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and security clearance departments.

It seems to me that the nations constituting the Soviet Union (and the Russians are no exception), which were denied—at first by the Russian Empire, and afterward by the Communists—the right to develop their national cultures, are now eager to go along with national development. Perhaps every nation, before it accepts a more universal view of itself and its neighbors, must go through the phase of being some form of nation-state. And due to the historical realities, Jews will be held as scapegoats and, if not persecuted, then just pushed out by all such nations. It seems that the time is coming for this wandering nation to say farewell to the USSR, as they did in earlier days to Spain, Germany and Poland. For the nations of the Soviet Union, their national problems are, of course, much more important than the relatively marginal problems of the tiny Jewish minority. Such universal values as human destiny, common good, human rights and tolerance were virtually wiped out from the average person by Communist ideology, and society will need a lot of time for painstaking learning. National tensions are rapidly mounting, and unfortunately Russians, the most numerous and leading nation, do not serve as an example of reserve. Fortunately we now live in a "civilized" time, and a new *Endlösung* ("final solution") is not an immediate threat. I believe the Soviet state will be generous enough to allow an exodus of Jews like the one from Poland in the late 1960s.

A huge "brain drain" seems inevitable if no new "Berlin Wall" is erected. Society will not change drastically, and several generations are needed to develop tolerance. The claim by one of the Soviet scientists quoted in Goodwin's report that he doesn't know anybody who wishes to emigrate seems to be relevant mainly to those who are 40–50 years old. I am 35, and potential emigrants are also not very numerous among colleagues of my age, though many would love to go West for a couple of years to work and broaden their horizons. However, the younger generation, those under 30, seems to be different and represents an enormous pool for emigration. More than half a million applications have been submitted for emigration to the US and Israel, and that may be only the beginning of the wave.

After more than 70 years of totalitarian rule almost everybody in the Soviet Union is crippled—morally crippled by Communist ideology and practice. Jews are doubly crippled due to the additional pressure they receive for being Jewish. Even when Jews have tried to find a refuge in assimilation and surrendered all their national values, language, religion and culture, even when they tried to hide their origins and many even felt shame for being Jewish, they were not accepted as non-Jews by society. They were methodically reminded of who they were. And Jews hired at a "good job" were so grateful for being allowed to work in an important institution that they often were scared to discuss any problems concerning Israel, Jews and so on anywhere but under their own blankets in their own beds. The younger generation has not yet gone through this crippling process, and having had the instructive example of their own parents, many of them will definitely decide to emigrate.

This letter may be considered too emotional, but better to be on the safe side and ring the bell early rather than too late. Who can guarantee that unscrupulous persons of authority will not play the Jewish card in their struggle for power? *Historia est magistra vitae.*

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The Ancestry of the 'Anyon'

The interesting news story "Bosons Condense and Fermions 'Exclude,' but Anyons . . . ?" by Anil Khurana (November 1989, page 17), though quite detailed in its attributions, actually omitted some significant work on the mathematical and physical foundations for fractional statistics of particles in two dimensions prior to Frank Wilczek's 1982 articles. In 1980 and 1981 Gerald Goldin (Rutgers) and Ralph Menikoff and David Sharp (Los Alamos) discussed the possibility of such particles using an approach quite different from the 1977 work of Jon M. Leinaas and Jan Myrheim described in the story. Goldin, Menikoff and Sharp derived their result from a mathematically rigorous study of unitary representations of current algebras and groups.[1]

These papers included several of the fundamental facts about "anyons"—the fact that the angle parameter interpolates between Bose and Fermi statistics, the shifted angular momentum and energy spectra, and the connections with the topology of configuration space and with the physics of a charged particle making a circuit about a solenoid. One consequence of the Goldin–Menikoff–Sharp approach is that it is not necessary to assume a particular configuration space or to exclude "singular" points arbitrarily from the configuration space; rather, the nontrivial topology and fractional statistics emerge naturally from the classification of group representations. In 1983 these authors also identified the braid group as the group whose one-dimensional representations describe the statistics of anyons,[2] and in 1985 they noted (in a comment on a paper by Yong-Shi Wu[3]) that higher-dimensional representations of the braid group could describe important quantum systems in two-space.[4]

This work had its roots in earlier work by Roger Dashen, Sharp, Goldin, Jesse Grodnik and others on local current algebras and groups in quantum theory, growing out of a systematic study beginning in 1968 and spanning more than a decade. In 1975 Mario Rasetti and Tullio Regge (Torino, Italy) proposed to apply these ideas to the quantization of vorticity in superfluids, a program still being actively pursued.[5] A similar perspective on infinite-dimensional Lie algebras and diffeomorphism groups evolved independently from work by Heinz-Dietrich Doebner, Jiri Tolar and others, based on a fundamental reexamination of quantum systems on manifolds.[6]

Like so many deep ideas in physics, the topological underpinnings of anyons can be traced back to Dirac (who in fact originally interpreted the Pauli *Verbot* as a *symmetry* principle). Dirac explained the double covering of the three-dimensional rotation group by means of a string construction,[7] which was in 1942 analyzed by M. H. A. Newman[8] using the braid group—to our knowledge, the first use of the braid group for a physical problem. Though it was recognized at the time that the covering group for two-dimensional rotations has infinitely many sheets (allowing fractional angular momentum), this was considered unphysical. David Finkelstein and Julio Rubinstein in 1968 argued for the topological origin of the exchange phase ± 1 in three dimensions, noting explicitly that this no longer holds in two dimensions.[9]

These comments are not intended to detract in any way from the important contributions of those mentioned in the story.

