayatollah Khomeini to lead the reform of Iran's universities in the early 1980s. His efforts led to the introduction of modern analytical philosophers such as Karl Popper and Bertrand Russell into the curricula of Iranian universities. Another influential modern reformer is Abdelwahab Meddeb, a Tunisian who grew up in France. Meddeb argues that as early as the middle of the eighth century, Islam had produced the premises of the Enlightenment, and that between 750 and 1050, Muslim authors made use of an astounding freedom of thought in their approach to religious belief. In their analyses, says Meddeb, they bowed to the primacy of reason, honoring one of the basic principles of the Enlightenment.

In the quest for modernity and science, internal struggles continue within the Islamic world. Progressive Muslim forces have recently been weakened, but not extinguished, as a consequence of the confrontation between Muslims and the West. On an ever-shrinking globe, there can be no winners in that conflict: It is time to calm the waters. We must learn to drop the pursuit of narrow nationalist and religious agendas, both in the West and among Muslims. In the long run, political boundaries should and can be treated as artificial and temporary, as shown by the successful creation of the European Union. Just as important, the practice of religion must be a matter of choice for the individual, not enforced by the state. This leaves secular humanism, based on common sense and the principles of logic and reason, as our only reasonable choice for governance and progress. Being scientists, we understand this easily. The task is to persuade those who do not.

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