Women in Soviet Mathematics

Anatole Katok and Svetlana Katok

MATHEMATICS IN THE

FORMER SOVIET UNION

Anatole Katok is professor of mathematics, and Svetlana Katok is associate professor of mathematics at Pennsylvania State University. They emigrated from the Soviet Union in 1978.

1. The "Woman Question" Throughout Soviet History

Before discussing the place of women in mathematics during the Soviet period, we would like to give a very brief outline of the general situation of women in the Soviet Union from its beginnings. Early Bolshevik ideology emphasized the destruction or radical transformation of all major structures of society, including the family. Total emancipation of women was their avowed goal. On the other hand, in the practical work and the power structure of the Bolshevik party, women played a rather modest role from the very beginning. Still, the history of the movement and of the early Soviet State features several prominent women Bolsheviks who exhibited certain feminist attitudes and whose names were surrounded by a romantic aura.

Inessa Armand (1874–1920), French by origin, was brought up in Russia in a wealthy textile manufacturer's family of French extraction. She married the scion of the family, had five children, and became involved in traditional "bourgeois" feminist activities. After she amicably separated from her husband, she converted to socialism, became an underground propagandist in Russia, was exiled and imprisoned, and was forced to emigrate. She became one of the most trusted associates and a close friend of Lenin, gained a reputation in Bolshevik circles for her worldly sophistication and linguistic abilities, and returned to Russia in 1917 in the famous (and notorious) "sealed train" with Lenin. After the Bolsheviks seized power, she held a number of important assignments and advocated creation of a special party body to deal specifically with women's problems. Despite the indifference and even hostility of many Bolshevik leaders (the first Soviet "president", Ya. M. Sverdlov, being a notable exception), she succeeded and thus became the top authority in the early Soviet years on women's problems and affairs. She died early enough not to face the consequences of Stalinist reaction.

An even more distinguished revolutionary woman was Aleksandra Kollontai (1872–1952), who made the struggle for women's liberation in the context of the Communist movement the central goal of her life. She consciously sacrificed her early (and happy) marriage to that goal. Her ambivalent attitude toward the Bolshevik faction stemmed from their comparative insensitivity to the specific problems of women. For many years she belonged to the moderate Menshivik faction, which was more open to parliamentary methods and to the dialogue with the mainstream "bourgeois" women's movement. She joined the Bolsheviks later to become a member of the Central Committee during the 1917 October uprising and went on to become a people's commissar (minister) in the first Soviet government. Later, she became Armand's successor as the top party functionary in charge of women's affairs and the Soviet ambassador in Norway, Mexico, and Sweden. She was very proud of her status as a single woman without a permanent or long-term attachment and relished the widespread attacks on her "immoral" behavior. In her influential 1926 autobiography[1] and other writings, she passionately advocated a radical transformation of the traditional family.

Larisa Reisner (1895–1926) was younger and belonged more to the revolutionary literary avant-garde than to the party cadre. She was a fiery journalist and writer compared by some of her colleagues with John Reed. She was distinguished by an exceptional personal bravery which she demonstrated on a diplomatic assignment in Afghanistan with her husband F. F. Raskolnikov in 1921 and during her participation in the abortive Communist revolt in Germany in 1923. She was a good match for Raskolnikov, a veteran Bolshevik, later to become the only high Soviet official abroad (he was the ambassador in Bulgaria) who, during the great purge of 1937–1938, not only refused to return to almost certain death, but who openly denounced the purge and Stalin. Instead of perishing in the GULAG, he died a few months later in a hospital in Southern France under not completely clear circumstances.

We mention the names of Armand, Kollontai, and Reisner not for their own sake (after all, there were women among poets, artists, etc. of that period who were arguably even more remarkable), but because their personal examples, their writings, and other activities strongly influenced the first

---

[1] A. Kollontai, An autobiography of a sexually emancipated woman, Herder and Herder, N.Y., 1971.

postrevolutionary generation of educated women in the Soviet Union, including those who were not ardent Communists themselves.

Less known to the general public but influential and revered by many in the mathematical community was Sofia Yanovskaya (1896–1966). A fiery commissar in her youth, she later became a respected logician and historian of mathematics, and during the 1930s and 1940s was one of two women who held a position of Professor of Mathematics at Moscow State University (the other was Nina Bari, see below). Yanovskaya was also notable for her keen interest in discovering and taking care of young people with exceptional mathematical talent (Olga Oleinik was one of her early lucky strikes).

The major factors which formed attitudes of young women in the 1920s were: a declaration of equal access for men and women (but not necessarily for people from different social background) to all forms of nonmilitary education and jobs, backed by actual attempts to bring more women to various positions of authority and influence; an extreme simplification of the divorce procedure; legalization and removal of any moral stigma from abortion; acceptance of "cohabitation" without marriage; and the militant atheism of the official culture, which led to a sharp decline of church marriages among educated people. As a result, the character of the family among many educated urban young people changed considerably. Women strived with a certain degree of success for careers in many areas (including some traditionally exclusively male ones), the birth rate dropped dramatically, and among the most elite group it even became fashionable not to formalize their (civil) marriage in order "not to put a piece of paper above the mutual trust".

