

Iran is pouring money into world-class facilities for biotechnology, particle physics, and astronomy. But growing tensions with the West threaten a scientific community just coming into its own

An Islamic Science Revolution?

TEHRAN—In a quiet suburb that seems light-years from the hubbub of downtown Tehran, Amir Mousavi beams with pride at a state-of-the-art gene gun for injecting DNA into cells. “It’s a dream of many universities in Iran to have one,” says Mousavi, a molecular biologist with the National Research Center for Genetic Engineering and Biotechnology (NRCGEB). The lab has become a magnet for young talent, filling up with researchers who in other times might have left Iran to make their mark in science.

The rising campus is a prime example of Iran’s recent push to create oases of elite science. Other brick-and-mortar initiatives include the country’s first world-class astronomical observatory, a linear accelerator, and a facility for international conferences. The sails of Iranian science have been filling with government support of several kinds—including a rapid expansion of foreign cooperation that embraces even “the Great Satan,” as the United States is still known in some circles here.

But some fear that Iranian science may be heading into the doldrums. President Mahmoud Ahmadinejad, an ultraconservative who took office last month on a promise to restore the values of the Islamic Revolution, has yet to express his views on R&D, although he has named a mathematician as his science minister. If the new government attempts to roll back the social reforms begun by Ahmadinejad’s predecessor Mohammad Khatami, academic freedom could become restricted, and science could suffer, says Shapour Etemad, director of the

National Research Institute for Science Policy in Tehran. “The mood in the scientific community is very poor,” he says. Moreover, Iran’s refusal to halt a nuclear fuel enrich-



Thinking in many dimensions. Physicist Hessemaddin Arfaei is the nucleus of IPM’s highly rated group of string theorists.

ment program may endanger collaborations with the West. Immunologist Mostafa Moin, an architect of scientific reforms in Iran and a presidential candidate who placed fifth in the first round of voting in elections last June, is concerned for the future. “All research is in danger,” he says.

Trials and tribulations

What worries Iranian intellectuals most is a reprise of the scientific stagnation that followed the 1979 revolution. After a fundamentalist coup toppled the shah, universities were

closed for 3 years, and many research projects wilted. The Cultural Revolution “rejected science as a product of the West or endeavored to promote an ‘Islamic science’” focused on development, Iranian sociologist Farhad Khosrokhavar of the École des Hautes Études en Sciences Sociales in Paris wrote in the summer 2004 issue of *Critical Middle Eastern Studies*. That spurred an exodus of talented researchers. Hit hard were the prestigious Hamadan University and the Institute for Biochemistry and Biophysics in Tehran. Scientists who chose to stay, says Etemad, “often were suspected of being counter-revolutionaries.”

During this dark period, the remnants of an elite group of mathematicians and theoretical physicists struggled to prevent an implosion of Iranian science. Meeting weekly for a “Tuesday Gathering” at the University of Tehran’s Institute of Physics, the scientists “fought against the prevailing atmosphere and convinced the new generation to continue its efforts for the survival of scientific activity in Iran,” Khosrokhavar wrote. One safe haven was the Atomic Energy Center, the nerve center of Iran’s efforts to develop nuclear power—and, some Western analysts contend, atomic bombs.

The Tuesday Gathering lobbied the government hard to permit universities to train Ph.D.s. Its efforts paid off in 1988, soon after the Iran-Iraq war ended, when Sharif University of Technology launched Iran’s first science Ph.D. program, in physics. Moin, appointed minister of culture and higher education in 1989, says he sought to breathe life into the largely moribund universities. Since then, undergraduate enrollment has shot up 10-fold, to nearly 1 million. “People are thirsty for higher education,” says Mohammad Javad Rasaei, dean of medical sciences at Tarbiat Modarres University in Tehran. Meanwhile, science spending has climbed steadily, from about 0.2% of gross domestic product in 1990 to 0.65% this year.

Although few researchers have reached the highest echelons of their disciplines, Iran’s scientific leaders say their community is coalescing. “Scientific output has skyrocketed since 1993,” Rasaei says. In 2003, scientists in Iran published 3277 papers in international journals, a 30-fold increase over 1985, placing the country well ahead of Pakistan and on par with Egypt. Since 2000, the number of international collaborations has risen



Home is where the lab is. Modern facilities at the National Research Center for Genetic Engineering and Biotechnology in Tehran have persuaded some talented young biologists to stay in Iran.

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threefold, with chemistry, engineering, and physics leading the pack.

Iranian science has been bedeviled by shifting relations with the West. As higher education minister, Moin encouraged science students and faculty members to make a beeline for Western labs. NRCGEB's Mousavi, 36, is a star example. He won a Japanese government scholarship for his Ph.D. studies at the Nara Institute of Science and Technology in Japan. After a postdoc stint, he turned down a job offer from the University of California, San Diego, to return to Iran. "Many scientists love their country and come back," he says.

