of a well-collimated beam (by a factor roughly equal to the amplification factor). The situation turns out to be less favorable when amplifying a diverging beam owing to the loading of the receiver by the spontaneous radiation of the OQA.

3. Receiver with a Microantenna. A. Javan has shown that infrared radiation can be detected with the aid of a microantenna and a metal oxide-metal point contact. Such a receiver turns out to be the direct analog of the UHF detector. The merits of the receiver are the exceptionally high speed of response (of the order of 10^{-13} sec) and the fact that there is no need for cooling. The volt-ampere characteristics of the contact were computed in a joint paper by G. D. Lobov and some American co-workers. The threshold power was found by A. A. Drugova using a numerical method. In the heterodyne regime, it is 10^{-14} W/Hz, in agreement with R. Abrams's experimental results. The disadvantages of the receiver with the microantenna are the extreme instability of the contact and the small value of the sensitive area (of the order of a wavelength). These circumstances have so far allowed the application of the receiver with the microantenna in only unique physical experiments.

4. Noncontact Converter of Modulated Optical Signals into UHF Signals (''UHF Shift''). The idea of the method of ''UHF shift'' was proposed and realized by us in 1957. It consists in measuring the additional microwave-power absorption during the interaction in the semiconductor between the wave and the nonequilibrium carriers induced by radiation of the optical band or by some other method. The semiconductor is in this case considered as a dielectric with losses which can be modulated by an optical radiation. Several types of UHF devices were used in P. V. Zarubin and F. I. Bakun's investigations and in a large number of American investigations. For the widest-band reception, a circuit with a serrated waveguide is preferable. In the presence of low-noise amplifiers a UHF circuit (of the cooled parametric type) can realize a response time of 5×10^{-11} sec.

The experience of the use of the UHF-shift method has shown that its advantages over the usual direct-current circuit manifest themselves only for very wide frequency bands (of the order of 1 GHz).

The possibility of using materials of arbitrarily high resistivity (e.g., germanium with impurities at liquid-helium temperatures) should also be acknowledged as some merit. An obvious disadvantage is connected with the complexity of the apparatus and the unwieldiness of the construction. Nevertheless, the use of the modern techniques of microcavity lines and Gunn diodes as UHF sources eases this disadvantage.

S. M. Ryvkin. Solid-State Nuclear-Radiation Counters. Semiconductors, which have made a big contribution to the development of a number of important fields of technology, are for the past decade being successfully introduced into the field of experimental nuclear physics, where they function as high-performance precision counter-spectrometers for nuclear particles and photons.

In solid-state ionization chambers based on semiconductors of the n-i-p structures, it is possible to realize the main advantages of the solid body: high efficiency (connected with the high matter density), a relatively large charge that can be released during ionization (at the expense of the small energy of formation of the electron-hole pair), and a very high energy resolution, determined only by the unavoidable fluctuations of the ionization process (owing to the practically complete collection of the charge produced by the ionizing particle, i.e., the exclusion of the structure-sensitive recombination processes).

In the report we analyze in detail, on the basis of the investigation of the principal mechanisms underlying the action of semiconductor detectors (SCD), specific semiconductor problems of the realization of solid-state ionization chambers with a high resolving power. The causes of the insufficient resolving power of dielectric and semiconductor ''homogeneous'' crystal counters are explained.

Analysis shows that in order to eliminate the effects of polarization of the counter and charge losses connected with capture and recombination of the current carriers, it is necessary to use a material of very high degree of purity (not greater than 10^{11}—10^{12} impurity centers in 1 cm^3) and homogeneity. Thus, the level of requirements which materials for SCD must satisfy is considerably higher than that obtaining for the other applications of semiconductors.

In the Soviet Union we have extracted from our own raw materials, material (germanium and silicon) of the requisite quality, and we have organized the mass production of some of the most important SCD models, including large-capacity SCD based on lithium-doped germanium, and germanium SCD which are stable at room temperature (i.e., do not require to be kept at a liquid-nitrogen temperature), and which are prepared by the ''cold-doping'' method (the creation of the operating band of the counter on account of the compensation of the material by radiation defects).

In Figs. 1 and 2 we present examples of spectra obtained with the aid of these detectors. These spectra demonstrate the high resolving power of the detectors.

The use of the SCD already allows us to solve important scientific and technological problems including the problem of the synthesis of a number of transuranic elements, the investigation of the structure of nuclei by the methods of Coulomb excitation of the nuclei, the study on board satellites of the earth's radiation belts and of the solar wind, neutron activation analysis of ores, the use of SCD to construct crystalless x-ray spectrometers, etc.

The subsequent development of this new class of solid-state instruments should, besides the improvement

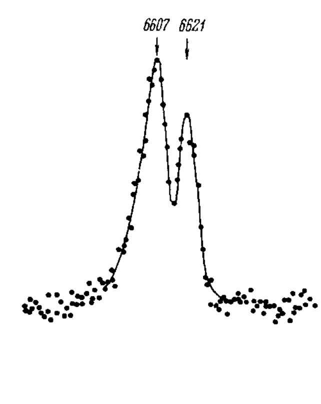

FIG. 1. The spectrum of the γ-radiation of the 7.640-MeV level of the isotope Fe^{57}, taken with the aid of a coaxial germanium-lithium detector of volume 25 cm^3 (the ''double runaway'' peaks were detected).

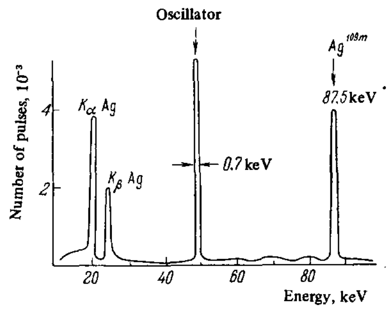

FIG. 2. The x-ray emission spectrum of silver, taken with the aid of a germanium radiation-type detector (the radioisotope source Cd^{109} was used).

of the mass-produced SCD, envisage the following:

a) The development of a Soviet technology for the extraction of ultrapure germanium with minute donor concentrations $\sim 10^{10}$ cm^{-3}, which will allow the construction on the basis of the "cold-doping" method of germanium SCD that will be stable at room temperature and have volumes not less than those of the germanium-lithium detectors.

b) The use of new materials (e.g., cadmium telluride), which should allow the construction of efficient spectrometers that would not require cooling and would consequently be suitable for still many "mass" areas of technological utilization.

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