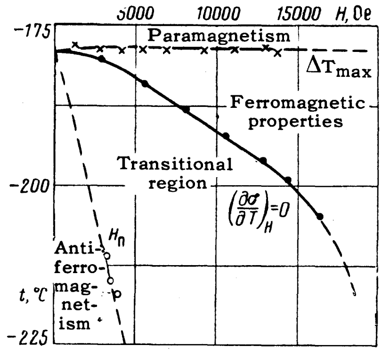

FIG. 2

The magnitude of the threshold field changes with change of temperature and, for example, is equal to 4000 oe at 56° K. Above 94° K, the alloy studied is paramagnetic and obeys the Curie-Weiss law at all values of the external magnetic field.

Figure 1 shows magnetization curves taken at temperatures below, near, and above the magnetic transformation point. Figure 2 gives, by way of graphic representation, an approximate diagram of the magnetic states of the alloy as they depend on the temperature and on the intensity of the external magnetic field. T_{max} corresponds to the temperature at which, in the given magnetic field, the magnetocaloric effect reaches a maximum.

It should be mentioned that the alloy we studied is similar in its magnetic properties to the intermetallic compound $MnAu_2$. It would be very valuable to study the magnetic structure of this alloy by neutron diffraction and to compare it with the magnetic structure of $MnAu_2$, which consists of a complicated spiral distribution of magnetic moments.[6]

The authors are very grateful to V. N. Novogrudskii and É. A. Zavadskii for their share in the discussion of the results of the measurements, and also to L. V. Smirnov, who prepared the alloy.

[1] L. Néel, J. phys. radium **3**, 160 (1932).

[2] S. Valentiner and G. Becker, Z. Physik **80**, 735 (1933).

[3] Otter, Flanders, and Klokholm, Phys. Rev. **99**, 599 (1955).

[4] H. P. Myers, Can. J. Phys. **34**, 527 (1956).

[5] Owen, Browne, Arp, and Kip, J. Phys. Chem. Solids **2**, 85 (1957).

[6] E. Scheil and E. Wachtel, Z. Metallk. **48**, 571 (1957).

[7] A. J. P. Meyer and P. Taglang, J. phys. radium **17**, 457 (1956).

[8] L. Néel, Compt. rend. **242**, 1549 (1956).

[9] Herpin, Mériel, and Villain, Compt. rend. **249**, 1334 (1959).

Translated by W. F. Brown, Jr.
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A SEARCH FOR NEAR-THRESHOLD ANOMALIES IN THE ENERGY DEPENDENCE OF THE TOTAL CROSS SECTION FOR INTERACTION OF PROTONS

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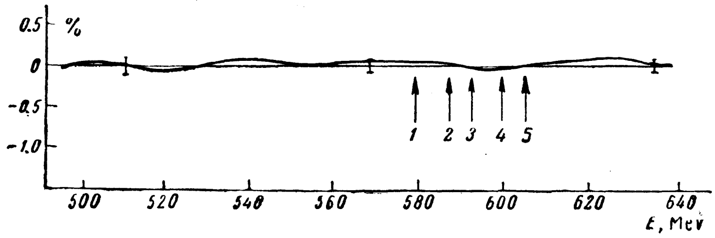
As has been shown by Wigner and by Baz',[1] the energy dependence of the cross section for the elastic scattering of two particles can have an anomalous character near the threshold for the production of a new particle. The shape of such an anomaly is a narrow "peak" or "step"; the anomaly is associated with a sharp change of the derivative of the cross section at threshold point. Near-threshold anomalies can also occur in the energy dependence of the total cross section for the interaction of two particles (for more details see the review article by Fonda[2]).

We have made a search for these anomalies in the neighborhood of the thresholds for the production of π-meson pairs in proton collisions (580 — 600 Mev). Studies of the energy dependence of the total cross section σ for the interaction of protons were also made in regions above and below the thresholds. Observations of anomalies in such cases could be an indication of the existence of new particles[3] and could make it possible to determine their masses.

A differential ionization chamber was used for the registration of the protons. This made it possible to achieve an accuracy in determining the relative shape of the energy dependence of the cross section which is an order of magnitude better than the accuracy characteristic of earlier experiments,[4] in which particle counters were used to measure σ.

