kev, in agreement with our earlier interpretation. It appears, however, that the line width is too large to allow a significant differentiation between these two cases; it has been pointed out already[2,4] that this line width arises principally from variations about the average number of ion pairs produced by the β-rays in the initial ionization process, and it is unlikely that the uncertainty will be resolved by relatively slight increases in the accuracy of measurement.

We should like to take this opportunity of thanking Professor P. I. Dee for his advice throughout the work and we are indebted to Dr. W. B. Lewis for a number of helpful comments and suggestions.

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[2] Curran, Angus, and Cockroft, Phil. Mag. **40**, 36 (1949).
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On Positive Excess of Meson Component near Sea Level

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THE scarcity of experimental data concerning the distribution of positive excess in the meson spectrum and the common opinion that the positive excess is closely related to the meson production by the N component, lead us to perform an experiment at sea level, in which positive and negative mesons are separated by means of a magnetic field of 14,000 gauss in air. The experimental apparatus is shown in Fig. 1.

The upper telescope consists of five channels of double coincidences $1-1$, $2-2\cdots 5-5$, which limits a not strictly convergent beam of cosmic rays traversing the central region of magnetic field. The field focuses particles of $pc=2\ 2\cdot 10^8$ ev which are revealed by counters CDE; $C'D'E'$.

Putting in S 4.7 cm of lead, fivefold coincidences register only mesons, the fourfold, besides mesons, protons and electrons. The absorber T has the object of degradating the energies of incident particles. Experimental results and their probable errors are reported in Table I.

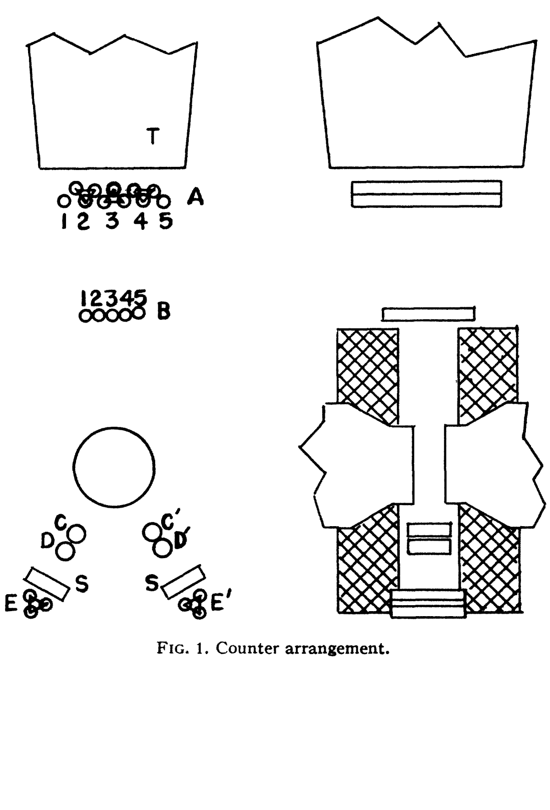

FIG. 1. Counter arrangement.

TABLE I. Experimental results for coincidence rates.

Absorber thickness (g/cm² Pb)	Counts per hour	δ	[IV–V]⁻	[IV–V]⁺
290 g/cm²	1.18 ±0.06	0.16 ±0.10	0.13 ±0.03	0.04 ±0.02
540 g/cm²	1.36 ±0.06	0.22 ±0.12	0.10 ±0.06	0.02 ±0.04
1150 g/cm²	1.14 ±0.05	0.25 ±0.07	0.20 ±0.04	0.04 ±0.05

In the second column counts per hour are shown, they agree with the Wilson spectrum. In the third column, the excess as commonly defined by

$$\delta=2\frac{N_+-N_-}{N_++N_-}$$

is indicated.