However, many others have stayed abroad. "It's hard to attract people back to meager facilities and meager salaries," says Yousef Sobouti, director of the Institute for Advanced Studies in Basic Sciences (IASBS) in Zanjan, a fast-growing center for graduate science education in the foothills of the Zāgros Mountains, 300 kilometers west of Tehran. That has prompted worries that Iran's push for foreign training has shortchanged its own growth. "We came to the conclusion that this is not a safe way to develop science," says Iran's deputy research minister Reza Mansouri.

Bringing on big science

The science ministry has tried to shore up a weak infrastructure by showering money on a handful of institutes founded after the revolution. One beneficiary is the Institute for Studies in Theoretical Physics and Mathematics (IPM) in Tehran. "We go after people who can build a field," says Hessamaddin Arfaei, IPM's deputy director of research, who returned to Iran in 1979 after earning a Ph.D. at the University of California, Berkeley. His reputation as a top string theorist has enticed some of Iran's best young minds to work on the problem at IPM.

The institute's main focus is particle physics. Since 2001, IPM has been sending researchers to CERN, the European laboratory for particle physics near Geneva, Switzerland. "It took 10 years to get a green

light" from the Iranian government to proceed with the collaboration, says Arfaei. IPM scientists are helping construct the Compact Muon Solenoid, a detector for CERN's Large Hadron Collider due to come online in 2007.

The collider project is laying the groundwork for IPM's own dream: to start building an accelerator in the next decade that can infuse particles with 1 billion electron volts (GeV) of energy. Arfaei says such a machine "would allow us to do modern science," such as looking for violations of charge-parity symmetry, which would confirm that matter and antimatter are not always completely equivalent. As a dry run, IPM has begun constructing a 10-million-electron-volt linear accelerator. "You could go and buy one of these in Europe," Arfaei says. Instead, IPM staff members are devising superconducting magnets and other technologies on their own.

As further preparation for the GeV accelerator, the institute, under a deal inked last month and awaiting formal approval by Par-



Looking outward. Yousef Sobouti says Iran's planned new observatory will provide opportunities for foreign collaboration.

liament, will build magnets for boosting the power of the SESAME synchrotron in Jordan. IPM's longtime director Mohammad Javad Larijani, an influential conservative, is the brother of Iran's new nuclear negotiator, Ali Larijani. The institute should continue to fare well under Ahmadinejad, Etemad says.

Astronomers, too, are about to reap a reward. The government has begun site selection for an \$18 million observatory, likely to be dedicated to surveys for objects such as near-earth pulsars and extrasolar planets. Iranian astronomers began a campaign for the project in the 1970s, but it wasn't until 2004 that funds were allotted, thanks to a push from astrophysicist Mansouri. After specifications for the 2-meter optical and near-infrared telescope are drafted later this year, orders for components will go out to government factories.

In the meantime, scientists are surveying four sites—Kashan, Kerman, Khorosan, and Qom—in the running to host the observatory. The scope should see first light by 2010. "After so many years, we'll finally be able to make world-class observations in Iran," says Mansouri. The facility will create a wealth of new opportunities for foreign collaborations, adds Sobouti, an astrophysicist. "If you're in a position to offer something, you are in a position to be offered," he says. Centuries ago, in the early days of Islam, astronomers in Persia and Central Asia were at the vanguard of their profession. "We hope that cuts ice with the new government," says one scientist.

The darling of Iran's previous administration was biotechnology. Its largess included Tarbiat Modarres University, which has sunk millions of dollars into its labs in the last few years. "There is nothing we cannot buy," claims Rasaei. A recent purchase is a \$1 million nuclear magnetic resonance x-ray fluorescence microscope. Biotech is so popular, Rasaei says, that 700 undergrads vied for five positions in his lab, which recently succeeded in producing recombinant immunoglobulin from the Bactrian camel.

The first fruits of Iran's biotech boom are ripening. The Agricultural Biotechnology

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Tradition and change. Akram Amani, a medicinal chemist and lab chief at the Pasteur Institute in Tehran, predicts that female scientists will continue to make gains.

Research Institute of Iran has completed field trials of a genetically modified variety of local rice called tarom molai. Risk assessments and biosafety studies of the rice, equipped with the gene for making a *Bacillus thuringiensis* protein that's toxic to insects, are under way. At NRCGEB, meanwhile, the plant biotechnology group is conducting field trials of virus-resistant sugar beets and herbicide-tolerant canola, and the industrial biotech department is scaling up, in a new pilot plant, production of recombinant human growth hormone.