The proton beam brought out from the chamber of the six-meter synchrocyclotron of the Joint In-



Dependence of the quantity $[\sigma(E)-\overline{\sigma}(E)]/\overline{\sigma}(E)$ on the proton energy E. The thresholds of the reactions $pp \to pp\pi^0\pi^0$(1), $pp \to d\pi^0\pi^+$(2), $pp \to pn\pi^0\pi^+$(3), $pp \to pp\pi^+\pi^-$(4), and $pp \to nn\pi^+\pi^+$(5) are indicated by arrows.

stitute for Nuclear Research was shaped by a system of collimators, and then was sent through three identical thin-walled ionization chambers. The first chamber served as a monitor. The second and third chambers, with the polyethylene target placed between them, formed the differential ionization chamber. The current i_2 from this differential chamber was proportional to the amount of weakening of the beam in passing through the target, i.e., to the product of the total cross section and the beam intensity J. The current i_2 was amplified and recorded on the chart of a recording potentiometer.

As the thickness of the filter by which the proton beam was slowed down was smoothly increased, a curve was traced on the chart of the potentiometer; this curve shows the variation of the quantity $i_2 \sim \sigma J$ as the proton energy E is decreased. Simultaneously another potentiometer registered the change of the current $i_1 \sim J$ from the monitoring chamber. The desired quantity $\sigma(E)$ was obtained by dividing i_2 by i_1. This operation was performed by a continuously acting electronic device, whose output, proportional to i_2/i_1, was recorded on the chart of a third potentiometer. The measurements were repeated many times to eliminate the effects of small fluctuations in the current from the differential chamber.

The energy of the beam was determined to an accuracy better than 1 Mev (cf. reference 5). The energy resolution was ±5 Mev and was due to the dispersion of the beam (±3 Mev)[5] and energy losses in the target (±4 Mev).

The results of the measurements are shown in the diagram. It shows the fractional deviation of the measured cross section $\sigma(E)$ from the smoothed energy dependence $\overline{\sigma}(E)$ found by averaging over a broad range of energies; in the region in question this smoothed dependence is linear.[4] As can be seen from the diagram, in the entire range studied, 490 — 640 Mev, there are no anomalies in the energy dependence of the total cross section for pp interaction that exceed the errors of measurement (0.1 percent).

It follows from this that there is little probability that a bound state "π meson + nucleon" with binding energy close to zero exists.

At the same time control experiments were made with a graphite target. The energy dependence of the total cross section for carbon should not contain any appreciable anomalies, owing to the motions of the nucleons in the carbon nucleus. In agreement with this, the measurements showed that for carbon the deviation of $\sigma(E)$ from $\overline{\sigma}(E)$ does not exceed 0.05 percent.

In conclusion we take the occasion to thank A. I. Baz', L. I. Lapidus, and B. Pontecorvo for a discussion of this work.

[1] E. Wigner, Phys. Rev. **73**, 1002 (1948). A. I. Baz', JETP **33**, 923 (1957), Soviet Phys. JETP **6**, 709 (1958).

[2] L. Fonda, Inelastic Collisions and Threshold Effects, Preprint, 1960.

[3] Zinov, Konin, Korenchenko, and Pontecorvo, JETP **36**, 1948 (1959), Soviet Phys. JETP **9**, 1386 (1959). V. I. Gol'danskii and Ya. A. Smorodinskii, JETP **36**, 1950 (1959), Soviet Phys. JETP **9**, 1387 (1959).

[4] Dzhelepov, Moskalev, and Medved', Doklady Akad. Nauk SSSR **104**, 380 (1955). Chen, Leavitt, and Shapiro, Phys. Rev. **103**, 211 (1956).

[5] I. M. Vasilevskii and Yu. D. Prokoshkin, Атомная энергия (Atomic Energy) **7**, 225 (1959).

Translated by W. H. Furry
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EFFECT OF TEMPERATURE ON HYPERFINE STRUCTURE OF GAMMA RADIATION

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In investigating the resonance absorption of γ quanta with energy 23.8 kev by Sn^{119} nuclei, it was found[1] that in a white tin crystal (β-Sn) at liquid