The first two plots are in a good agreement with the previous data by Nereson[1] and Conversi, Pancini, and Piccioni;[2] the value of the excess in the third plot, on the contrary, is remarkably high, and indicates that, at least for energies up to 2 Bev, the excess does not decrease. This is in agreement with a recent isolated result by Brode[3] who finds an excess about 0.3 for energies from 1.4 to 2 Bev. The fourth column indicates the number of negative particles per meson whose energies are about 2.2×10^8 ev and which do not penetrate 4.7 cm of lead. They should in the first line be interpreted as knock-on electrons. The fifth column is concerned with positive particles that we may explain as protons, but the last data are less significant because of large errors.

The present results may be explained in terms of multiple meson production with the existence of two sources distributed in the atmosphere, of which the first formed by mesons created in the first collision by primary protons is substantially responsible for the excess A detailed paper will be submitted for publication in *Nuovo Cimento*.

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Heat Flow in Metals below 1°K and a New Method for Magnetic Cooling

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MEASUREMENTS have been made of the thermal conductivities of tin and tantalum both in the superconducting and normal states in the temperature range 0.2° to 1°K and experiments have been carried out on the question of thermal contact by heat flow through superconductors in this temperature range. The preliminary results of these experiments may be of interest in connection with two stage magnetic cooling methods, such as have been proposed for the study of nuclear paramagnetism[1] and consequently are reported herewith. In addition the experiments have led to a convenient method for adiabatic magnetic cooling.

The general experimental arrangements consisted of two chromium potassium alum ellipsoids (one approximately five times the volume of the other) separated from one another by a distance of about 10 cm and connected thermally by the superconducting metal specimen under investigation. The salt-metal connection was made by high pressure molding of the salt powder. The salt ellipsoids were differentially cooled to low temperatures by the magnetic method,[2] and the thermal conductivity of the metal link between them calculated from observations of the rate

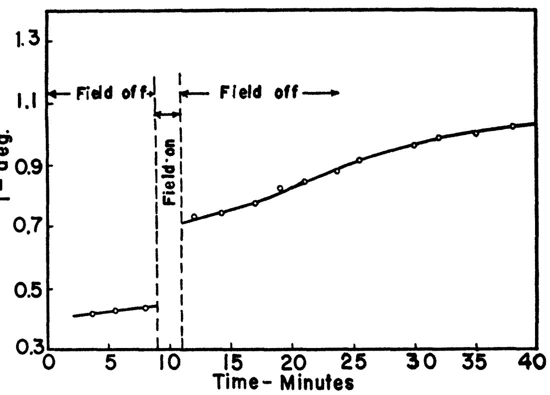

FIG. 1. Sample warm-up curve for a 3 cc chromium potassium alum ellipsoid.

of warm-up of the ellipsoids. Temperatures were calculated from ballistic mutual inductance measurements of the susceptibilities of the ellipsoids as described in previous publications.[2]

The thermal conductivity of both Sn and Ta was found to be considerably smaller in the superconducting state than in the normal state; for example for Ta the ratio of these conductivities, K_s/K_n, was found to be somewhat less than 1/60 at 0.55°K, and for Sn, $K_s/K_n \simeq 1/40$ at 0.65°K. It appeared that below 1°K the thermal conductivity of two different samples of Sn of the same purity could be expressed by $K_s = cT^3$ with $c = 1.1 \times 10^{-2}$ watt-unit. The results both for Sn and Ta were approximately such as would be expected if $K_s/K_n = (T/T_c)^2$, a relationship that can be deduced if at these low temperatures the thermal resistance is largely due to impurity scattering. Our measured values of K_s/K_n below 0.6°K were higher than those given theoretically by Heisenberg.[3]

By extrapolation our results to lower temperatures (<0.1°K) it would appear the ratio K_s/K_n would become very small, e.g., for Sn at 0.01°K, $K_s/K_n \simeq 7 \times 10^{-6}$, effectively describing the superconducting state as a thermal insulator.[4] Heat contact could therefore be made or broken, as process necessary for example for a two stage magnetic cooling system,[1] by having a metallic link either in the normal or superconducting state, a change that can easily be affected by the application of small external magnetic fields.

