Commentary

Journal *Physics–Uspekhi* celebrates its centennial

In the fall of 1980, I had just been admitted for my final two years at the specialized physics and math school of Novosibirsk State University. Students there were strongly encouraged to participate in research at one of the more than two dozen institutes of the nearby Academy of Sciences of the Soviet Union. I began spending one day a week and my weekends in the laboratory of ultrahigh magnetic fields at the Institute of Hydrodynamics.

My task was to build and test a thyratron-based high-voltage, high-current switch that would discharge a very large capacitor through a one-turn copper coil to create a pulsed magnetic field. If the magnetic flux could be trapped inside a small conductive tube and that tube compressed by an external explosive, then fields in excess of 1 megagauss could be obtained and measured. I liked the idea of explosion—I was a teenager, after all—and I also liked the atmosphere of a real research lab, with opportunities to communicate freely with senior scientists.

When I asked my supervisor about the limitations of the flux-compression method, he told me to read Andrei Sakharov's article[1] describing the status and records of the technique, including results from the strongest compression possible—a nuclear blast! The article, in *Uspekhi Fizicheskikh Nauk* (*Advances in Physical Sciences*), was the first scientific article I had ever fully read, and I proudly thought I understood most of it. My assessment was a delusion, of course; I now know that the complexity of the physics involved is still the subject of active research worldwide.

Sakharov's article claimed attainment of a 15- to 25-megagauss field in an unspecified blast type, and the spread of the values puzzled me. Moreover, the upper value was obviously estimated from a cut-off oscilloscope trace—the signal was obviously higher than expected, and there was no opportunity to repeat the test with properly adjusted scope gain. Thus I learned that some physics experiments are unique and that one must consider even small details beforehand.

I glanced through the rest of the issue and found an article criticizing "sensational effects" of water when it passed through a strong magnetic field. That was a subject of hot debate at the time, since the miracle of "magnetized" water was sold to the public as snake oil. All in all, I found that first journal impressively broad, intended for a relatively diverse physics audience, and quite readable.

Since then I have stayed with *Physics–Uspekhi* for almost four decades: as a reader, an author, and an adviser. Below I briefly describe the history of the journal, whose centennial was in April 2018.

The study of physics in Russia began in the early to mid 18th century with polymaths that included Daniel Bernoulli, Leonhard Euler, and Mikhail Lomonosov (see my article in PHYSICS TODAY, February 2012, page 40), who were members of the Saint Petersburg Academy of Sciences. They mostly published in Latin in the academic journal *Novi Commentarii Academiae Scientiarum Imperialis Petropolitanae*. By the 19th century, science disciplines had greatly diverged and expanded to universities. Russian physicists were not as prominent as those in other fields, such as mathematicians Nikolai Lobachevski and Pafnutii Chebyshev, chemists Aleksandr Butlerov and Dmitri Mendeleev, and bioscientists Ilya Mechnikov and Ivan Pavlov.

In an attempt to boost physics and in response to breakthroughs such as quantum physics and relativity at the beginning of the 20th century, the Russian physics community initiated a new journal, *Uspekhi Fizicheskikh Nauk* (cover shown in the figure), in April 1918. The idea was to review recent advances in physics worldwide, reflect on the physics community's most important events, host discussions on a wide spectrum of hot topics, and offer history, biography, and book review sections.

Physics–Uspekhi survived many hardships during the 20th century—Russia's civil war in 1918–22, the "Great Patriotic War" of 1941–45, and the disastrous post-perestroika period. However, its publication has continued essentially uninterrupted, and the journal celebrated its 1000th issue in February 2018.

During its most illustrious time, from the 1950s into the 1990s, the journal was attuned to the country's physics community and actually became its home and organizer.[2] Over that period Soviet physicists were awarded 8 Nobel Prizes—the dominant share of the country's 14 total Nobels. And the researchers who received them were connected in one way or another to *Physics–Uspekhi*—as the journal

1918. № 1.

УСПѢХИ

ФИЗИЧЕСКИХЪ НАУКЪ.

ПРИ УЧАСТІИ

ФИЗИЧЕСКАГО ИНСТИТУТА

МОСКОВСКАГО НАУЧНАГО ИНСТИТУТА.

КУРАТОРІЙ:

академикъ проф. П. И. Вальденъ и академикъ проф. А. Н. Крыловъ.

ПОДЪ РЕДАКЦІЕЙ

академика проф. П. П. Лазарева.

Томъ I. вып. 1-8.

МОСКВА 1918.

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I томъ „Успѣхи Физическихъ Наукъ" можно получать въ Московскомъ Научномъ Издательствѣ, Варварка, д. 26, и въ издательствѣ „Природа", Моховая, д. 24.

COVER PAGE OF THE FIRST ISSUE of the journal *Uspekhi Fizicheskikh Nauk* (*Advances in Physical Sciences*) published on 29 April 1918.

and its English translation (since 1958) are known in the West. Vitaly Ginzburg, a corecipient of the 2003 Nobel Prize for the theory of superconductors and superfluids, was its editor from 1998 to 2009. Other Nobelists have served on the editorial board and are among the journal's most-published authors.

