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Scientific Research in the Soviet Union

R. E. Marshak

The "new look" in the Soviet Union since the death of Stalin has probably had a greater impact on science than on any other field of human endeavor. It appears that there has been a tremendous improvement in the scientific climate in the U.S.S.R. and that, to a considerable extent, freedom of science has been reestablished there. I should like to make it clear that when I refer to Soviet science, I am thinking chiefly of physics, the field in which I work and in which I made most of my observations during my recent visit to the Soviet Union.

Scientific Freedom

The significant changes that have taken place since Stalin's death, particularly as they bear on scientific research, are as follows.

1) It seems that all scientists who were formerly in disgrace or under arrest have been rehabilitated and that all the brilliant scientists who had been in trouble have been returned to positions of leadership. An excellent example is the case of Kapitza, an outstanding physicist, who was placed under house arrest for 7 years when he refused to work on atomic weapons research. Kapitza was released soon after Stalin's death and is now back as director of the Institute of Physical Problems in Moscow at the same high salary (30,000 rubles per month) as the president of the U.S.S.R. Academy of Sciences, the most powerful scientific body in the Soviet Union.

2) All the usual scientific channels of communication are now open, including the exchange of scientific and technical information with foreign scientists.

3) Personal contact with foreign scientists is now allowed. Soviet scientists are permitted to attend international conferences outside their own country, and foreign scientists are invited to attend scientific gatherings in the Soviet Union and to visit Soviet laboratories.

4) The rigid mobilization of Soviet scientists to work on war projects has apparently been discontinued. For example, Soviet physicists are no longer required to work on radar, rockets, or nuclear weapons; they are permitted to concentrate their energies in such a pure nonmilitary field as high-energy nuclear research.

5) A much more liberal policy of declassification of scientific research has been adopted. The results of basic research in such fields as nuclear physics can now be freely published in scientific journals. Indeed, in some fields such as controlled thermonuclear fusion, Soviet policy has been more liberal than United States policy. On the other hand, in such a field as that of electronic computers, Soviet security regulations are still much stricter than ours.

6) Soviet science is much less nationalistic now than it was in the Stalin era. It is no longer claimed that all the important scientific discoveries are of Russian origin (which they are not,) and it is no longer necessary for Soviet scientists to publish their papers exclusively in Soviet journals and to use the Russian language.

7) There has been a considerable devaluation of Marx's philosophy insofar as pure science is concerned. For example, in biology, Lysenko is no longer political czar of Soviet genetics. In the more abstract science of physics, no lip service of any sort seems to be paid now to dialectical materialism and its alleged indispensable role in the development of physical science. In our discussions of physics at the Moscow conference, we Americans and our Soviet colleagues spoke the same language.

8) Freedom of criticism in science is accepted as a virtue. There was vigorous and uninhibited discussion at the Moscow physics conference, and young Soviet physicists did not hesitate to call to task distinguished academicians if points of difference arose.

Lack of Political Freedom

I can go on in this fashion, but I believe that it is evident that many of the ingredients of scientific freedom now exist in the Soviet Union, certainly as far as physics is concerned. The reemergence of scientific freedom is not to be confused with political freedom in which there has been some slight improvement in the U.S.S.R. but in which there is still a very long way to go. After all, the government of the Soviet Union is still in essence a dictatorship, a collective dictatorship if you will, but still a dictatorship. The Supreme Soviet only meets 4 or 5 days at a time, twice a year, just as it did in pre-Stalin days, and it is no more a true legislature than it was before. There is still only one party in the Soviet Union, there is no freedom of assembly, censorship continues, Lenin has replaced Stalin as the great authority on all matters of public policy, and so forth. However, the naked terror of the Stalin regime with its mass arrests, its complete isolation, its vindictiveness and single-minded suppression, and its great suspicion of and hostility to the West *appears* to have ended. Because of the failure thus far to achieve a genuine democratization of Soviet society with its concomitant built-in guarantees of permanence, the situation is an unstable one, and one cannot be certain that a new Stalin will not arise. However, it is clear that the Khrushchev smile is not solely for foreign consumption; there are observable changes associated with it as far as the general populace is concerned and, in

The author is Harris professor of physics and chairman of the department at the University of Rochester. This article is based on a talk given before the Research Committee of the National Association of Manufacturers, which met in New York on 19 Oct. 1956. The author attended the Moscow Conference on High Energy Particles held 14–22 May 1956 as a member of the American delegation.

many ways, there are remarkable changes resulting from this smile in the scientific domain.

The rebirth of scientific freedom in the Soviet Union is not tied in with any commensurate increase in political freedom and may have only a temporary basis, but the fact is that it now exists. It is now possible for a Soviet scientist to choose the subject matter of his own research and to draw the conclusions to which his investigations lead without subjecting them to the requirements of some nonscientific authority. However indispensable as are these moral and spiritual factors in the development of a healthy science, scientific research will not prosper in the present day and age without powerful material support.