These comparatively favorable conditions which were prevalent during the 1920s started to change in the 1930s after Stalin consolidated his power. The first generation of Bolshevik leaders contained people from various backgrounds, including many intellectuals touched by the liberal ideas from the prerevolutionary period, even if they were violently opposed to political organization of the prerevolutionary society. Some of these people—such as I. Armand, or the prominent intellectual and Soviet Minister of Education, A. V. Lunacharsky—died before Stalin's great purge of 1937–1938, others disappeared during the purge, and very few, including A. Kollontai, survived in relative obscurity. Stalin himself and his close associates did not possess any liberal attitudes. Stalin came from a very traditional (and troubled) family from the Caucasus, was educated in an Orthodox seminary, and throughout his life demonstrated a very conservative attitude toward women and their place in society. There were no women of the caliber of Inessa Armand or Aleksandra Kollontai in the second generation of the Bolshevik leadership despite an "opportunity" for promotion which opened for younger cadres after the purges of 1937–1938. A few years later, ominous legal changes came: in 1944, under the pretext of strengthening the family during the war, divorce was made almost impossible legally and highly unacceptable for people with any standing in society; abortion was criminalized, and "illegitimate" children as well as their mothers became a discriminated category. Primary and secondary schools were segregated by gender. A very strong emphasis was put on traditional family values. There was, however, a peculiar twist in the Stalinist social policy. While traditional duties of a woman as wife, mother, and keeper of a household were emphasized and to a certain extent glorified, her burden as a productive full-time worker outside of the home was not supposed to disappear or even ease. In that respect, the Stalinist attitudes differed from the very reactionary but consistent policies of the Nazis, who on ideological grounds discouraged employment of married German women to the point of (according to A. Speer[2]) damaging Germany's war effort.

This change in attitudes and policies had several implications. First, most married women, even those who were highly educated, led a miserable life, struggling to cope with two full-time commitments. The quality of family life was very low. Most accomplished males were dissatisfied with their overburdened wives and, since divorce was almost prohibited, adulteries and "second families" became almost the norm in the higher and middle echelons of society. Of course, at the very top of the social pyramid the problems were alleviated by the availability of domestic help (often provided by the state) and by the possibility for women not to work under the pretext of being a "faithful companion of a distinguished cadre" or, more frequently, to have a token job.

Secondly, the careers of most women were severely constrained. Even in the absence of direct gender-based job discrimination, very few had the energy and stamina to advance their professional pursuits while caring for their husbands and children (usually one or two) in the traditional way in a society which did not care to make the necessities of life easily available, not to mention providing labor-saving devices. On the other hand, there was pressure on women to marry early because celibate single women did not enjoy high respect in society, and sexually active single women were disapproved of by the state, even if sometimes admired by people who surrounded them.

Thirdly, whatever advances had been made in the previous period in accepting a broad equality of sexes by individuals were reversed. Most males primarily viewed women (allowing for exceptions) as sexual objects and domestic servants, certainly in practice, but also, amazingly, they would often try to justify such an attitude. This looks particularly ugly in light of the fact that most people became irreligious, so that the justification of the unequal position of the sexes in life (as opposed to unequal abilities or worth) which is sanctified by many religious creeds was not valid for them. Besides the direct impact in the family sphere, this "philosophy" may have influenced employers in their decisions about appointments and promotions even without any direct intention on the part of the state to impede women's professional advances. However, in order to demonstrate the advantages of the "most progressive society on the earth", a number of visible "decorative" positions were reserved for women. For example, from its creation in 1937 until "perestroika", around 49% of the

---

[2] A. Speer, *Inside the Third Reich*, Avon paperback, pages 294–295.

members of the rubber-stamp Supreme Soviet were women, while after the partially-free elections of 1989 the proportion of women in the new parliament, which acquired some real power, dropped to about 15%.

After the death of Stalin in 1953, the most grotesque elements of his social policies were quickly alleviated. Divorce became reasonably easy, and its stigma was removed. Children born outside of marriage were given equal status with the rest. Abortion was decriminalized and, unfortunately, quickly became the leading method of birth control, strengthening the exploitative and irresponsible attitudes on the part of the male population. The state transferred some resources from the military and heavy industry to food production, residential construction, manufacturing of domestic appliances, and child care, among other things. The rigid social mores of the Stalinist era were relaxed, and the attitudes toward the roles and burdens of the sexes became somewhat more balanced. Schools were desegregated.

However, internal changes lagged behind. The society remains male-dominated to a degree which most Americans would find hard to comprehend, given that more than half of the workforce is female and the vast majority of women work full-time without interruption from the end of their education to retirement. The "one-sided emancipation", in which women work full-time and are supposed to care for their families as if they do not, remains the dominant feature of the society. A striking lack of respect for women is still very common among men. The prevalent male attitudes toward the division of domestic duties, care for children, sex, and birth control are still very archaic. An amusing commentary on Soviet society's attitude towards women is a general negative reaction of the people from all walks of life to the relatively high visibility given to Raisa Gorbachev, obviously an accomplished and intelligent woman, during her husband's tenure as the Soviet leader. It seems that many people were particularly incensed by the fact that Gorbachev seemed to have been taking his wife's opinions seriously. By contrast, Yeltzin, a man with much keener political sense than his predecessor, demonstrates a healthy Russian attitude towards his wife: he likes her, but she knows her place and stays completely away from the public side of his life.

As a reaction to the unbearable and demeaning double burden, which was viewed as a norm, many bright, highly educated women with a high potential for professional accomplishment voluntarily chose not to work outside of the home or, much more frequently, to hold easy cushy jobs (usually obtained through connections), which left a lot of spare time. We know some of those women and think that in the U.S. they would be driven hard by professional ambitions and would have distinguished careers in various fields.

