In conclusion, I would like to thank A. D. Galanin for discussions of the results of this work.

* This cross section is evaluated (see Ref. 1) by a formula analogous to Eq. (1), where the cross section $d\sigma_f$ for the photoproduction of the free particles by two quanta is calculated, together with the first radiative corrections, by Brown and Feynman[5].

** The following summation rule has been used:

$$(ab) = a_0b_0 - a_1b_1 - a_2b_2 - a_3b_3.$$

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A Bubble Chamber for the Study of Cosmic Rays

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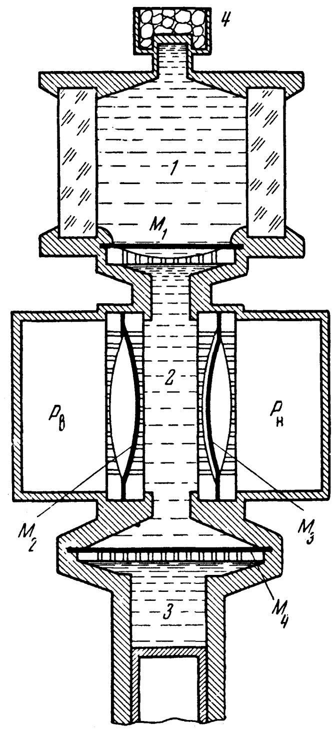
UP until now bubble chambers have not been used for the study of cosmic rays. The reason for this lies in the lack of control of such chambers, since the life–time of the embryonic bubbles formed by ionizing particles in going through the chamber is significantly less than the time in which decompression occurs. However, as will be seen in this work, bubble chambers can be used to study cosmic rays. This can be accomplished by increasing the efficiency of the chamber, that is, by increasing the fraction of the time in which the chamber is sensitive. The efficiency is determined by the sensitive time in each cycle as well as by the length of each cycle. By shortening the cycling time and taking certain other precautions, we have increased the efficiency of the chamber so that it has become practical to work with cosmic rays.



A schematic plan of the set–up is given in the Figure. It consists of the chamber *1*, a limiter *2*, and compressor *3*. The chamber *1* has a cylindrical form and is filled with freon–13 ($CClF_3$). The volume of the chamber is 1 liter. The viewing windows are discs of organic glass mounted without gaskets. The membrane M_1 is constructed out of rubber made from domestic synthetic nayrite.

The compressor *3* is made like the air-compressor type KVD and produces a periodic compression and decompression of the chamber at a rate of 10 cycles/sec. The horespower used in such a compression process is not large since the energy expended by the rotor during the compression part of the cycle is returned upon decompression. In this way, the method described is advantageously different from one using a gas. The cylinder of the compressor is filled with oil. The pressure exerted on it by the plunger is transmitted to water occupying the central volume of the limiter and through it to the working fluid in the chamber *1*.

The limiter *2* determines the limits in which the pressure in the chamber can vary. It gives the pressure curve the shape of a square wave. The upper limit is determined by the pressure p_u of the gas in the left part of the limiter; the lower limit is determined by the pressure p_1 in the right part. P_u is 1.5–2 times higher than the vapor pressure of the working liquid; P_1 is of the order of 10 atms. less than the vapor pressure of the liquid. When the plunger is in the lower part of the cylinder, as indicated in the drawing, the membrane M_2 is pressed against the right screen, the membrane M_3 is found in some middle position and the pressure in a system is equal to P_1. When, however, the plunger is in the upper position, the membrane M_3 is pressed to the right screen and the membrane M_2 is in a neutral position. The pressure in the system now is equal to P_u. The relation between the time of compression and the time of decompression can be changed by changing the amount of working liquid in the chamber or the amount of water in the limiter. The pressure curve taken using a condenser manometer has been observed on an oscillograph.

Bubbles which do not collapse during the compression, rise to the trap 4 which is cooled with dry ice; there they collapse.

The adjustment of the chamber was made using a cobalt 60 γ-ray source and cosmic rays. Figure 2 shows one of the first photographs taken of such tracks with the flash initiated by a counter telescope.

The chamber, in the basement of a two-story building, registers on the average 5 cosmic ray particles each minute. A rough efficiency calculation gives the value 0.1.

A more detailed description of the construction of the apparatus will be published later.

We are grateful to Academician A. I. Alikhanov for support of the idea of a high efficiency bubble chamber and to A. G. Meshkovskii for interest in the work. Likewise we thank Iu. V. Bardiukov who carried out most of the technical work and who contributed many valuable improvements to the construction of the chamber.

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Some Properties of Rotating He II

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As is well known, it has been established experimentally that for oscillatory motion of a stack of discs in He II[1] only the normal component is entrained, while for rapid uniform rotation of a vessel containing He II[2] the liquid rotates as a whole. The results of these experiments have been explained in papers by Landau and Lifshitz[3] and by Feynman[4], according to which the condition of thermodynamic equilibrium for a rotating vessel filled with He II corresponds to entrainment, not only of the normal component, but of the superfluid as well; in addition, He II must have a moment of inertia which varies with the velocity of rotation from a value corresponding to entrainment of the normal component alone to a value corresponding to rotation of the liquid as a whole[5]. However, as follows from the papers cited above[4], entrainment of the superfluid component must occur at velocities smaller than those encountered in the experiments with stacks of discs, and the fact that this effect has not been observed might be explainable on the basis of an appreciable relaxation time. It would therefore be most desirable to verify experimentally the dependence of the moment of inertia of rotating He II upon the angular velocity, and to attempt to determine the relaxation time.

To resolve this question, the rotational damping of a vessel filled with He II was investigated under conditions approximating as closely as possible continuous equilibrium between the normal and superfluid components. Since the relaxation time was unknown, it was necessary for the rotating system to suffer as little damping as possible. To insure this, the method of suspending a plexiglass beaker of He II in a magnetic field was used, permitting the beaker to rotate for several hours after receiving an initial angular velocity of a few revolutions per second. The beaker (R = 1.5 cm) contained approximately 300 light aluminum discs separated by distances smaller than the penetra-