Financial Support

The U.S.S.R. is sparing no effort to provide the necessary financial support for scientific research. This effort consists of providing both financial and prestige incentives to qualified students in science and engineering and also of providing funds for a very large technical and educational plant. The stipend of a Soviet graduate student exceeds the salary of an unskilled worker, and the salary of a distinguished scientist in the Soviet Union is as much as 50 times the salary of an unskilled worker. Prestige incentives are equally as great. One of the great honors for a scientist in the Soviet Union is to be elected to the Academy of Sciences, a body which plays a dominant role in the direction and support of scientific research. The honor of belonging to the U.S.S.R. Academy of Sciences is coupled with a financial remuneration equal to 10 times the salary of an unskilled workman. As a result of this policy, scientists form an élite whose scale of living—although not outstanding by American standards—stands in extreme contrast to the still low living standards of the general populace. It is therefore not surprising that of the 16,000 students at Moscow State University, 2000 are majoring in physics.

In addition to providing major financial and prestige incentives to scientists and engineers, the Soviet Union has developed an educational and technical training system with excellent facilities and high standards. Indeed, in some areas, the standards are higher than they are in the United States. For example, the average Soviet electrical engineer takes more mathematics and basic physics in his curriculum than his American counterpart and as a result appears to be more independent, creative, and critical than the average American electrical engineer. As a special twist in the whole situation, these highly talented engineers receive higher salaries and enjoy more prestige in laboratories where basic research is done than they do in an industrial set-up. During my visit to the Soviet Union, I was greatly impressed with the close collaboration that exists between physicists and engineers in research laboratories. In my own field of high-energy nuclear physics, many of the papers on fundamental accelerator design, topics which in the United States are still the exclusive concern of physicists, were delivered at the Moscow conference by engineers.

The close attention which the Soviet government is paying to the support of scientific research is manifest not only in the attractive salaries paid to its scientists and engineers and in its insistence on high standards in higher education, but is also demonstrated by the lavish provision which it makes for new up-to-date laboratories and the most modern experimental equipment. It seems that scientific research in the Soviet Union is being pursued with an urgency which is reminiscent of a wartime operation. As my colleagues and I toured the nuclear research laboratories in the U.S.S.R. last May, we noted the same personal dedication to the task at hand, the same emphasis on speed rather than cost, the same unlimited financial support for facilities and equipment which we ourselves had known at Los Alamos during World War II. It seems clear that the scientific research program in the Soviet Union is gathering enormous momentum and that the objective is to overtake American science in its great diversity, its high quality, and its magnificent sweep.

The fruits of scientific research in the Soviet Union have been the rapid industrialization of the country and the development of a modern technology which, in many ways, is second only to that of the United States. However, a strange dichotomy exists in the U.S.S.R. Although there has been remarkable progress in industrialization and technology, the developments have had relatively little impact on the general standard of living. Indeed, it appears that to a very great extent the astonishing speed of industrialization and technologic innovation has been made possible by withholding its benefits from the people at large. It seems that the lot of the common man in the Soviet Union will not be greatly improved until heavy industry and advanced technology have achieved a level comparable to that in the U.S.

From what I have said, it follows that scientific research in the Soviet Union has a potential for great achievements. Not only have the moral and spiritual conditions for independent and creative research been greatly improved since Stalin's death, but the material support is as great as it was before, if not greater. These factors, with their resulting high morale among the scientists, plus the excellence of scientific training, plus the education of the public on the value of science, will unquestionably lead to an efflorescence of Soviet science and to strong competition with the United States.

Meeting the Challenge

I believe that this challenge can be met in our own American pragmatic way without adopting the centralized control of scientific research which is part and parcel of the Soviet system. Scientific freedom already exists in the United States and indeed has existed for a long time. There is an occasional lapse such as Secretary of Commerce Weeks' dismissal of the director of the National Bureau of Standards in connection with the battery additive incident or former Secretary of Health, Education and Welfare Hobby's withdrawal of Government funds from medical researchers in whose files some derogatory information was found. But, by and large, the American scientist has been free for a long time to choose the subject of his own research and to publish his results without approval by a nonscientific authority. As far as material support of science is concerned, there has also been much improvement during the past decade.

But the whole point of my remarks is that the Soviet scientific challenge underlines the importance of a frank reappraisal of the scientific picture in our country, a reappraisal that in any case is long overdue. I believe that all responsible Americans will draw the necessary conclusions from the new situation in the Soviet Union. However, I should like to list several of my own conclusions to indicate how the quality and productivity of scientific research can be improved in the United States.

It seems to me that the financial and prestige incentives in this country are not such as to persuade the scientist or engineer to remain at the university where most of the basic research is done and where all the training of new scientists and engineers takes place. I believe that American industry might do well to ponder the possibility of subsidizing greatly increased salaries of a sizable number of outstanding scientists and engineers who remain at their university posts and continue their teaching and basic research programs. As far as our educational standards are concerned, the quality of scientific training in our graduate schools is of high quality, but the same cannot be said of the quality of training of our engineers or of scientific training in our high schools and colleges.