Finally, a peculiar phenomenon needs to be mentioned which seems to be relevant to the following discussion about women in mathematics during the Soviet period. In the country as a whole, urban men usually marry in their mid- or late twenties, women in their early to mid-twenties. Surprisingly, among the children of certain groups of the highly educated elite ("the intelligentsia"), early marriages

became rather common, beginning in the 1960s, and still seem to be popular. In those marriages, both spouses are in their late teens or very early twenties; they are often university undergraduates in their second or third year.

2. Outstanding Women Mathematicians

The 1920s was the first golden age of mathematics in the Soviet Union. While St. Petersburg was the leading center of mathematics in the country before the revolution, in the 1920s Moscow quickly became a world-class center. An astonishing group of young mathematicians in their twenties and early thirties produced fundamental work in set theory, function theory, probability theory, differential equations, general and algebraic topology, differential geometry, and other fields. Among this group were several excellent women mathematicians. They were a part of a general wave of change which opened many new fields to women, although in mathematics their success was on the whole less prominent than in some other fields, such as chemistry.

One of the early avenues which brought women to successful careers in various fields of science can be exemplified in its ideal form by the famous story of Pierre and Marie Curie. A talented young woman begins to work as an assistant to a distinguished researcher senior to her, marries him, and at the same time becomes his full-fledged partner in research. The history of science in the Soviet Union knows several such stories. In mathematics, the one which probably fits most closely to that model is that of A. A. Andronov (1901–1952) and E. A. Leontovich-Andronova (b. 1905). Andronov, a great radio-physicist, also made fundamental contributions in mathematics, the most important one being a concept of structural stability which appeared in his famous 1937 paper written with L. S. Pontryagin. Andronov created an active group of researchers in the modern qualitative theory of ordinary differential equations in Nizhnii Novgorod (then Gorky). His wife, Evgeniya Leontovich-Andronova, was a prominent member of this group. After Andronov and his most brilliant associate, A. G. Maier, died in the early 1950s, Leontovich-Andronova became the leader of the group. Her students and their students form one of the very few respectable mathematical schools in Russia outside of the three major centers in Moscow, Leningrad (now St. Petersburg), and Novosibirsk.

The two most accomplished women mathematicians of the first Soviet generation were N. K. Bari (1901–1961) and L. V. Keldysh (1904–1976). Nina Bari was one of the leaders in real function theory and harmonic analysis of her time. Her lifetime work is summarized in a fundamental monograph[3], which is arguably the second most important classic in the field, after the famous book by A. Zygmund. Ludmila Keldysh, the topologist and set theorist, was a remarkable personality in several respects. She came from a very prominent scientific family. Her father, V. M. Keldysh, was a leading expert in the area of structural engineering. Her younger brother, M. V. Keldysh (1911–1978), started his career as a brilliant complex analyst, later became a chief mathematician in the

---

[3]N. K. Bari, *A treatise on trigonometric series*, Macmillan, N.Y., 1964.

Soviet space program, and then the president of the USSR Academy of Sciences. Another brother, Yu. V. Keldysh, is a distinguished musicologist. L. V. Keldysh's own family was no less remarkable. Her husband, P. S. Novikov (1901–1975), was a great logician and algebraist, and two out of her five children, Leonid V. Keldysh and S. P. Novikov, are prominent scientists; the latter is a 1970 Fields medalist.

L. V. Keldysh's own mathematical achievements are very considerable. She made first-rate contributions to the areas of descriptive set theory and general topology, which were popular in the 1920s and 1930s, and later, when she was in her late fifties, she created an original school of geometric topology. She did important work in this field herself and brought up several students who became well-known mathematicians, including A. B. Sossinsky and A. V. Chernavsky. A short scientific biography of L. V. Keldysh has been published[4]. L. V. Keldysh and her husband were also known for their exceptional honesty, independence, and extreme reluctance to bend their professional integrity under political pressure. In particular, L. V. Keldysh was openly critical of her all-powerful brother for his ambiguous stand on issues involving the relationship between the state and the scientific community and his reluctance to intervene on behalf of persecuted scientists. So, this is an example of a woman who had it all.

The striking continued flourishing of Soviet mathematics during the 1930s and 1940s presents a dramatic contrast to the tragic state of the society in general. Not only the above-mentioned paper of Andronov and Pontryagin, but a number of other fundamental works of Soviet mathematicians date from years (like 1937) which symbolize immense suffering inflicted from within on a large part of the society. The mathematical community was not exempt from terror and harassment (L. G. Shnirelman (1905–1938) committed suicide after an encounter with NKVD[5]), but by the brutal standards of the time, it was not hit particularly hard. Most importantly, the professional activity of mathematicians remained mostly free of direct interference. For example, harassment of Lusin in the mid-1930s is so well remembered by mathematicians because it was a relatively atypical event. Thus, it seems that many highly gifted young people chose mathematics, perhaps unconsciously, as a "clean" and "safe" occupation.

