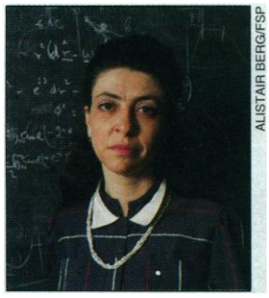
GROUND-BASED ASTRONOMY

New Borders Divide Up a Once-Strong Discipline

Life for astronomers in the former Soviet Union would be bad enough if they only had to deal with the problems afflicting their colleagues in other disciplines: low salaries, lack of funds for maintaining and operating equipment, many more trained scientists than their fledgling economies can afford to support, and the loss of the more ambitious researchers to the new enterprise culture and to the West. But astronomers also have a unique problem of their own: Since the break-up of the Soviet Union, many smaller observatories are now in independent republics which have nationalized them and so cut them off from institutes in Moscow that were once a main source of funding and collaboration. Perched on remote mountain tops, many of these observatories are situated close to war zones or in economically unstable republics with limited electricity and fuel and no funding.



ALISTAIR BERG/FSP

No going back. Expatriate Ludmilla Kiseleva.

Fortunately for Russian astronomers, the main observing site in the Caucasus is on Russian soil and is certain to be maintained for the foreseeable future. The Soviet Union was particularly strong in theoretical astronomy, and there is still a sizable community of theoreticians in Moscow and St. Petersburg. But for how much longer? In a country where a free-market economy is seen as the main hope of national salvation, astronomy has even less to offer in terms of wealth creation than other basic sciences. "All the observatories and institutes in Russia are just about continuing to work," says Nikolai Bochkarev, co-chairman of the Euro-Asian Astronomical Society in Moscow, "but with funds for science reduced this year, the main problem is to find enough money to pay the younger scientists."

Some observatories in the newly independent republics are in a more perilous position. For example, fighting between Armenia and Azerbaijan has meant that the Armenian Byurakan Observatory, which has a 2.5-meter telescope and several smaller ones, has virtually closed down. It has electric power for only 2 hours a day, and although the instruments are being preserved, the observatory seems unlikely ever to operate properly again. "Most of the astronomers there have left or are struggling to survive," says Boris Shustov of the Institute of Astronomy in Moscow, "I know one talented astrophysicist carves wooden pipes which he sells to buy food."

No one in Moscow knows the fate of the Shamakha Observatory, which has a 2-meter Zeiss telescope. It is close to the war zone in Azerbaijan, and nothing has been heard from there for well over a year. The situation at Georgia's Abastumani Observatory, with its half-dozen small telescopes, is just as bad, Shustov says, because of the civil war. "Electricity supplies are again severely limited. The monthly salary for a senior researcher there is about $2, enough for bread but not for meat or cheese."

The observatories in Central Asia are faring somewhat better. The small Sanglok Observatory in Tadjikistan has power, and some astronomers are still working there. The Maidanak Observatory in Uzbekistan, with some of the best climatic conditions in the world for its small telescopes, is forging new links with Russia. The Sternberg Astronomical Institute in Moscow, which used to run the observatory, signed a deal this year to collaborate with Uzbek astronomers, with a view to making Maidanak an international observatory funded by Russia and Uzbekistan.

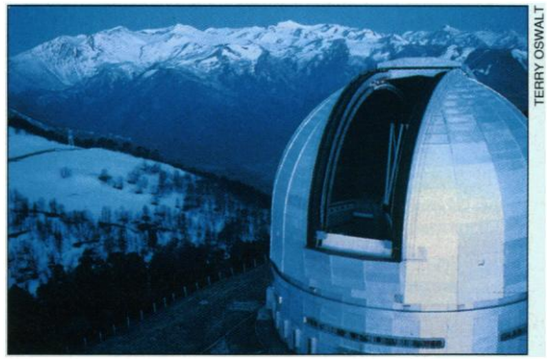
The future of the Crimean Astrophysical Observatory (CAO) depends on the Crimea's own uncertain political future as part of the Ukrainian republic. Once the second-largest facility in the Soviet Union, the CAO has a 2.6-meter reflector and is very strong in solar physics; its astronomers still maintain links with their Moscow colleagues. But most of the Crimean population is ethnically Russian and is campaigning to split from Ukraine, making the area a potential point of conflict with Russia.

