stalled this kind of source in their accelerator at Wisconsin.[6]

To make their spin filter the McKibben group adds an rf field at a frequency corresponding to the energy difference between 2S atoms with $M_J = +1/2$ and $-1/2$. An equilibrium mixture of these states in which all atoms have a particular nuclear-spin state remains in the emerging beam. Other metastables fall into the ground state. By varying the longitudinal magnetic field, they can unambiguously select the nuclear spin that remains in the beam.

In the race for the best beam, proponents of the Lamb-shift devices show some confidence that they will outdo the conventional scheme. On the other hand, their optimism is tempered by realization that the conventional system is improving too. Whichever wins, experimenters will have their probe for observing spin dependence.

Meanwhile Donnally is at work on an entertaining by-product. A polarized-electron source may be available by letting collisions detach electrons from the polarized metastables.[7]

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A Visit to the Semiconductor Institute in Leningrad

One of the leading Soviet centers for solid-state physics is the Semiconductor Institute in Leningrad, which has 170 scientists and 800 employees. When we visited the Institute shortly after attending the ninth International Conference on the Physics of Semiconductors, we talked with institute director A. R. Regel, one of the conference vice-chairmen. He told us of research and development activities and explained how the scientific soviet helps run the institute.

A. R. REGEL is director of the Semiconductor Institute in Leningrad.

Research. V. N. Bogomolov, D. N. Mirlin and I. I. Reshina reported at the conference that they had observed polaron absorption in rutile crystals. Although many-body theory predicts the existence of polarons, experiment had not conclusively identified them.

The Leningrad experimenters shine an infrared beam on the sample and observe the optical absorption as a function of frequency. Even though they varied number and types of donors by changing the doping (using lithium, phosphorus, chromium or niobium), the absorption spectra kept the same broad shape with a maximum at about 0.8 eV; so the group concludes that the spectra are due to the interaction of light with the current carriers.

According to polaron theory, if you apply light of the appropriate frequency, electrons are no longer free, but must interact with a lattice phonon at the lattice vibration frequency; hence absorption increases. One can think of a polaron as an electron with virtual phonons surrounding it. Bogomolov and his collaborators find their experiment agrees well with the theory of small-radius polarons (rather than that for large-radius polarons).

At the conference G. E. Pikus and A. G. Aronov discussed a theory of interband anisotropic electroöptical effects and of the Faraday effect in crossed electric and magnetic fields,

