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the surface would have little chance to contribute). However, in other cases the direction remained unchanged, but the intensity went through a maximum for a particular voltage, as one would expect from the requirement of a constructive phase relationship between scatterings from different atomic layers. As Davisson and Germer pointed out, every diffraction maximum based on scattering from a space lattice also corresponded to a possible peak due to scattering from a line grating of surface atoms. In their summary of all their results they identified several peaks due to a single layer of surface atoms and a larger number of others due to scattering by a space lattice. These latter peaks gave the first indications that the scattering angle was not necessarily quite what one would predict from a knowledge of the electron wavelength *outside* the crystal.

It is true that in subsequent experiments Davisson and Germer did deliberately explore Bragg scattering from the planes of atoms parallel to the crystal surface.⁴ By studying the regular reflection of electrons incident on the crystal surface at angles other than 90°, they were able to compare their results with the theoretical predictions based on a refractive index for electron waves entering a crystal,⁵ and found substantial agreement. All this, of course, is old and well-established history. The only point I would wish to make is that except for the initially mysterious phenomenon of a refractive index for electron waves entering a solid, Davisson and Germer had a full and realistic picture of what was going on in their experiments, whereas Best's brief comments about their analysis might be taken to suggest otherwise.

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Did Privilege Blunt Soviet Scientists' Politics?

My attention was attracted by the

letter from Eugene M. Chudnovsky and Alex Vilenkin that appeared under the headline "Soviet Scientists' Apolitical Past" (December 1992, page 11). I know the authors in person and I took an interest in the problem they touched upon. However, as I read through the letter, I realized that it is quite biased: The main point of the letter is not a proper analysis of past apolitical behavior, but only that former Soviet scientists neither deserve nor need individual financial support.

How can an apolitical past be related to current support? I by no means wish to get into an argument with Chudnovsky and Vilenkin. My only goal in this letter is to let Western readers, especially young people, know the truth about the situation of Soviet physicists and their attitude toward politics.

Soviet physicists were patriots and played an important role in strengthening their country's defense potential, just as their American and English colleagues did in their countries. Andrei Sakharov never blamed himself for his participation in this work. On the contrary, he was proud that his efforts promoted the creation of thermonuclear weapons for his country. Igor Kurchatov also contributed essentially to this program. They, like many hundreds of other physicists, did their job not because they were bought with "privileges," as Chudnovsky and Vilenkin state, but only out of their sense of duty. And what enormous privileges are these authors jabbering about? Kurchatov's "privilege" was that he did not live till 60 and died of a heart attack. My "privilege" was that in addition to my main salary of 500 rubles per month, I got 350 more as a member of the Academy of Sciences. But I had neither "cars with drivers" nor "dachas." As far as I know, neither did more prominent scientists such as Lev Landau, Vladimir Fock, Igor Tamm and Isaak Pomeranchuk. Once I heard a story about Pomeranchuk calling the head of a canteen seeking help in getting a pound of rice for his sick wife.

And now about politics. Chudnovsky and Vilenkin claim that Soviet scientists' "freedom of thought rarely went beyond discussions around the kitchen table, while objectively they were supporting the regime by their complacent behavior." However, physicists such as Fock and Moisey Markov struggled for the scientific truth contained in quantum mechanics and relativity, both general and special, against strong attacks from orthodox Marxist

philosophers who charged them with idealism. When a powerful anti-Einstein article was prepared for publication in *Pravda*, Kurchatov succeeded in stopping it. Weren't conferences on physics and philosophy held in Kharkov and Kiev at which the ideas of quantum mechanics were defended? Those conferences were very important in legalizing quantum mechanics and relativity at Ukrainian universities. It is surprising that Chudnovsky and Vilenkin, educated at Kharkov University, have forgotten that.

And how can we forget the courage of the great physicist Peter Kapitsa, who literally pulled Landau from the hands of Lavrenty Beria, the head of the Soviet secret police? Was that not politics? Was it not an act of heroism that preserved Landau for science throughout the world? I cannot help recalling the courageous talks of Mikhail Leontovich, Tamm and others against electing Trofim Lysenko and his myrmidons to the Academy of Sciences. Note also that during the hard times of *Lyenskovichina* Kurchatov opened a biological division at his institute in which genetics was studied, and that the geneticist Nikolai Timofeev-Ressovsky gave talks at the seminar held by Kapitsa and at other physical meetings. Incidentally, let me mention the dissident Yuri Orlov. Many physicists supported him, and the academicians Abram Alikhanov, his brother Artemii Alikhanian and Pomeranchuk helped him to get a job at Yerevan and backed up his election to the Armenian Academy of Sciences.

Perhaps all this is not sufficient for Chudnovsky and Vilenkin, and they would like to demand more martyrs for the sake of science. But is it not enough that the brilliant physicist Lev Shubnikov was shot dead by a firing squad, and such talented physicists as Matvey Bronshtein, Vadim Gorski and Lev Rosenkiewicz also were killed?