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Giving Women Astronomers Their Due

In their article "Gender and Science: Women in American Astronomy, 1859–1940" (March, page 58) John Lankford and Rickey L. Slavings discuss at length women's role as computers at the major observatories. Their description, while perhaps not pejorative, made it sound as if US astronomers were running sweatshops.

There is another view, namely, that their work as computers gave women an opportunity to pursue careers in science that would not otherwise have been available to them. I had the sad responsibility of preparing a memorial for Charlotte Moore Sitterly, who died recently at the age of 91. Sitterly produced monumental works on the solar spectral lines and on the spectra of the elements during her 70-year career at Princeton University, at the National Bureau of Standards and, in retirement, at the Naval Research Laboratory. She began her career as a computer at the observatory at Princeton in 1920, immediately upon obtaining her bachelor's degree from Swarthmore. By 1926 she was publishing. One of her first papers, for which she was the lead author, was written with Henry Norris Russell, who was to remain one of her principal collaborators. She did eventually earn a PhD, from the University of California, Berkeley, in 1931. Incidentally, she wrote at least one paper, in 1933, with Robert Grant Aitken of the Lick Observatory, who is cited in the article as having been "unable to recall anything of special importance about those women who passed through Lick."

I don't wish to excuse the appalling manner in which women have been treated by the professions—even in the 1950s, when I was a graduate student at Princeton, women were not being admitted there as undergraduate or graduate students—but it is not clear that Sitterly suffered scientifically for having started her career as a computer. It is not easy for an individual to pursue a science career starting on the wrong "track," which in Sitterly's case was with an undergraduate education and as a woman.

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There are numerous examples of the problems cited by John Lankford and Rickey Slavings with respect to women in astronomy. One with a slightly different twist—the woman was the donor of a prize—concerns the awarding of the Bruce Medal of the Astronomical Society of the Pacific. At the first meeting of that organization, on 30 March 1889, William Holden, its president and the director of the Lick Observatory, proposed that the society bestow a medal for notable astronomical research.[1] Through the offices of Edward C. Pickering, director of the Harvard College Observatory, Holden had already had contact with Catherine Wolfe Bruce of New York City, who, in what turned out to be the last decade of her life, had been making generous donations to astronomy, generally after seeking Pickering's advice. In due course Bruce endowed the award named after her, which has been presented to most of the major figures in astronomy in the past century.

Under the original terms of the award, the directors of three American and three foreign observatories were asked to nominate candidates. In 1901, three years after the initiation of the award, Pickering wrote: "I cannot do better than repeat my recommendation of last year that 'in view of the important part taken by women in American astronomy, and since the Bruce Medal was established by a woman, I recommend the woman who has made the most important astronomical discoveries, Mrs. W[illiamina] Fleming.' "

Four years later he elaborated: "Your letter asking me to nominate candidates for the Bruce Medal is received. I therefore make the following nominations:

"First, Mrs. W. P. Fleming for her discoveries and continuing researches in stellar spectroscopy, extending over the last twenty-four years. She has discovered nearly all of the novae, stars of the fifth light and stars having hydrogen less bright which have been found during the last twenty years."

Not only did Fleming never win the medal, but neither did her prominent successor Annie Jump Cannon. The list continues: Henrietta Leavitt, Cecilia Payne-Gaposchkin, Priscilla Bok, Emma T. R. Williams, Helen Sawyer Hogg. . . . Not until 1982 did a woman—E. Margaret Burbidge—win the Bruce Medal. Burbridge's is the only one of the 78 Bruce Medals awarded through 1985 to go to a woman. Maybe someone from the current crop of brilliant women astronomers will start a new trend. [*Note added in proof:* Such a trend may have been started with the awarding of the 1990 Bruce Medal this July to the late Charlotte Moore Sitterly.]

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BURBIDGE REPLIES: I am pleased to have the opportunity to comment on the letter by George Mumford, since I also read with great interest the article by John Lankford and Rickey Slavings on the sociological aspects of the professional lives of women in American astronomy in the period 1859–1940. The end of that period marked the beginning of my own professional life in astronomy, as a graduate student at the University of London. Mumford is correct in pointing out that there is a "crop of brilliant women astronomers" in the present generation. They are already winning some of the awards for younger astronomers and are being elected to important positions on the council and committees of the American Astronomical Society, as well as to the position of president and membership