minorities that earn Ph.D.'s in their disciplines, and the AAAS, together with the National Academies of Sciences and Engineering, should ask each funding agency to include in every research grant funds to enable undergraduates to participate in research-related projects.

"Perhaps the most important thing we can do to generate support for science is to show that we are doing our bit to address this national crisis in science education," Massey said. ■ COLIN NORMAN

"Oh, I Thought You Were a Man."

The woman who played a major role in the discovery of fission was once required to work in a converted carpenter's shop with a detached entrance, so as not to fluster her male colleagues. When the British physicist Ernest Rutherford met Lise Meitner (1878–1968) for the first time, he exclaimed with astonishment: "Oh, I thought you were a man." Meitner spent the rest of Rutherford's visit playing the role of hostess to Mrs. Rutherford.

And so it went. At a AAAS session on "the uneasy careers and intimate lives" of great women in science, the biographical sketches combined themes of frustration and genius and farce. For instance, Meitner's first lecture at the University of Berlin was entitled, "Problems of Cosmic Physics." A newspaper reporter at the time wrote that Meitner spoke on "Problems of Cosmetic Physics."

Perhaps it was fitting, then, that three of the five women profiled during the session were physicists, since, as Stephen Brush of the University of Maryland at College Park noted, women make up only 7% of employed physicists and astronomers, the lowest percentage of any of the sciences. Said Brush: "Physics seems especially repulsive to girls." Only half as many girls as boys take physics in high school, and only one quarter of all high school physics teachers are women, even though women comprise half of all high school teachers.

Though common themes run through their stories, the women profiled were all individuals. Meitner was shy and "almost timid," said Sallie Watkins of the University of Southern California. Others were painfully self-effacing. When Marie Goeppert Mayer (1906–1972), the winner of the Nobel Prize in physics for her elucidation of the structure of atomic nuclei, was offered a part-time job at Argonne National Laboratory in 1946, she replied: "But I don't know anything about nuclear physics."

Carnegie Institution of Washington

Nettie Stevens. *The first to observe that the X and Y chromosomes determine sex.*

Others were not so retiring. Dorothy Wrinch (1894–1976), the mathematician turned biologist who proposed a theory on protein structure, wanted to be "a woman Einstein" and "aspired to both professional and popular acclaim," said Pnina Geraldine Abir-Am of Harvard University. A vigorous suffragette, Wrinch confronted "men with an air of moral self-righteousness."

For all their differences, there were many striking similarities in their stories. The women seemed blessed by supportive parents, often a father who encouraged his daughter's interests and talents. Mayer, for example, came from a family of seven generations of professors. "She was said to have been told by her father that she should not grow up to be a woman, meaning a housewife," said Robert Sachs of the Fermi Institute at the University of Chicago.

The women also had mentors, a crucial ingredient in the rise of most famed scientists. For instance, Wrinch had Bertrand Russell. Meitner had Max Planck. Mayer had Max Born.

The women, too, faced a world that only grudgingly yielded to the aspirations of female scientists. Finding a paying job was a difficult feat. Cecilia Payne-Gaposchkin (1900–1979), the astrophysicist who showed that the atmospheres of stars are composed primarily of hydrogen and helium, found no opportunities for her in England. Indeed, during her undergraduate days at Cambridge University, Rutherford "gave her the distinct impression he wasn't interested in female students," said Peggy Aldrich Kidwell of the Smithsonian Institution. Payne-Gaposchkin went to Radcliffe and Harvard, where she held low-paying jobs until finally becoming one of Harvard's first woman professors in 1956.

Finally, the women struggled to get the credit they deserved for their work. Though no longer excluded, "women were being systematically and effectively marginalized in the world of education," said Watkins of Meitner, who for reasons that are still being debated, did not share with Otto Hahn the Nobel Prize for the discovery of fission.