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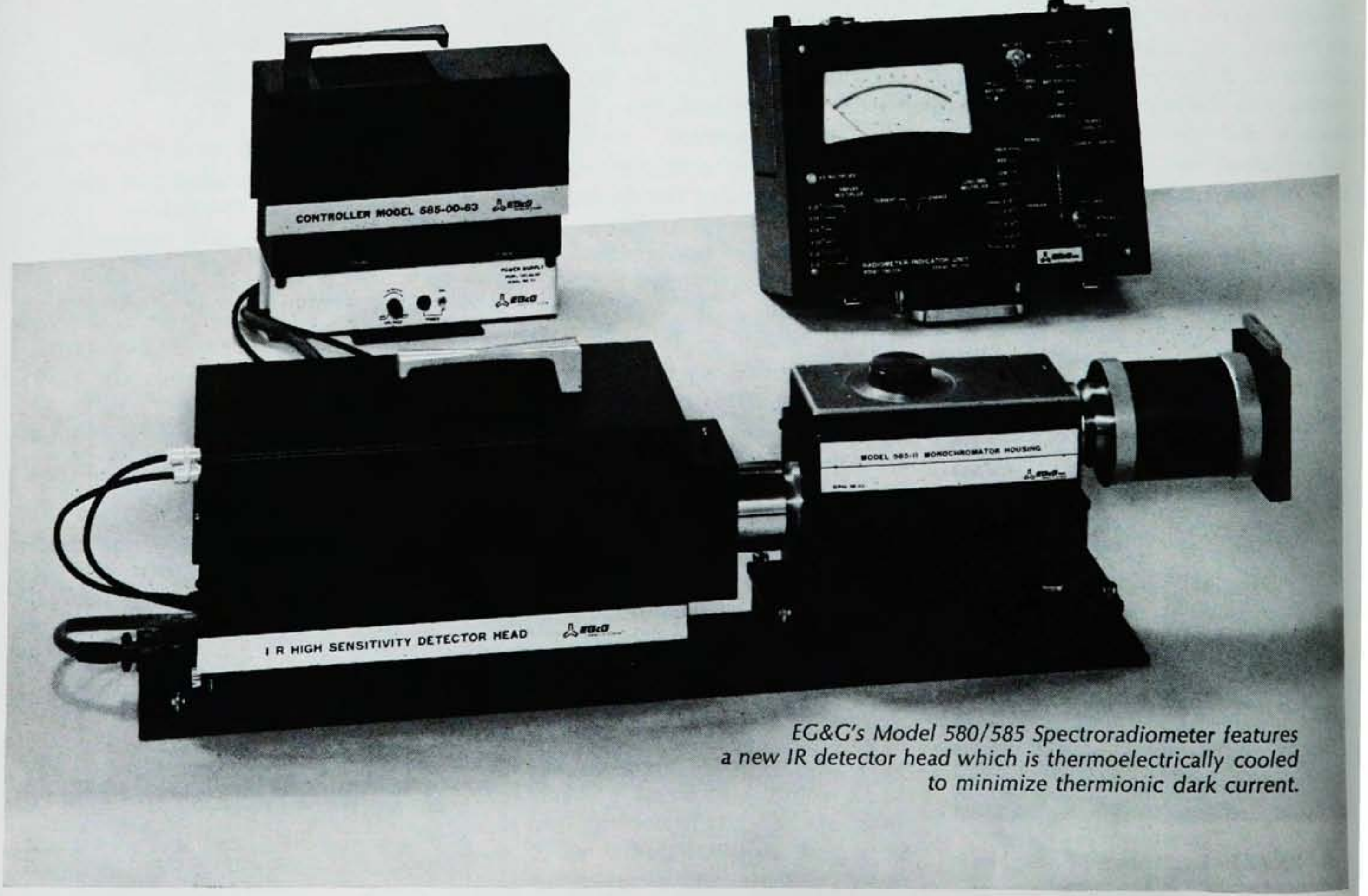

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when electric fields are very intense.

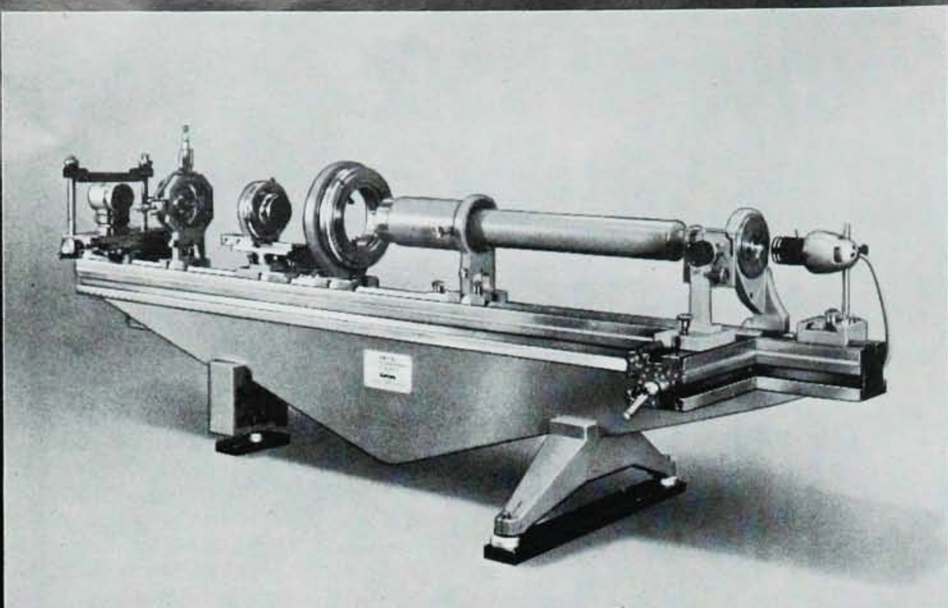
V. P. Zhuze and his collaborators are making semiconducting solid solutions of rare earths mixed with tellurium, selenium or sulfur.

Using low-energy neutrons from the Ioffe Institute reactor, M. M. Buedov, B. A. Kotov and N. M. Okuneva are studying thermal lattice vibrations. They have obtained a distribution of thermal vibrations for many simple materials such as silicon, germanium, sulfur, selenium, tellurium and lead.