Some of the young stars of the 1920s and 1930s became recognized leaders in major fields of mathematics, attracted large numbers of exceptionally bright students, and created brilliant "schools". We will use the word "school" in quotation marks as the name for a particular phenomenon, characteristic of mathematics of the former Soviet Union: Mathematicians of different ages are grouped around a leader, who is the former or current advisor to many (or most) of them. Lack of geographical mobility makes such an arrangement stable and natural. A weekly evening seminar run by the leader, or sometimes by a couple of his closest associates, is the

focal point and the meeting ground for most members of the group. The "school" is usually referred to by the name of its founder, and sometimes it may continue to be referred to that way even after he moves away from active leadership. Among the "schools" which developed in Moscow from the late 1920s on, those by A. N. Kolmogorov, P. S. Aleksandrov, I. M. Gelfand, and I. G. Petrovsky stand out. A very high percentage of the most accomplished Soviet mathematicians of the next two generations are either their students or students of their students.

It turns out that the only women from the next generation of Soviet mathematicians, and in fact of the whole Soviet period, to have achieved long-lasting world-class reputations—O. A. Ladyzhenskaya (b. 1922) and O. A. Oleinik (b. 1925)[6]—were associated with Petrovsky's school, which was probably the smallest in size of the four. We will later offer some insights into specific features of the Soviet mathematical culture which may be related to the difficulties mathematically gifted young women faced there. Probably those features were less pronounced around Petrovsky than elsewhere. This is highly speculative, but it is well known that Petrovsky was a very sensitive and humane person. For example, later, during his tenure as the rector (president) of Moscow State University, he was willing to help in numerous individual cases, while being incapable of effectively controlling a vicious bureaucracy nominally subordinate to him.

Olga Ladyzhenskaya, who was a student of both Petrovsky and S. L. Sobolev, created a distinguished "school" in partial differential equations and mathematical physics. Among her students were L. D. Faddeev and N. N. Uraltseva, another highly accomplished woman mathematician. Ladyzhenskaya and Uraltseva wrote a highly acclaimed monograph[7]. This is one of the few mathematical books which continues to serve as a basis for ongoing research in a wide variety of areas.

Olga Oleinik started her mathematical career with a series of joint papers with Petrovsky on the 16th Hilbert Problem, which became classic, and later made numerous contributions to various branches of the theory of partial differential equations. She also created a large "school"; probably the best known among her students is Yu. V. Egorov.

Now let us move to the period of time with which we are familiar from first-hand experience, roughly from the late 1950s to the late 1970s. It seems fair to say that the 1960s was the second golden age of mathematics in what was then the Soviet Union; as in the 1920s and 1930s, Moscow led the way while Leningrad was second with smaller numbers, but still world-class quality. While great stars of the previous epoch were still active and the best mathematicians of the middle generation, including Ladyzhenskaya and Oleinik, were in their prime, an exceptionally brilliant group of young mathematicians appeared who made fundamental contributions very early (usually by their mid- or late twenties) and

---

[4]*Russian Math. Surveys*, **29**:4 (1974) 155–161.

[5]People's Comissariat for Internal Affairs—the name for the dreaded secret police at that time.

[6]The interested reader will find a survey of work of Ladyzhenskaya in *Russian Math. Surveys* **38**:5 (1983) 171–181, and of Oleinik in *Russian Math. Surveys* **40**:5 (1985) 267–287.

[7]O. A. Ladyzhenskaya, N. N. Uraltseva, *Linear and quasilinear equations of elliptic type*, Academic Press, N.Y., 1968.

quickly became the leaders and the driving forces of Soviet mathematics. The fields where the previous generations held strong or commanding positions in the world, such as differential equations, group representations, and probability theory and its applications, received a new impetus. However, the greatest excitement seems to have been concentrated in the areas which had been somewhat neglected, first of all in algebraic and differential topology, algebraic geometry, algebraic number theory, and complex geometry. There is no need to mention specific names; those people are well known and, now in their fifties, many of them remain among the leaders in world mathematics.

Only one woman held a prominent place among that group and, unfortunately, her life was tragically short. G. N. Tyurina was born in 1938, graduated from Moscow University in 1960, received her Ph.D. in 1963 (advisor, I. R. Shafarevich), published several pioneering papers on rigidity of complex structures during the late 1960s, and died in an accident during a kayaking expedition in the Polar Ural region in 1970. Her work, although not great in volume, turned out to be very influential[8]. Galina Tyurina's personality defied many of the current stereotypes about successful women among Russians. Quiet and personally modest, but at the same time tough and self-confident, she clearly commanded a great respect among her ambitious, brilliant, and not always considerate male contemporaries. Making long trips in faraway, poorly accessible areas on foot, on skis, or by a portable kayak, which involved both hardships and danger, was almost an obsession among many young Russian intellectuals at that time. Strangely enough, those activities were called "tourist trips". Mathematicians were at the forefront of these activities. Although organized "tourist" clubs existed, it was considered more appropriate among the intelligentsia to travel in informal groups. On each trip there was a leader, usually the most experienced and authoritative person in the group. An accomplished alpinist, skier, and kayaker, Tyurina participated in many long and dangerous "tourist trips". On most occasions, she was the leader of predominantly male groups. This was the case on her last trip. Tyurina also played a very active role in the mathematical activities for talented high school students which we are about to describe.