Russia's own observatories are in only slightly better shape. The country's largest facility is the Special Astrophysical Observatory (SAO) at Zelenchuk in the northern Caucasus mountains, home to Russia's pride and joy, the 6-meter optical telescope—from 1974 until 1993 the largest in the world—and its main radio telescope, RATAN-600. In its early days the 6-meter telescope, which had a worrying crack in its mirror, was dismissed by Western astronomers. But with improved temperature control and electronic charge-coupled device cameras, it is gaining favorable reviews in the West.

The observatory has more basic problems, however. Because of its remoteness, the SAO houses and supports its 500 staff and their families on-site and provides amenities such as transport, restaurant, and kindergarten. But the SAO is currently receiving only 20% of its former funding, and this infrastructure is taking up most of the money: Only 7% of the SAO budget is spent on science. One astronomer reports that the price of motor fuel rose so much that they could not afford to plow snow from the roads, so people had to don snowshoes to hike the several hundred meters from the institute up to the observatory.

These hardships have led many Russian astronomers to pursue their careers in the West. Says Richard Green of Kitt Peak Observatory in Arizona: "Visiting astronomers from the SAO are really grateful for the opportunity to continue working." But it is only a short-term solution, he adds. "What they really wanted was to set up long-term collaborations that would allow them to continue at their home institution."

For many, however, the only hope of continuing to work is to find a permanent post in the West. "I have no intention of going back to Russia," admits Ludmilla Kiseleva, a theoretical astronomer now working at the Institute of Astronomy in Cambridge, United Kingdom. "My parents who live in St. Petersburg have advised me not to return." Kiseleva, who came to Britain last year on a grant from the Royal Society, has brought her husband and son over and is now trying to find a permanent position. But she is finding it difficult—it is hard enough for young Western astronomers to find permanent jobs.



TERRY OSWALT

Bright spot. Russian astronomers still have access to 6-meter Caucasus telescope, but little money to use it.

The chance to make even a short visit to the West can make a huge difference to astronomers from the new republics where a few dollars go a long way. Eric Fossat at the Nice observatory in France has been collaborating with a group in Tashkent, Uzbekistan, to set up a helio-seismology network run from France. "The CNRS [the French gov-

ernment funding agency] gives us excellent support in paying the traveling and living expenses," says Fossat. "When one colleague came over recently for a few weeks, he stayed with me so as to save his French living expenses. With that money he could feed the families of the six young people working with him for a year."

Aid is also trickling in from other Western sources. Two years ago, the American Astronomical Society raised $50,000 from its members, which was distributed as $100 grants. "It sounds small," says Stan Woosley of the University of California, Santa Cruz, who helped to organize the grants. "But we were told that it made the difference between people staying in the field and not." The Society is now making a second round of 250 $500 awards, much of the money coming from the International Science Foundation (ISF). The ISF is now on its second round of larger grants and has earmarked around $1 million for astronomy in the former Soviet Union. The European Southern Observatory (ESO), a collaboration of nine European nations which runs a large observatory in Chile, is providing a similar sum in grants.

But some Russian astronomers are adapting to the mood of the times and taking a more entrepreneurial approach to funding. A team led by Viktor Afanasiev, a former director of the SAO, secured a scientific trip for his team to the 4-meter telescope at Kitt Peak in exchange for building a new spectrograph for the instrument. "It was amazing; it worked," says one American astronomer. Other researchers at SAO are trying to raise money by establishing a visiting astronomer's program, whereby foreign astronomers pay $100 a night to observe there, including flights from Moscow. Terry Oswalt from the Florida Institute of Technology was a guinea pig for the program: "It's the darkest site I've ever seen—including Mauna Kea [in Hawaii]."

But astronomy is never going to be a great moneymaker. "Organized visits from foreign scientists work well, but they don't improve things in general," says SAO's Valentin Lipovetsky. Large sums will be needed for state-of-the-art computers and electronic imaging equipment if astronomers in Russia and the other republics are to do any useful science in the future. "The bottom line," says Woosley, "is that eventually the former Soviet Union has to solve its own problems." Russian astronomers can only hope that their strong traditions will help them weather the financial storm. "The next few years will be critical," says Richard West of ESO, "but if the economy stabilizes, then with Russia's long track record of excellence in astronomy, it would be difficult to imagine astronomy disappearing completely."