Physics in the Soviet era was incredibly productive. The USSR provided arguably better science funding than any other country, and scientists were treated as popular heroes and had many privileges. Not surprisingly, many of *Physics–Uspekhi*'s most notable articles were published during that time. For example, its most cited paper both in Russian and in English was Viktor Veselago's "The electrodynamics of substances with simultaneously negative values of ε and μ,"[3] which eventually established the field of modern metamaterial research.

Given *Uspekhi*'s standing as a review journal, articles are relatively easy to read and provide general knowledge of the areas they cover. Therefore, the publication has the largest impact among all Russian-language and Soviet physics journals. My own choice of subfield, beam physics, was influenced by an excellent review of the first colliding beams in Novosibirsk by the method's trailblazer Gersh Budker.[4] And in 1944 Pyotr Kapitsa wrote an impressive review[5] about the superfluidity of liquid helium. That research earned him the 1978 Nobel Prize.

Physics–Uspekhi belongs to a rare group of physics journals that have served national physics communities over decades and even centuries. They include *Physical Review* (1893–1970), *Annalen der Physik* (1799–present), and *Il (Nuovo) Cimento* (1844–1965), but unlike them, *Physics–Uspekhi* was never interrupted or split.

Several approaches have helped maintain the journal's popularity. For example, in 2008 the journal published side-by-side critiques, by Vladimir Lukash and current *Uspekhi* editor-in-chief Valery Rubakov, alongside Arthur Chernin's paper "Dark energy and universal antigravitation."[6] Chernin was made aware of the criticism and given the option to either revise the paper or withdraw it. I believe such discussion can energize the exchange of scientific ideas, and I look forward to seeing more in physics journals.

The 1990s fall of the Soviet Union had a devastating effect on the country's physics community. Funding dropped at least three- to fourfold, the science community shrank correspondingly, and a new social ideology often questioned the value of science.

The Russian physics community is now regaining its health, with some 35 000 staff in almost 80 basic and applied physics research institutes. Russian physicists commonly participate in large international endeavors such as ITER, the Large Hadron Collider, the European Synchrotron Radiation Facility, and the European XFEL. They also develop megascience projects of their own, like the Nuclotron-Based Ion Collider Facility at the Joint Institute for Nuclear Research, the lab famous for discoveries of the heaviest transuranium elements (see the article "A beachhead on the island of stability," by Yuri Ts. Oganessian and Krzysztof P. Rykaczewski, PHYSICS TODAY, August 2015, page 32). Russian scientists also have prominent roles in the *RadioAstron* space observatory run by the Lebedev Physical Institute, which hosts and publishes *Uspekhi*; the world's longest Raman fiber laser (270 km); and ultimate-brightness colliding beams in the Budker Institute of Nuclear Physics.

Entering its second century of publication, *Physics–Uspekhi* is well poised to continue its success. Congratulations!

References

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LETTERS

Experiences in improving introductory physics labs

The article "Introductory physics labs: We can do better" by Natasha Holmes and Carl Wieman (PHYSICS TODAY, January 2018, page 38) might have been describing our department's recent and dramatic reconstruction of the student laboratory curriculum. Last summer, after students for years had given the mandatory second-year physics lab a poor evaluation, our team was tasked with updating it. Instead of the traditional cookbook approach, we set out to simulate research in a guided environment. The aim was to instill in the students basic experimental skills, including thinking critically, planning experiments, understanding the limitations of lab equipment, and presenting results to colleagues.

Our pilot student lab was similar to the "structured quantitative inquiry labs" mentioned in the article. Over the semester, students performed four to six experiments on advanced topics that included dark energy, superconductivity, and optical spatial light modulation and on more classical subjects such as blackbody radiation, the Faraday effect, and ferromagnetic Curie temperatures.

For each experiment, students were given the main research goal and were introduced to the available equipment. They then formulated hypotheses and decided how to reach their goal. Lab instructors, usually graduate students, functioned as personal advisers, who discussed the ideas with the students and guided them through the experiment. We emphasize to the students that, as in real-life research, there are multiple ways to conduct each experiment. Students learned how to plan lab time, test different methods to decrease experimental errors, and recover from mistakes. Perhaps the biggest conceptual change in our approach is that instead of having to write traditional lab reports, about which both students and instructors complain, students went over their lab notebooks and results in a brief meeting with their instructor, just as they would present results to their adviser in a working research lab.

The lab instructors have radically revised the classic experiments by cutting redundant or dull elements and encouraging students to demonstrate independent decision making. Furthermore, students are invited to submit proposals for personal lab projects. If the personal projects are accepted, the students set up their own experiments and present their research in a poster session at the end of the semester. The project will gain them extra-credit points in their final grade. We also have detailed and flexible grading protocols to enable fair and consistent grading.

The new approach has received positive reviews from both students and lab instructors. Many say that either learning or teaching the lab introduced them to basic conceptual and experimental skills that appear nowhere else in the traditional course load; we were gratified to read in Holmes and Wieman's article that students maintain those skills in subsequent years. We also often hear from students that the lab is "hard but fun."

Our experience supports the authors' findings, and we enthusiastically encourage other institutions to consider this approach to modernizing their teaching labs.

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I am delighted and impressed by the steps being taken to improve teaching laboratories, as described in "Introductory physics labs: We can do better." However, I wish that those involved in revising the labs had gone further. Real physics research seeks to answer questions whose answers are not known. All