3. Trying to become a Mathematician

Now let us try to follow the typical path of most talented young men and women into mathematics. It usually started fairly early. Beginning in the early 1960s, special mathematical high schools were organized in the major cities. Most of them were run by highly accomplished professional school teachers, sometimes with help from the faculty of a local teachers' college or a university. Programs in several schools were run by professional mathematicians either in a completely institutionalized fashion, as in the "internats" (boarding schools) in Moscow, Leningrad, and Novosibirsk, or via semiformal

initiatives from individual prominent mathematicians such as A. S. Kronrod (Moscow high school #7) or I. M. Gelfand and E. B. Dynkin (Moscow high school #2), who attracted younger colleagues as well as top graduate and undergraduate students as associates. Another older and less formal form of mathematical activity for talented high school students was *kruzhki* (this word literally means "circles", but the closest English equivalent is probably "workshops"). They usually met at the university once a week in the evening and were run by top undergraduates and sometimes graduate students who had tremendous enthusiasm for mathematics, and were usually themselves products of this system. *Kruzhki* did not offer any formal certificate to their graduates and were not geared to any particular "practical" purpose, such as preparation for entrance examinations to the university, polishing the knowledge of the required high school curriculum, or even preparation for the olympiads (mathematical competitions). Instead, there were discussions of isolated or interrelated challenging problems, as well as essays from both nonstandard "elementary" and higher mathematics. Olympiads were organized in most major cities for the students in the last four years of the secondary school. Beginning in the early 1960s, the hierarchical system of regional, republican, and All-Union Olympiads were created, in which the teams of winners of the lower level olympiads competed. Each participant, however, worked individually.

Female students were well-represented in all these activities (special mathematical schools, workshops, and olympiads). It was quite clear at every level that they formed a minority among the participants (and in the case of olympiads, also winners), but it was a sizable and stable minority. We don't venture to offer any overall statistics, but it is quite clear that by any reasonable calculation, which would take into account both numbers and quality, the percentage of girls among the high school students successfully involved in these endeavours was much higher than the percentage of women among successful research mathematicians ten years down the road. For example, we compared the future fate of male and female students who at least once during their high school years received first or second prize in the Moscow Mathematical Olympiads during the period covering most of the 1960s. We do not guarantee that our list is complete, but any omission is certainly not intentional, and almost surely we did not miss any women. This group contained sixteen men and four women. They all entered the mathematics program at Moscow State University with the intention of becoming professional research mathematicians. About 60% of the men from this group clearly achieved this specific goal. Moreover, most of those who became working mathematicians really made it to the top: for example, among them there are a Fields medalist, two Harvard professors, and at least five invited speakers at the International Congress of Mathematicians. A dramatic fact which is relevant to our topic is that no women from this group were fortunate enough to achieve this particular goal. They, as well as the remaining 40% of the men, either never received Ph.D.s in mathematics or stopped doing mathematical research soon after obtaining their Ph.D.s

We do not imply that their lives were not fulfilled in other (including professional) ways. Let us go down the road and try to see what happened and why.

It seems that the family and the high school environment, as well as the general prevailing attitudes in society, did not impede an early development of interest in mathematics among women. For example, during most of the 1960s, when the admission process was generally fair, women formed about 30% of the freshmen class in the mathematics program at Moscow State University, indisputably the most selective and prestigious mathematics program in the country. The attrition rate during the five years of study was fairly low, definitely not more than 20%, and even if it was slightly higher among women than among men, it did not affect the proportion in a serious way. Thus, more than a quarter of the graduates of the top mathematics programs in the country were women. In other top universities this proportion was at least as high and often higher. On the other hand, among several hundred clearly successful research mathematicians from the former Soviet Union of that generation (roughly forty to fifty years old), the number of women can be counted in single digits. The picture in the fifty to sixty years old group is approximately the same. Although our information about the younger generation (twenty-five to forty years old) is less complete, we have no evidence that the situation is very different among mathematicians who completed their education in the former USSR. In order to appreciate how dismal the situation is, one should go beyond the Ph.D. statistics and use employment figures with a certain care. There are tremendous differences in the quality of dissertations from different institutions in the former Soviet Union; and there is often little correlation between, on the one hand, the research merit of a mathematician and, on the other, his/her place of employment (at least under the old Soviet regime). For example, many highly accomplished mathematicians who emigrated from the Soviet Union and were given high level positions in top American universities had not been employed as academic or research mathematicians in the Soviet Union at all. On the other hand, there are a large number of various technical and pedagogical colleges around the country. Not all the faculty of those institutions, which included a large number of women, necessarily hold an equivalent of a Ph.D. Most of them have to teach about twenty hours a week (in class), and either do not do any research at all or produce a small number of papers which usually appear in proceedings of their own institutions.

A certain, although still biased, indication of the situation of women can be extracted from their number (between zero and two) among about a hundred members of the Steklov Mathematics Institute in Moscow during most of its history, their representation among the members of the USSR Academy of Sciences (only Ladyzhenskaya and Oleinik are members, and both were elected during the last decade), and by the very small number of women among the authors of articles in, say, the top ten Soviet mathematical journals. Let us consider a representative example. The journal *Uspehi Matematicheskich Nauk* (translated into English under the title *Russian Mathematical Surveys*) is unique in publishing major survey articles by leading scholars, which usually, to a considerable extent, are based on the authors' own research and often contain previously unpublished results. Thus authors of those articles in the long run can be viewed as representative of the elite of Soviet mathematics. Among 564 original (nontranslated) articles published in *Uspehi* during the period 1961–1985, twenty-three have a woman author or a coauthor[9]. Here it must be noted that in ten out of the twenty-three articles the woman (co)author was O. A. Oleinik (a remarkable personal achievement), who was the deputy chief editor of the journal for most of the period. Finally, probably the most reliable test is the following. During the last four years, mathematicians from the former Soviet Union became frequent visitors in mathematical institutions all over the world. Since they have no funds for travel, their ability to travel is totally dependent on obtaining paid invitations, and it is reasonable to assume that on the whole the number, length, and level of such invitations agree in general with their research merit. As everybody knows, the number of women among these visitors is extremely small.