But here let me step aside from the Soviet reality and get into a more general problem of politics and science by addressing the case of Galileo. Only Bertolt Brecht condemned Galileo for not struggling against the church and not dying like Giordano Bruno. You see, that made Brecht's play about Galileo look more spectacular! Most of us, however, have another opinion. And not only do we have it, but so did Einstein and David Gilbert. Einstein said: "He [Galileo] needlessly got into the lion's jaws, going to Rome to fight priests and other intriguants. I do not think I could attempt something

like that to advocate relativity. I would think, The truth is much stronger than I, and trying to defend it with a sword, riding [Don Quixote's horse] Rocinante, would seem to be a funny sort of quixotism."¹ Gilbert said that Einstein was not an idiot: Only an idiot can think that scientific truth requires martyrdom.²

Maybe the above quotation is enough to demonstrate the balance that had to be struck between Stalin and Soviet physics. One has good reasons to say that Soviet physicists acted with dignity during the hardest times and never sold their birthright for a mess of pottage as far as their scientific ideas were concerned. Thus Chudnovsky and Vilenkin sound odd speaking about physicists' "responsibility for what happened to the country." Let that responsibility remain on their own consciences alone.

The problem of physics and politics thus seems to be settled. What does it have to do with the aid to Soviet physicists nowadays, when we are going through hard times? Chudnovsky and Vilenkin artificially connect these problems, and from this false, unworthy connection and under the pretense that physicists were obedient to the Stalin regime, they draw the conclusion that there is no need for support from the West to individual Soviet physicists. I am uncomfortable asking for financial aid to physicists from the FSU, because I myself am a Ukrainian physicist. Nevertheless I share the viewpoint expressed in the articles by Roald Z. Sagdeev and Evgenii L. Feinberg in the May 1992 issue of *PHYSICS TODAY* (pages 22 and 30): I would say it is necessary. Sure, support is needed to buy magazines and books, as Chudnovsky and Vilenkin agree, but we also need living, working scientists to read them! Aid in the form of individual grants seems to me quite reasonable. It will be useful not only to the physicists of Russia, Ukraine and so on, but also to American physics, since the grants will lead to specific results and publications.

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3/93

The main idea of the letter by Eugene Chudnovsky and Alex Vilenkin is to

condemn the entire scientific community of the former USSR for being apolitical and for not fighting the criminal Communist regime in the times of Stalin and Brezhnev. Moreover, Chudnovsky and Vilenkin even declare the young scientists of the former USSR to be spoiled forever by the influence of the privileged members of the USSR Academy of Sciences. It is an old idea—to condemn not individual people but an entire class or ethnic group.

If continued logically, this idea would mean that all ex-Soviet people who lived under the Communist regime and who did not actively oppose it have to be condemned—why only scientists? According to the same idea the scientific communities of Germany and Japan should have been condemned and isolated after World War II, because the resistance against the Nazi regime was even weaker than the resistance against Stalin's regime, and internal resistance against the militarist regime in Japan is unknown. The common people who lived under totalitarian regimes and who committed no crimes have already been severely punished by the very life under those regimes.

Chudnovsky and Vilenkin describe the USSR scientists as members of a privileged class who lived much better than other Soviet people. This is absolutely false. They make the common mistake of confusing two different notions of the USSR Academy of Sciences:

▷ The Academy of Sciences as a "closed club." The total number of full members, who really had definite privileges, was 290 in 1985. Being under severe pressure from the Communist government, the academy had, since the early 1930s, elected to its ranks many people who were pleasing to the regime. In the last several decades many directors of the giant institutes of space and military technology, known as "science generals," became members of the academy. (Many of them really had the military rank of general.) The academy's divisions of general physics and astronomy and of nuclear physics were less touched by these changes. Among their members were outstanding physicists: Lev D. Landau, Peter L. Kapitsa, Andrei D. Sakharov, Vladimir A. Fock, Igor E. Tamm, Evgenii M. Lifshitz, Ilya M. Lifshitz, Yakov B. Zeldovich, Isaak Ya. Pomeranchuk, Arkady B. Migdal and others. However, only the president and vice presidents of the academy had cars with personal drivers. Landau, who had no car of his own, had to order a car from the academy garage

before being driven anywhere.

▷ The Academy of Sciences as an organization of more than 100 scientific institutes with about 50 000 employees. It is true that the salaries of all scientists increased drastically, multiplying several times over, in 1945 (obviously because of the accelerated R&D work on weapons), but for decades after, the salaries remained almost fixed. When one takes into account the increases in the wages of the more numerous workers and peasants, the true salaries of academy scientists declined since the 1960s. In particular, the salaries of junior scientists, even those who had PhDs, were lower than the average salary in the country. In the 1980s the salaries of even very well-known scientists were lower than the salaries of many "blue collar" workers. In recent years the salaries of scientists have become among the lowest in the country, and in 1991 even some full members of the Academy of Sciences received less than a truck driver. At present the scientists receive slightly more money than pensioners, but being younger, they have children to feed.