Applications. G. B. Dubrovsky and his collaborators have built attractive alphanumeric display devices from diodes made of silicon carbide. Soviet physicists trying to build experimental display systems from semiconductors have emphasized silicon carbide, unlike Western workers, who put most of their money on gallium phosphide, gallium arsenide, and their alloys. Silicon carbide may have advantages: It has many crystalline forms, a wide variety of energy gaps ranging from 2.2 to 3.1 eV (higher than those of gallium arsenide and gallium phosphide), and is capable of operating at higher temperatures. However, growing large, pure crystals is very difficult. But the crystals displayed at the institute, which came from a central crystal plant in Moscow, were larger than a centimeter across. The experimenters said that some silicon-carbide diodes converted electrical energy to light with an impressive efficiency—better than 1%. By introducing appropriate impurities the experimenters produce diodes that emit yellow, red or green.

The technical-applications laboratory develops apparatus for medicine and industry. We saw an apparatus for local diathermy of the brain; temperature can be varied continuously. Surgeons use the equipment at −8° C. One device looked like a hat and is used to cool the entire brain. Other equipment included a cataract extractor, which freezes the cataract at −8° C, and a cryostat with a temperature range of −60°C to 60°C.

Soviets in action. Regel explained that the institute is divided into 20 laboratories. He and the laboratory directors form the scientific soviet of the institute, which allocates money for each laboratory. The USSR Academy of Sciences supplies 1.5 million rubles a year, which is 75–80% of the institute budget. Another 20–25% comes



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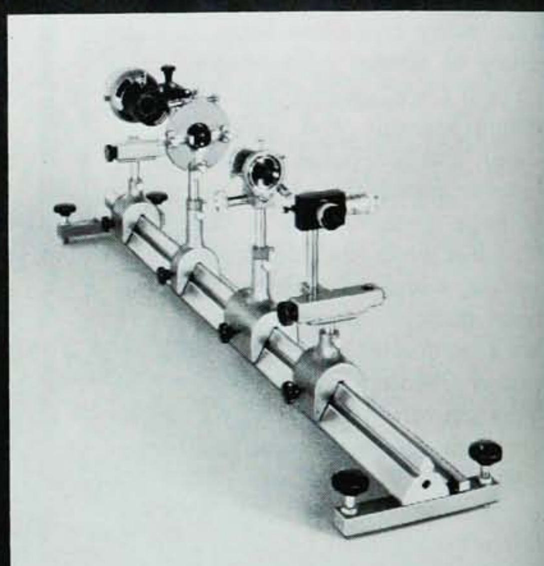

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to the institute from Soviet industry.

The institute soviet decides how 80% of the academy money should be spent, and Regel uses the remainder to fund new projects and give further support to existing ones (usually in consultation with the soviet). Technically Regel has the final say on time and money allocations, with the soviet acting as his adviser. Regel says they usually agree.

The industry income is shared by the institute and the industry-oriented laboratory; typically 1/3–1/2 of it goes to the institute. Besides paying for the institute's services, industry supplies materials and equipment. Although the institute manufactures some items, such as thermoelectric refrigerators, generators and photoelements, most of the time the institute's product is ideas; then the institute and industry collaborate on development. Regel pointed out that at larger institutes money can be allocated by individual laboratory directors, and there may be several scientific soviets.

At the Lebedev Institute in Moscow, which has 1000 scientists (PHYSICS TODAY, November, page 57), Nikolai G. Basov told us that they have five scientific soviets, each of which has about 18 members. Income from the Academy of Sciences is assigned to individual laboratories; each soviet decides how much money will go to a specific project in a laboratory. To increase a laboratory budget, the institute must apply to the academy itself.

The Semiconductor Institute was the last to be founded by A. F. Ioffe, for whom the Physicotechnical Institute in Leningrad is named (PHYSICS TODAY, December, page 51), and he was its first director, from 1954 until his death in 1960.

The institute occupies three ancient buildings, scattered over Leningrad. We visited the main building, home of the French embassy before the revolution, and found the view more impressive than the interior, which was never intended to house scientific apparatus. Regel hopes, however, that the institute will be in a new building by 1970.

We had heard that Soviet physicists are more open in criticizing the work of others than is customary in the US, for example, and Regel agreed that this is so. He feels that such criticism is essential for high-quality research. —GBL □