4. An Attempt at Analysis

Having described a sad overall situation of women in Soviet mathematics, where very often a promising start leads to an eventual nonfulfillment of the original goal, let us try to discuss specific causes of that state of affairs. It seems to us that the general features of Soviet life described in §1 provide at least a partial clue. The slowdown in the professional development of talented women usually takes place in the later part of their university years or, for some of those who manage to get into the three-year postgraduate program, during that period. In other words, it happens between the ages of nineteen to twenty-four. By U.S. standards, this is a very early age to decide whether a person would be a successful mathematician. Quite a few mathematicians in this country who eventually became very successful did not prove themselves until their late twenties or even thirties. However, in the former Soviet Union, especially in the top centers, it is usually assumed that a young person who does not demonstrate aptitude for independent research by the end of her or his university years (i.e., by the age of twenty-one or twenty-two) has no chance to succeed later. Furthermore, this aptitude is often gauged by the ability to handle relatively complicated questions fast and by self-confidence in handling sophisticated modern material. This helps to explain an unexpectedly high failure rate among both men and women who have shown an early promise. Faced with new types of challenges, such as learning about spectral sequences or quantum groups, and striving to perform at the level compatible with their earlier successes in, say, olympiads, some of them lose interest while others begin to doubt their ability to become mathematicians.

Why, however, do women suffer proportionally more from this kind of ordeal? Firstly, it seems that, for whatever reason, whether internal or imposed by societal attitudes, women on

---

[9] *Russian Math. Surveys*, **42**:1 (1987).

the average tend to be somewhat less self-confident and more prone to self-doubt. Even a benign but tactless comment from a revered advisor, which implies insufficient quickness of reaction or depth of penetration of a new concept, may hurt some young women more than their male counterparts.

A much more important, and arguably the principal, reason why the emphasis on early success was harder on women lies in the consequences of the peculiar tendency to early marriages, mentioned at the end of §1. A promising young woman mathematician gets married—very often to her classmate, and, naturally, sometimes a top one—and usually has her first child during the crucial late undergraduate years. At that time an approximate equality in the speed of her professional development and that of her male classmates (often including her husband), which held through the high school and early university years, gradually begins to erode. The hardships of keeping a household and raising even one child in Russia are very considerable and usually are shared, even by the most well-meaning men, only marginally. Naturally, those difficulties are often aggravated if the marriage breaks down or is in trouble. Still, all these difficulties would not overwhelm a woman who possesses both talent and a reasonably strong character if she were allowed to adjust the pace of her professional development. Examples of women who emigrated from the Soviet Union and made a successful mathematical career quite "late" by accepted Soviet standards underscore this point. The problem was that in the Soviet Union the prevailing attitude was basically "once out, never back again". Perceived failures of women to develop their early mathematical potential fed back on the prevalent attitude among men (including many top intellectuals) that this was not accidental; women simply cannot devote themselves as fully and entirely to mathematics as it demands. So rather than get back "in shape" after the most difficult period of raising young children is over, our woman mathematician (who has a diploma from a top university and sometimes even managed to write a passable Ph.D. thesis) would at best settle for an easy sinecure where she would be able to continue caring for her family and enjoy such pleasures of life as nice vacations, theater, etc., and at worst would join the majority of her female compatriots who face exhausting and nonrewarding jobs and still take full care of their often troubled families.

Some features of mathematical culture, prevalent at least in the most prestigious mathematical "schools" of Moscow, attenuate this picture. Opinions concerning the merit of particular works, individual mathematicians, and whole areas of mathematics were strong and often not very favorable. Those opinions often reflected genuine deep understanding of mathematics and an uncompromising attitude toward mediocrity, and could be understandable when they were expressed by brilliant mathematicians still young but already broadly acclaimed. But they produced certain side effects on not so well-established people and especially on young students. Many promising students developed unrealistically high standards for themselves and were willing to work only on big new theories or on exceptionally difficult problems. The word "trivial" was very popular among students, and for some

of them it became a synonym of "clear" or "understandable". Some of the olympiad winners mentioned above fell victim to that attitude. Elitism and the cult of excellence sometimes reached excessive levels, at which everyone and everything who was not perceived to be the very best was ignored or treated in a patronizing fashion. Although mathematics seems to be one of the fields farthest removed from politics, and although upholding scientific integrity and abiding by scientific criteria was to an extent viewed as a form of indirect protest against the system, certain elements of the totalitarian mentality did not escape even some of the best mathematical minds. A certain lack of tolerance and an excessive conviction in their righteousness are perceptible among them. An ultimate example of such an attitude, which spreads beyond the purely professional judgment, appeared recently in a conversation one of us had with a very distinguished mathematician who made a political accusation against a colleague. When confronted with a retort that his evidence was insufficient and hence the presumption of innocence should apply, he answered that the presumption of innocence was good for "our" (i.e., Western) world, but they in Russia simply see through things.