Improvements along these lines can be achieved if sufficient funds are made available by all levels of government and industry to train better teachers and to keep these teachers in the high schools and the colleges, to re-examine scientific and engineering curriculums, to educate the American public on the value of science and engineering, to provide financial support for *all* young people who desire to embark on scientific and engineering careers, and in many other ways. It is also essential for American government and industry to provide the increasingly large sums of money which are required to carry on basic research in the sciences in this, the middle of the 20th century. Finally, it seems to me too that American industry must re-examine the use to which it is putting its scientific manpower: Are engineers being utilized to the full extent of their intellectual resources, or are they being placed in inferior and less productive positions? Can basic research programs that are now being started up in industrial laboratories be undertaken more profitably by throwing the equivalent financial support to high-quality university laboratories where at the same time the scientists are reproducing their own kind—that is, developing new scientific manpower?

I am convinced that all these and many other things can be done without losing the essential ingredients of the scientific freedom which now obtain in the United States and without impairing the research that must be carried on in our government and industrial laboratories. I should like to conclude by stating my firm belief that American scientific research still holds a substantial lead and will continue to do so if the American government, industry, and the universities work harmoniously together in strengthening those areas in which we have developed weaknesses, in throwing our full resources into the support of basic research, and in treating the American scientist as a responsible and dedicated person. The minimum that I foresee is that American science will help to preserve the peace and that Soviet scientific achievements, impressive as they may ultimately become, will simply make their just contribution to the welfare of the human race.

AAAS Meeting, New York

Raymond L. Taylor

In the months following the preliminary announcement of the New York meeting, which will be held 26–30 Dec. inclusive [*Science* **123**, 947 (25 May 1956)], the symposia listed there have been implemented and augmented and the sections and participating societies, in a number of instances, have had to open additional sessions for contributed papers. From such program details as the names and addresses of authors, and from the volume of advance registrations and applications for housing accommodations, it is quite apparent that this year's 123rd AAAS meeting will have an excellent attendance representing all sections of the continent and abroad.

Apparently because Wednesday, 26 December, is not a holiday but Monday, 31 December, is, most sections and participating societies have started their programs on the first day, 26 December.

As the outline of symposia shows, virtually no principal field of science will be neglected. The special Moving Frontiers of Science program, "Fundamental concepts and units of science," has already been announced [*Science* **124**, 945 (9 Nov. 1956)]. Other programs that have appeared in *Science* in recent weeks are AAAS special sessions and conferences, 16 Nov.; mathematics, physical sciences, and earth sciences, 23 Nov.; biological sciences, engineering, social sciences, and philosophy, 30 Nov. The programs in psychology, agriculture, industrial science, and science in general will appear in the issue of 14 Dec.

A conspectus of symposia, panels, groups of invited papers on a particular subject, and the like, follows. (Single sessions unless otherwise noted.)

Symposia

AAAS general symposium: Fundamental concepts and units of science (two sessions).

Mathematics: The application of digital computers.

Physics: Optical absorption in solids; Optics and oriented nuclei; Diffusion in solids (two sessions); Crystal growth (two sessions).

Chemistry: Chemical and biological aspects of cellular competition; Biosynthesis of isoprenoid compounds; Organic reaction mechanisms.

Astronomy: The recent close approach of Mars; The benefits of astronomy to young people.

Geology and Geography: Recent advances in geochronometry (three sessions); Carbonate sedimentation; Ground water (two sessions); Appalachian stratigraphy and structure (two sessions); Geographical research in progress (two sessions).

Biological sciences: Modern ideas on spontaneous generation (two sessions); Museum techniques (two sessions); Biochemistry of the cell nucleus; Some unsolved problems in biology; Problems of aging (two sessions); Recruitment and training of biological scientists; Values in human ecology; The social significance of ecological research (two sessions); Biotic communities in the past and today.

Entomological sciences: Communication in insects (two sessions); Teaching entomology; The nematode situation; Responsibilities of the extension entomologist; Insect attractants; Museums and their problems; The role of insects in nature; The fate of insecticides in plants and animals.

Botanical sciences: Genetics of the fungi.

Anthropology: American archeology; Commemorating the 100th anniversary of the discovery of Neanderthal man; Man in the tropics: the Caribbean (two sessions); Anthropological theory; Transitional communities in India, Pakistan, and Burma; Current studies in cultural evolution: Oceania.

Psychology: Experimental approaches to research with children; Avoidance conditioning and anxiety; Motivational and rewarding effects of direct stimulation of the brain; Sensory processes; Advances in experimental psychopathology.

Social and economic sciences: The impact of natural science on social science; Labor mobility and earnings; Statistics in public health; Resource devel-