Russian scientists belonging to the Academy of Sciences were never greatly motivated by the Communist government. They were, and still are, motivated simply by the delight in discovery. Now, since Russia is no longer a threat to the world, Russian scientists have become a part of the international scientific community. All of them who are able to make a valuable contribution to science have to be helped. (Indeed all scientists, not only Russians, have to be helped who, by the conclusion of experts, are able to make such a contribution.) This is not the usual charity of helping the poverty-stricken. It is support for talent, hard work and results that are useful to the scientific community everywhere. I have confidence in the scientists whom an American foundation has entrusted to distribute money to the Russian scientists. They are capable of organizing a system that will support the most capable scientists and prevent the distribution of money to the elite "science generals."

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2/93

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CHUDNOVSKY AND VILENKIN REPLY: Our letter was written in response to an article by Roald Z. Sagdeev (May 1992, page 22), where he argues that "Soviet scientists prepared and launched the fight against totalitarianism that finally succeeded in re-

cent years" and that financial help to them would therefore "represent political support for nascent democracy." The main point of our letter was that such a portrayal of Soviet scientists is totally false. In the pre-Gorbachev years they were a privileged and politically passive group. Courageous individuals who stood up for their principles were rare exceptions and found little following in the scientific community.

Alexander I. Akhiezer and Shulim Kogan say nothing that would contradict this assessment, and the examples they provide only illustrate our point. On the subject of privileges, we should hardly feel sorry for academicians who "had to order a car" with a driver from the Academy of Sciences garage, could get rice from the director of the canteen when there was none available from the academy distributor, or had a salary of 850 rubles per month (close to former Soviet leader Leonid Brezhnev's official salary¹ of 900). We might add that most of the 50 000 rank-and-file scientists working in academy institutes enjoyed, in addition to prestige and higher-than-average salaries (before the late 1980s), a rather relaxed life style with no teaching responsibilities and few other duties.

On the issue of responsibility, it is important to realize that the stability of the Soviet regime was in large measure based on the passive support of the population. In many ways this is similar to the situation of the Nazi regime in Germany, and in both cases scientists contributed their share of support. In addition, the aggressive posture of the Soviet regime was enormously strengthened by the weapons developed with the help of scientists (Soviet patriots, as Akhiezer points out). It is therefore hard to deny the responsibility of the scientists for the past and present state of the country. Incidentally, the portrayal of Andrei Sakharov as someone "who was proud that his efforts promoted the creation of thermonuclear weapons for his country" is absolutely incorrect. On the contrary, Sakharov's transformation into a political dissident actually began when he realized that the power he had helped to release had gone into the wrong hands.²

Responsibility should not be interpreted as "condemnation" (as in the letter by Kogan). A typical Soviet scientist was not a villain; he simply kept his mouth shut, to avoid risking his job, promotion or a foreign trip. But there is a long way from this behavior to a "fight against totalitari-

anism." We believe that recognition of the past would be a healthy step in the development of interaction between FSU and Western scientists.

On the issue of financial aid, we agree (as we did in our letter) that Western physicists should help their colleagues at this time of crisis. In fact, the debate over whether or not the aid should be given is at present largely academic, because a massive amount of aid is now being distributed by the APS and the Soros fund. [See PHYSICS TODAY, January 1993, page 63, and October 1993, page 113.] Both Akhiezer and Kogan insist that this aid should be viewed as a profitable investment rather than as charity. The truth, however, is that although there are many world-class physicists in the FSU, world physics is now in the midst of an overproduction crisis. In particular, many talented young physicists in the US cannot find jobs and are forced to leave physics. The massive aid from the West is not likely to continue for very long, and given the economic realities, it is obvious that the present armies of physicists in Russia and Ukraine cannot be sustained by the budgets of those countries. The next few years could be used to restructure the scientific establishment there so that it becomes much smaller and, hopefully, more democratic. Most of the physicists would then have to move to education or industry. At this time, however, many top administrative positions are held by the same "old guard" (especially in Ukraine), and physicists continue to be produced on a massive scale.

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8/93

Biographer Seeks Tales of Bohm's Effect

I am researching and writing a biography of the late physicist David Bohm and would appreciate hearing from any colleagues or friends who could provide information or anecdotes about the incidents of Bohm's life.

I would also be interested to learn

of those whose work has been influenced by Bohm's research or teachings or who may have specific comments on Bohm's work.

I can be reached on Internet at ad454@freenet.carleton.ca or at 90 Fentiman Avenue, Ottawa, Ontario, K1S 0T8, Canada.

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