How does all this affect women mathematicians? Well, for example, it gives a seal of approval from some of the top mathematical minds to some common prejudices about women and their role in society. Faced with repeated failures of their female students to live up to the early promise, they internalize the ideas of certain intellectual deficiencies or at least peculiarities of the female nature. They refuse to see that in most cases the slowdown is due to discernible outside factors and that given more time, a more tolerant environment, and sometimes a "second chance" to start from scratch, those women (and many men as well) would succeed. A particularly popular idea is that in order to succeed a promising woman would have to sacrifice her family life. As far as we can see, this is based on archaic ideas about family prevalent in Soviet society.

5. Comparison between Soviet and American Mathematical Culture

There are certain superficial similarities between the situation of women in mathematics in the United States and in the Soviet Union. In both places, the overall percentage of women among active research mathematicians is low, and the ratio of women decreases as the professional ladder is climbed. However, we would like to argue that, upon more thoughtful inspection, the picture looks very different. We are, of course, aware that the picture drawn in the previous sections reflects the situation in the Soviet Union mostly during the 1960s and 1970s, whereas our U.S. experience comes from the last decade. Still, we think that the main points in which the situation differs remain valid.

Two main problems in the way of enhancing women's participation in U.S. mathematics seem to us to be (i) certain cultural attitudes that act at the family and grade school level which discourage the interest and appreciation of mathematics among most young girls (and among many of

the boys as well!), and (ii) lack of interest in and appreciation of academic mathematical careers among female students who show aptitude toward mathematics (again this is true about many American male students as well). Thus, in the United States the problem is an insufficient "pool of talent", both on an undergraduate and graduate level. We maintain that the above discussion demonstrates that these factors do not play an important role in the Soviet Union. Rather, the problem is with wasting available talent at the crucial stages of development. There is an important difference in the attractiveness and prestige of mathematics (compared to other pursuits) as a career and lifetime occupation in the United States and the Soviet Union. In general, mathematics is more highly regarded in the latter. To put it simply, many of the Soviet olympiad winners magically transported to the United States' family, school, and social environment would end up in medical, law, or business schools rather than in graduate school in mathematics.

It seems to us that the professional environment for young people who already have committed themselves to a career in mathematics is in general friendlier and less harsh in the United States than in the Soviet Union. This certainly applies to young women, contrary to frequently expressed opinions. On the other hand, the pursuit of an academic mathematical career in the first decade after the Ph.D. is both more demanding and more stimulating in the United States. This includes a series of temporary appointments, moving around the country, uncertainty about tenure, and constant pressure "to prove oneself". In the Soviet Union, the equivalent of the Ph.D. is considered a certain landmark rather than just a starting point of a career. Usually, a mathematician would hold a job in the same place for many years after his/her Ph.D. The main outside stimulus to mathematical productivity is obtaining the higher, Doctor of Science, degree, roughly a prerequisite for a promotion to a full professor[10]. This difference brings us to another serious obstacle to women's mathematical advancement in the United States related to what is usually called "the two-body problem". The necessity for a professional (i.e., academic) couple to find two jobs in the same geographical area leads to various strains and often to disproportional sacrifices on the part of one of the spouses. Arguably, this is more often (although far from always) a woman than a man. Since in the Soviet Union most of the mathematicians are concentrated in a very few centers, and people are not disposed to move out of Moscow or Leningrad anyway, "the two-body problem" does not play an important role there. Weighing all these factors, we are inclined to assert that the current situation of women in the mathematical profession in the United States looks considerably less grim than that in the Soviet Union at any period of its history.

It is interesting to consider the fate of some women who experienced both systems. Among emigrants from the Soviet Union who eventually came to the United States during the

1970s and early 1980s, there are many mathematicians at all stages of their careers. According to our information, which is admittedly far from being complete, the number of women with Ph.D.s was rather small. On the other hand, we know of many dozens of women who graduated from mathematics programs in Moscow, Leningrad, and other top universities. The majority of them did not attempt to pursue an academic career. Instead, they found jobs in industry, in many cases in the advanced high technology firms. It seems that typically they were quite successful and satisfied with their careers, working on meaningful, challenging, and demanding projects which present a favorable contrast to jobs they held in the Soviet Union. A smaller number among those women went to graduate school in mathematics or related fields such as statistics or operations research and were able to obtain their Ph.D.s. One of the authors of this article belongs to this group. She graduated from Moscow University *cum laude* in 1969, and her story before the emigration from the Soviet Union in 1978 in general follows the pattern described in §3. In this case, as well as in many others, some additional difficulties arose from anti-Semitic policies prevalent in the Soviet Union during that time. In 1979, she entered the graduate program at the University of Maryland, received her Ph.D. in 1983, and after that experienced a more or less typical career of a young American mathematician which included facing and eventually successfully resolving a "two-body problem". The opportunity to do that (given sufficient determination) with a ten-year delay and after a first unsuccessful try seems to represent a quintessence of the difference between the two systems.

The group of women who came to this country from the Soviet Union with Ph.D.s in mathematics is much smaller, and we do not possess enough information to make any generalizations. One outstanding example, however, must be mentioned. Marina Ratner graduated from Moscow University in the early 1960s, received her Ph.D. in 1969, and immigrated to Israel in 1971. A few years later she moved to the United States and obtained a position at the University of California, Berkeley, where she is currently a full professor. Her accomplishments, especially during the last five years, indisputably brought her to the very first rank of U.S. mathematicians.