In March 2004, NRCGEB's 170-strong staff relocated from cramped digs in downtown Tehran to the first of five wings of the new campus in Chitgar, 17 kilometers west of Tehran. When construction is completed, the institute will have onsite staff housing and childcare for a staff expected to grow fourfold, Mousavi says. NRCGEB is also the anchor of a budding science village. A short drive down Research Boulevard is a polymer research center, chemistry and forestry institutes, the botanical garden, and the agriculture faculty of Tarbiat Modarres.

Gloomy outlook

Iranian scientists have a love-hate relationship with the world's most powerful scientific nation, which Iran's theocracy has branded an archenemy. On one hand, Iran has more collaborative projects with the United States than with any other nation. On the other hand, sanctions imposed by the United States after the revolution have taken a toll on science.

Sanctions forbid the direct sale of U.S.-made goods to Iran, impeding scientists here from obtaining certain specialized instruments and supplies. Although middlemen in places such as Dubai sell many of these items, their prices are inflated, and there is no after-sales service. "We train technicians to fix instruments," says Rasaei. "But spare parts are a problem."

New impediments to Iranian scientists are restrictions the United States imposed after the 11 September 2001 terror attacks and informal barriers thrown up after President George W. Bush labeled Iran a member of the so-called axis of evil in 2002. Iranians must obtain U.S. visas in a third country, and they are harder than ever to get. Rasaei would have preferred to spend an upcoming sabbatical in the United States, he says, but "I'm not going to humiliate myself by applying for a visa and not getting it." And one scientist says that at conferences, Westerners treat Chinese or Indian scientists with more respect than an Iranian with similar credentials. "Scientists endure many symbolic wounds due to their Iranian citizenship," Etemad notes.

Iran must overcome internal constraints as well. Only recently have universities created postdoc positions, primarily as a mechanism to try out talented young scientists for junior faculty positions. "Nobody wants to let a good graduate go," says Mohammad Reza Khajehpour, deputy director of IASBS, which has earned a reputation as one of the most productive scientific centers in Iran, publishing more papers per staff member than any other institute. At the same time, Iran's own strict visa regime sharply constrains the amount of time that any foreign researcher can work in Iran. "China and Malaysia have asked to send postdocs [to IASBS], but we can't take them," Khajehpour says. And although the government has raised scientists' salaries, many observers say the national science budget, about \$900 million, is not increasing fast enough.

People are waiting to see whether Ahmadinejad, the new president, will change the science agenda. After a restructuring earlier this year, a new High Commission for Science, Research, and Technology now controls the science budget. The commission, chaired by the president and

expected to meet in the fall, "will decide what will happen in science in the coming years," says Rasaei. Few scientists believe that Ahmadinejad's new science minister, mathematician Mohammad-Mehdi Zahedi of Shahid Bahonar University in Kerman, will radically alter course.

Rather, much hinges on whether the new government follows through on Ahmadinejad's vow to restore the values of the Islamic revolution, including greater segregation of the sexes. The ranks of women in academia swelled during Khatami's two terms: Of 28,000 scientists currently in Iranian universities, 5400 are women. Among the country's rising scientific stars is Akram Amani, a female lab chief at the Pasteur Institute in Tehran. Trained in medicinal chemistry in India, Amani returned to Tehran in 1996, just before Khatami came to power. She predicts that female scientists will continue to make gains under Ahmadinejad, who she says "did a very good job" as Tehran's mayor before becoming president. Others are pessimistic.

One pervasive fear is that academic freedom could be eroded. "I don't think the universities and research institutes can defend themselves" if conservatives grow more assertive, says Moin, president of the Immunology, Asthma, and Allergy Research Institute in Tehran. Rasaei adds that "if scientists cannot speak openly, and they don't want to keep quiet, they will probably prefer to leave Iran." Arfaei worries that funds for travel and hosting short-term visiting researchers may dwindle. "It could be like it was 20 years ago, when traveling abroad was a luxury," he says.

Not likely, says Mansouri, who is preparing to resign from the science ministry to pursue a sabbatical at McGill University in Montreal, Canada. He sees a bright future taking shape in the Dasht-é Kavir desert. There, in the Khoranagh oasis near the city of Yazd, the science ministry is refurbishing a 4000-year-old citadel and caravansary for hosting international workshops. The idea was born several years ago, when Mansouri and some colleagues were longing for a science retreat like the Snowmass Conference Center in Aspen, Colorado. "We need to bring more scientists from abroad to Iran," he says.

Khoranagh is the centerpiece of a new organization, the Center for International Research and Collaboration, formed under an agreement between the science ministry and the Abdus Salam International Center for Theoretical Physics in Trieste, Italy. The conference facility should be ready in about 5 years, Mansouri says. In the meantime, Iran's fragile scientific community will either continue to enjoy a renaissance or discover that, like the Khoranagh citadel, its vibrant days are already behind it.

—RICHARD STONE

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