Apparently, these days are not over. Brush notes that every biology textbook mentions that sex is determined in humans by the X and Y chromosomes. But few mention that the observation was made by Nettie Stevens (1861–1912) of Bryn Mawr College.

Women still face difficulties translating their contributions to positions of legitimate scientific authority, said Abir-Am. "Now, the key problem of women is no longer whether they can make great contributions but whether they can acquire the resources to preserve their scientific authority and thus protect their contributions from those to whom authority comes naturally in our culture, i.e. men." ■ WILLIAM BOOTH

A World of Megacities

Like "a gigantic Las Vegas," the largest cities in the world attract the "gamblers" of society, the young and the fecund who see in a huge metropolis not overcrowding and poverty, but hope and opportunity. And more and more, the cities of their dreams are no longer New York, London, or Paris, but Jakarta, Dacca, or Karachi.

By the year 2000, 17 of the 20 largest cities on Earth will be located in the Third World. All will support populations greater than 10 million persons, with São Paulo and Mexico City expected to exceed 25 million inhabitants. This is a world far different from the one in 1950, when the largest cities were located in the developed countries, and only New York, London, and Shanghai had populations greater than 10 million.

Not only are the locations of these "megacities" shifting from developed to developing nations, the pace and scale of growth are "beyond anything in human experience," said John Kasarda of the University of North Carolina in Chapel Hill at a AAAS session on the prospects and problems of giant cities. For instance, it took New York City some 150 years to reach a population of 8 million souls. It will take Mexico City only 15 years to add 8 million people to its existing population.

Yet despite the popular image of the destitute living in shantytowns and rummaging through the garbage dumps for their dinner, there is no consensus that megacities are all bad. Kasarda, for instance,

notes that outsiders from wealthy countries are often surprised to learn how optimistic many of the inhabitants of even the most grim Third World slums are. Destitution is relative. And who comes to the city? Not the dregs of society, but its most highly motivated members, said Janice Perlman of the Megacities Project at New York University.

In the 1970s, economists observed that productivity increased as cities grew, leading some to speculate that there might not be a limit to city size, and that the extra burdens of such phenomenal growth could be offset by the wealth and productivity of the megacity, said Harry Richardson of the University of Southern California in Los Angeles. But now Richardson believes that "the virtues of big city size were exaggerated."

Much of the early data on giant cities came from developed countries, particularly the United States. In the Third World, the "negative externalities" of pollution and congestion are more acute, said Richardson. Many megacities cannot provide even the most basic services. Only 11% of Manila has sewage pipes. Only 25% of Jakarta gets its garbage hauled away. The former planning director of São Paulo calculated that it would take the equivalent of 30 annual municipal budgets just to make up the current deficiencies in the city's water, sanitation, and road systems.

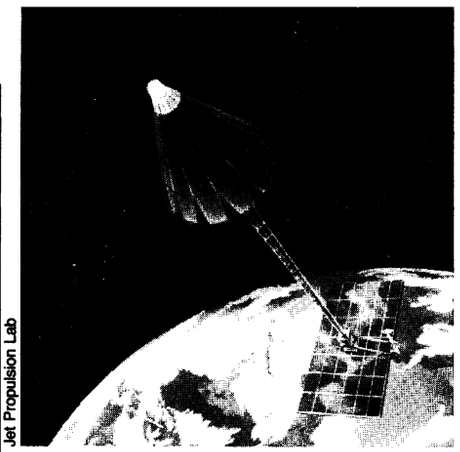
Perhaps more important to the economy of the megalopolis, the costs of housing and infrastructure are greater in the megacities than in smaller cities within the same country, said Richardson. These higher costs eat up the available investment capital.

But the continued growth of giant cities may be inevitable. "Efforts to limit size have failed," said Perlman. Nor is investment in rural development by agencies such as the World Bank keeping people on the farm.

Managing these giants will continue to be a daunting task, and perhaps greater than ability of present systems of urban management, said Duane Kissick of the Planning and Development Collaborative in Washington, D.C. There is some thought that the city should simply allocate its resources to dozens of neighborhood "governments," which could then spend the money on problems deemed most critical, be it sewage, overcrowding, or crime.