6. Do They Have a Future?

So far we have presented a historical study which describes a series of stationary or slowly changing situations taking place until 1988. Dramatic changes of the last four years led to the disappearance of the Soviet Union and changed life in its successor states beyond recognition. Thus it seems that our discussion so far bears little relevance to the present and immediate future of women mathematicians in the former Soviet Union. This question has to be addressed in a broader context of the present and future tendencies in Russia and other successor states of the USSR, and the answer is not going to be particularly specific to women.

In terms of living standards and infrastructure, those countries (with a highly tentative exception of the Baltics) are

---

[10]Due to the political considerations coming from both the state authorities and the mathematics establishment during the twenty-year period beginning in the late 1960s, many outstanding mathematicians were unable to obtain that degree.

bound to remain for some time at the Third-World level and far below such more advanced industrialized countries as Brazil or Mexico. On the other hand, both the general educational level and the quality of the scientific enterprise in some areas are comparable to the most advanced Western countries. In other words, the "supply" of advanced knowledge, expertise, and creativity in such areas as mathematics is rich. We would like to argue that, unfortunately, the domestic "demand" for such skills is bound to be low for a considerable period of time. In the new situation of impoverished market or semimarket economies, a premium will be put first on entrepreneurial talents (often with an unpleasant or even criminal streak), and second on direct applicable expertise in practical areas, such as agriculture, banking, and various service industries. Undoubtedly, some of the best young brains with an aptitude for mathematics will be (and already are) diverted to those and similar pursuits. However, in order to do that, people would have to "get their hands dirty", something the Russian intelligentsia, the main supplier of scientific talent in the country, has traditionally been loath to do. Besides, the living standard and especially the general quality of life of an even reasonably successful Russian or Ukrainian entrepreneur or manager will be lower than that of a typical Western professional, e.g., an academic. But bright young men and women with good mathematical university educations (which are still available and probably will continue to be) have another option: to go to a graduate school in the U.S. or (less likely) another Western country. The American system of graduate education seems to be made to provide a singularly welcoming environment to people who are bright, well prepared, and devoted to mathematics, with a high stake in their eventual success and comparatively uninterested in immediate gratification as consumers. Unlike many of their counterparts from the non-Western world, they were brought up within an exotic but brilliant offshoot of the great Western cultural tradition, which provided them with a cosmopolitan outlook, cultural values compatible in the broad sense with the American ones, and at least reasonable, and more and more often excellent, mastery of English. While established mathematicians are often torn between an acute desire to avoid material misery of life in the new states and loyalty to their places and their culture, this dilemma is much less acute for young people who have less to lose and on the whole more to gain. Ideally, those people should not be cutting the ties with their countries, as happened to the emigres who left in the 1970s and early 1980s. While it is unrealistic to expect that many of them would come back on a permanent or even half-time basis, they would tend to maintain various connections with their motherland(s), which they left with the consent of the authorities as unharassed, free citizens. Strengthening those ties should be one of the focal points of various assistance and exchange programs being launched in the U.S. and elsewhere in the Western world.

What will happen to the highly developed mathematical enterprise in Russia and other former Soviet republics? It definitely cannot continue to exist in the same form as when people were not free to move and science was heavily subsidized to make it an attractive pursuit within the range of options available in a closed society. A society that is both poor and open cannot afford a world-class scientific (in particular mathematical) enterprise according to the law of "supply and demand" (one of whose well-known manifestations is "brain-drain"), interpreted in an appropriately loose sense. This does not mean we should watch the demise of the great Russian mathematical tradition with a philosophical resignation. After all, the question is at what level the mathematical tradition will survive in Russia, and it is far from academic. A strong case can be made that mathematics there may still be amazingly vital and attractive to talented people when compared with other countries with similar living standards. A considerable number of established mathematicians may choose to keep their home base there, spending only a fraction of their time abroad. Given enough Western support, that kind of arrangement may become attractive to some of the best young people, including those who will have received their Ph.D.s abroad.

Let us now return to the discussion of women mathematicians. Predictably, the recent exodus of highly accomplished mathematicians from the former Soviet Union did not feature many women. There are some remarkable exceptions, though. We mention one of them. Vera Serganova, a young, brilliant mathematician from Moscow, was appointed last year as an assistant professor at the University of California, Berkeley, thus becoming the second female faculty member there.

Women are much better represented among graduate students from the former Soviet Union, whose numbers are rapidly increasing across the U.S. Quite a few of them are already married, in accordance with the trend described above. Usually both husband and wife come as graduate students, sometimes to the same department, but often to different departments of the same university or even to different universities located nearby. These couples are getting the taste of the American "two-body problem" even before they enter the country: they have to decide how to choose among the variety of options available to them. At that junction some of the male applicants discover to their surprise that the rules of the game are different in the U.S.: a wife may get better options than her husband by virtue of having, for example, a higher TOEFL score even if she is slightly more junior mathematically. The prospects of these young women, married or unmarried, look to us on the whole to be very bright. Having received an earlier education in a system which does not discourage women at an early age and puts a premium on early and deep commitment to mathematics, they are going to face the critical stages of their professional development in a more friendly and tolerant American environment. They do have a future as mathematicians, but the difference they are going to make will be felt in the context of American mathematical culture, where those women will be a significant part of the new wave of female mathematicians who will finally acquire an honorable place in the mathematical community. This will happen as a result of their efforts and achievements and not through any kind of affirmative action or preferential treatment.