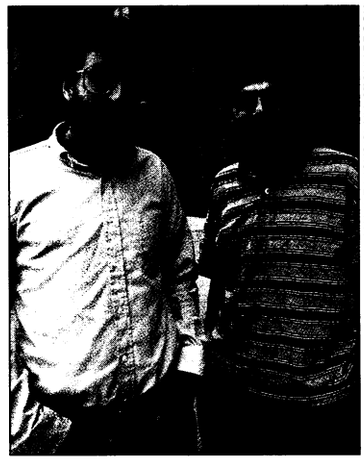
–Nina Hall

Nina Hall is a science writer in London.

MATHEMATICS

A World-Class Community, Scattered Around the World

For several weeks a year, the Euler International Mathematical Institute in St. Petersburg buzzes with the creative energy of top mathematicians from around the world. It's fitting that outstanding mathematical talent should gather in Russia, which has produced some of the twentieth century's finest mathematicians. But the Euler Institute doesn't quite feel...Russian. Perhaps it's the institute's 386-class personal computers, its Finnish heating system, or its swank furniture, fax machines, and laser printers. It's a far cry from the Soviet days, when seminars—the lifeblood of Russian math—were often held in cold, spare apartments.



MAXINE HICKS/SUNY, STONY BROOK

Greener pastures. Leon Takhtajan *(right)* and Vadim Schechtman, both left Russia in 1990 for Stony Brook.

A foreign visitor to the Euler Institute could easily get the impression that mathematics is flourishing in post-Soviet Russia. But nothing is further from the truth. The Euler Institute is something of an anomaly: Established in 1989 by the Soviet Academy of Sciences with international assistance, it is part of an effort to stem the hemorrhage of mathematics talent to the West. Its primary function is to "bring foreign and Russian mathematicians back to Russia" for meetings, seminars, and sabbaticals, says the institute's scientific secretary Anatoly Lanin. The hope is that the visiting scholars will provide an intellectual lifeline to mathematicians remaining in Russia, helping to keep Russian mathematics at the cutting edge. It will be a tough task.

So many top mathematicians have left Russia in the past 5 years that its math communities are eroding like sandcastles at high tide. Many math institutions have been decimated, and a once-formidable math education system is crumbling. "If things continue on the same course, the Russian mathematics tradition will be dead in 10 years," predicts Massachusetts Institute of Technology (MIT)'s Dan Stroock, a probability theorist who traveled to Russia last year with MIT colleague Robert MacPherson to assess how the American Mathematical Society (AMS) might help Russian researchers.

For now, the international mathematics community is hoping that a viable math culture can be sustained in Russia through the current crisis; foreign assistance is playing a key role in supporting mathematicians who remain. And, in the best traditions of Russian survival during hardship, some promising alternative institutions are beginning to take shape.

A mere 5 years ago the Soviet Union could claim a formidable math community. It began to flourish in the 1930s and '40s, when political forces began shaping many other scientific disciplines: Soviet biology, for instance, was warped by Trofim Lysenko's pseudoscience, while physics was swelled by military funding. Mathematics, on the other hand, was for years "ideologically unimportant," says algebraist Alexei Rudakov, a professor at the Independent University of Moscow, and it became a safe harbor for many of the country's finest scientific minds, particularly Jewish researchers.

A strong math education system also played its part. Schools in the Soviet Union had a long tradition of good mathematics instruction, and in the early 1960s, prominent mathematicians pushed through changes designed to encourage math prodigies. They took advantage of a lull in Soviet oppression and anti-Semitic policies—the "Krushchev spring"—to launch new institutions with a math bent, recalls A.B. Sossinsky, a senior researcher at Moscow's Institute of Electronics and Mathematics. In Moscow, for example, mathematicians supercharged four city high schools with enhanced math curricula, and math boarding schools were established in Erevan, Kiev, Leningrad, and Novosibirsk. And just in case promising students were unable to enroll in those math schools, one of Russia's star mathematicians, Israel Gelfand, set up the All-Union Mathematics Correspondence School in 1964 to get high-schoolers doing extracurricular math work.

But this burst of enthusiasm soon ran into a major obstacle: an ideological crackdown in 1968 that resulted in the re-establishment of anti-Semitic policies throughout the Soviet system, says Vladimir Arnold, a prominent mathematician at Moscow's Steklov