In experiments with magnetic cooling systems, it has been found sufficient to connect thermally the paramagnetic salt with the helium bath by a fine wire of superconducting material having a high transition temperature and dispense with the usual exchange gas. During magnetization at 1°K the wire is in the normal state and effectively conducts to the bath the heat of magnetization. On demagnetization the metallic link between the paramagnetic salt and the helium bath becomes superconductive and forms a satisfactory insulating support. Such a technique not only has the advantage of dispensing with exchange gas and its attendant equipment, but also the long periods of magnetization, which are generally required in order to pump out exchange gas, are considerably reduced. As an example of the effectiveness of this procedure we give in Fig. 1 a warm-up curve for a 3 cc chromium potassium alum ellipsoid thermally connected to a helium bath at 1.13°K through 56 cm of 0.017-cm diameter tantalum wire. From minute 0 to minute 9, the wire was in the superconducting state and the heat influx to the ellipsoid was approximately 7.3 ergs/sec. From minute 9 to minute 11 the Ta wire was transformed into the normal state by the application of a transverse field of 600 gauss. As a result the temperature of the ellipsoid rose immediately to 0.71°K, corresponding to a heat gain of 1.5×10^4 ergs. At minute 11 the wire being again in the superconducting state the heat influx to the ellipsoid fell back again to 6.7 ergs/sec.

The new technique outlined here would become still more effective if heat barriers composed of additional salt systems were employed[5] and experiments are now being carried out on this extension of the technique.

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Ion Source for Mass Spectrography

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It is known that the cathode material of a canal-ray tube sputters during the discharge. In this case neutral molecules or negative ions only can leave the cathode because positive ions are strongly linked to the cathode by the electric field. Those few neutral molecules only, which are ionized by accident on the axis of the discharge tube, especially near the anode, may leave the tube in form of canal-rays, if they are not scattered by gas molecules. Though the number of these particles may be very small and therefore the intensity low, this process has been successfully tried in many investigations in mass spectrography.

We have improved this method very materially:

(1) There are two electric fields: First the electric field in the canal-ray tube (*A*), (see Fig. 1) which is completely separated from the electric field immediately in front of the trial-substance (*C*). The first one produces the beam (*B*) of canal-rays, which causes the sputtering. The second one has the right direction to remove and accelerate the positive ions of the trial-substance for analysis in a mass spectrograph. It is produced by the cylinders (*D*) and (*E*), which are at different voltages.

(2) The sputtering takes place in a high vacuum, because the gas-filled canal-ray tube (*A*) is separated by the narrow canal (*K*) (which has a large gas-current resistance) from the space in front of the substance. This space is connected with a pump of high pumping speed. Hereby, losses by scattering on gas molecules can be avoided almost completely.

(3) All ions will be produced on an electric equipotential-surface and will be accelerated by the same voltage. Therefore the ions get a uniform energy. Hence of producing a mass spectrogram a magnetic field alone is sufficient, which is a great advantage. But it is an advantage too for mass spectrographs with energy-focusing,

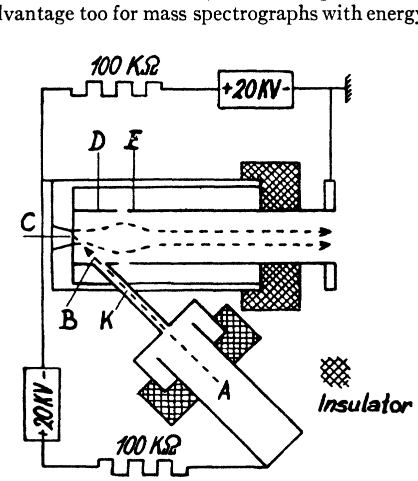

FIG. 1. Schematic diagram of suggested ion sources.