I express my gratitude to L. É. Gurevich for his constant attention to the work and also to V. N. Gribov, S. V. Maleev, and L. P. Pitaevskiĭ for useful discussions.

[1] B. A. Lippmann and J. Schwinger, Phys. Rev. **79**, 469 (1950).

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CERTAIN EXPERIMENTS WITH METASTABLE LIQUIDS IN AN X-RAY BEAM

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To establish the sensitivity of metastable liquids to low-energy electrons and the extent of this sensitivity, and also to carry out test experiments on the photography in a beam of penetrating radiation with the aid of metastable liquids, we placed a 0.75-liter propane bubble chamber in the beam of the URS-70 x-ray structural-analysis apparatus. To reduce the absorption of soft x-rays, an inlet hole 5 mm in diameter was made in the wall of the bubble chamber and was covered with a bakelite layer 3 mm thick. Owing to the pulsations in the tube electrode voltage and to the short sensitivity time of the chamber (on the order of several milliseconds), several pictures were taken for each set of conditions, from which we selected the cases of maximum intensity of action and associated them with the maximum value of the current and voltage in the tube. We observed that bubbles were produced at 10 kev and above (see Figs. 1 and 2), but the sharp change in the penetrating ability and the spectrum of the x-ray beam at low tube voltages does not allow us to draw more definite quantitative conclusions concerning the electron threshold energy necessary to initiate bubbling.

We attempted to photograph an object in an x-ray beam penetrating to the side glass of the chamber. The use of an illuminated layer of metastable (superheated or gassed) liquid as a converter and registrator for the image of objects in the transmitted beam of penetrating radiation (x-rays, γ rays, or neutrons) is of interest because of the extremely high

FIG. 1. Formation of bubbles by x-ray beams at x-ray-tube voltage 10 kv and a current of 10 ma. The input window of the chamber was 30 cm from the anticathode of the tube.

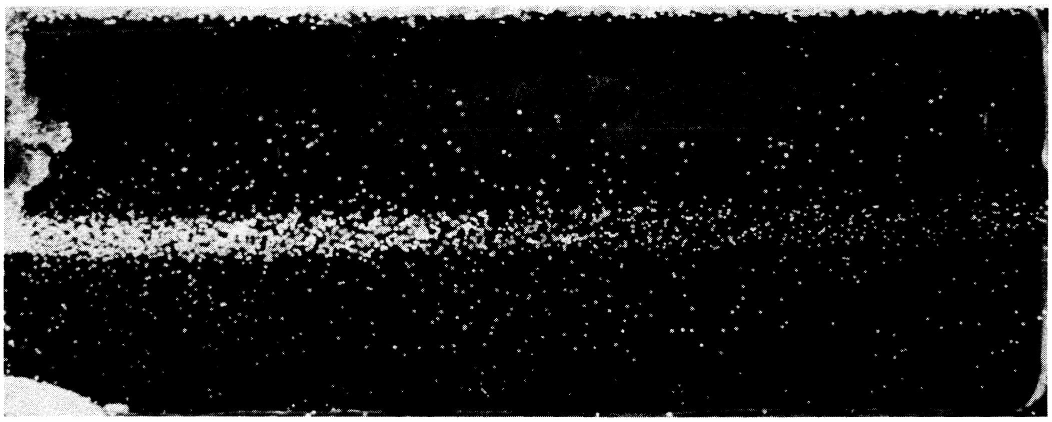

FIG. 2. The same at 30 kv and 1 ma, in the presence of a 9 cm paraffin n absorber in front of the entrance window of the chamber.