Kissick said one technological fix may involve the use of remote sensing technology to help cities plan, or at least monitor, their growth, since traditional mapping of the urban sprawl may be impossible. But then again, as a member of the audience asked, can a country afford to buy pretty pictures from space, when it can't afford to provide running water for its citizens?

■ WILLIAM BOOTH



Jet Propulsion Lab

The SP-100. *A reactor under development primarily to power SDI satellites.*

Space Reactors and Arms Control

A session on space nuclear power and arms control turned out to be especially timely. A week before the AAAS meeting, Soviet delegates to a conference in Albuquerque, New Mexico, announced that the Soviet Union has conducted two tests in space of a new reactor that is thought to be capable of powering radar reconnaissance satellites. Then, on the day of the AAAS session, the National Academy of Sciences released a long-awaited study on progress in developing nuclear systems to power satellites and weapons for the Strategic Defense Initiative (SDI).

The Soviet tests and the continuing development of reactors for SDI provide compelling reasons to negotiate a treaty banning nuclear-powered satellites in Earth orbit, argued Daniel Hirsch of the University of California at Santa Cruz. Hirsch, working under the auspices of the Federation of American Scientists, has put together a proposal with a group of Soviet physicists to prohibit orbiting reactors. "If we do not move forward with such a ban at this stage, we face the prospect of perhaps hundreds of reactors in space" early next century, said Hirsch.

The argument was supported by Joel Primack, an astrophysicist also at Santa Cruz, who pointed to the problems for astronomers that have already been caused by gamma rays emitted by reactors powering Soviet ocean reconnaissance satellites, or RORSATS (*Science*, 25 November 1988, p. 1119). These problems have intensified recently, apparently because of the new Soviet reactor tests, Primack said. The new Soviet reactor, some details of which were first reported in the *New York Times*, appears to be an improved version of the RORSAT reactors, Hirsch said.

Not surprisingly, the notion of prohibiting nuclear power systems in earth orbit was opposed by Colonel George Hess, deputy director of the SDI Organization. SDI, he said, should be debated on its merits and not be attacked indirectly by shutting off development of its power sources. Although nuclear power will not be required for any of the SDI systems planned for early deployment, satellites envisioned for later phases will require reactors to supply routine "housekeeping" power and to provide energy to place systems on alert when necessary. Some orbiting battle stations will also require several megawatts of "burst power" to drive weapons such as lasers.

The study released by the Academy indicates that technical problems in developing space reactors may, in fact, prove more troublesome for SDI than efforts to ban such systems. The report, prepared by a committee chaired by Joseph Gavin, former chief operating officer of the Grumman Corporation, concluded that major advances are required before nuclear systems will be available to meet SDI requirements, particularly for alert and burst power. Moreover, powerful reactors are expected to be so heavy that "the feasibility of space power systems needed for high-power SDI concepts appears impracticable from both cost and launch considerations."

The report noted that work has barely begun on high-power reactors and suggests that they may not be ready in time to meet SDI's needs. Consequently, "either major innovations in power systems and power system components will be required or SDI power requirements will have to be relaxed." Even the development of less powerful reactors for housekeeping duties is proceeding relatively slowly. The reactor currently under development, which is known as the SP-100, is also likely to have weight problems, according to Gavin, who spoke at the session.

The only uses of orbiting reactors currently planned are military ones, although thermal generators that use plutonium-238 are employed for some scientific deep-space missions (these would not be affected by the proposed ban). Gavin argued that the SP-100 program should be continued regardless of whether SDI goes forward because it may be useful for future military and civilian missions, such as providing power for radar reconnaissance satellites or a lunar base.

■ COLIN NORMAN

More AAAS meeting coverage next week: Topics will include the legal and scientific disputes over the 1990 census and the dismal state of public understanding of science.