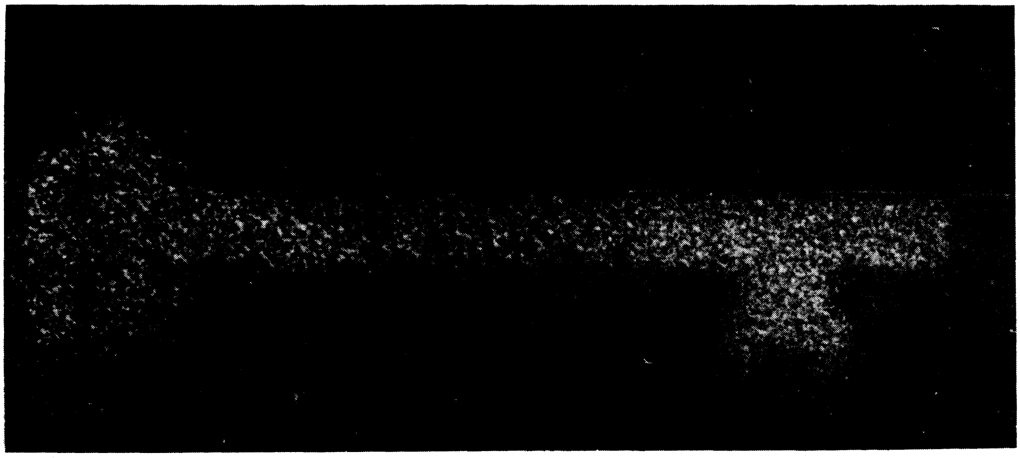

FIG. 3. Image of a key placed 20 cm in front of the chamber, with the chamber exposed through the glass window. The tube operated at 50 kv and 10 ma. The actual exposure was less than the sensitivity time of the chamber (on the order of a millisecond).

sensitivity of such systems to penetrating radiations. Actually, the production of ionizing particles in a liquid under the influence of a penetrating beam has a high probability because of the large density of the liquid, where the ionizing particles form bubbling centers which generate visible bubbles measuring from 1 micron to a fraction of a millimeter, depending on their growth time prior to the illumination flash. The intense scattering of light by such bubbles, the density of which depends on the local intensity of the penetrating beam passing through the object, produces an image of the object in reflected or transmitted light.

By varying the intensity of bubbling of the liquid and the time of illumination, it is possible to vary the sharpness of the image over a wide range. Image distortion due to the ionizing-particle track lengths can be made negligibly small at quantum energies up to several hundreds kev and neutron energies up to several Mev, owing to the smallness of the transverse projections of the paths of the secondary electrons and the recoil protons.

The use of a high-speed cyclic bubble chamber (see, for example, reference 1) makes possible either high-speed intermittent or continuous visual examination of objects. (When the cycle frequency exceeds 10 cps, the eye perceives a continuous image).

We have obtained the first test photographs of a key (see Fig. 3), using the same bubble chamber at 50 kv and 10 ma (the actual exposure time is less than the sensitivity time of the chamber, which is on the order of several milliseconds).

In spite of the very inconvenient conditions (great thickness of the chamber and of the glass, poor geometry, and large distance to the object because the key was placed outside the case in which the chamber and the illuminating lamps were installed), even the first photographs yielded relatively satisfactory image contrast. It is interesting to note that both negative and positive shadow images can be obtained, depending on the placement of the illuminating lamps and the degree of intensity of the scattering.

In conclusion, we consider it our pleasant duty to thank Yu. I. Skanavi and A. I. Demeshina for graciously permitting us to use the x-ray apparatus, and also thank K. V. Filippova, V. N. Mikhalenko, and A. F. Nalgranyan for useful advice.

[1] Kuznetsov, Lomanov, Blinov, and Huan, JETP **31**, 911 (1956), Soviet Phys. JETP **4**, 773 (1957).

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CAPTURE OF POLARIZED μ^- MESONS BY DEUTERONS

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THE capture of polarized μ^- mesons in deuterium has been investigated theoretically by Überall and Wolfenstein.[1] However, it is assumed in their work that the polarized μ^- meson is captured by an unpolarized nucleus. Actually, because of the long lifetime of the μ^- meson in the K shell, the nucleus is also polarized in this case;[2] the calculations for the capture in hydrogen with account of this circumstance were given in reference 3.

For μ-mesodeuterium, it is necessary to con-