We excluded the possibility that the observed activity was due to Hf,[2] which could be a serious contaminant from the point of view of lifetime and chemical similarity, by measuring the Cd ratio for 19-sec. Hf. It was found to be 3.1.

We should like to thank Mr. E. Der Mateosian for help in some of these measurements.

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[1] L. Seren, H. N. Friedlander, and S. H. Turkel, Phys. Rev. 72, 888 (1947).
[2] A. Flammersfeld, Naturwiss. 32, 68 (1944).

On the Absorption of Nucleonic Component in Cosmic Rays

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IN a previous letter[1] it was observed that the nuclear stars may be considered as "local indicators" of the nucleonic component. In this letter, from the comparison of the absorption of the star-producing radiation in air and Pb it was suggested that the related cross section was

$$\sigma \simeq k \cdot A^{\frac{2}{3}} \cdot 10^{-26} \text{ cm}^2, \quad (1)$$

where A is the atomic weight and $k \simeq 3$.

We can add now that the results of similar experiments performed in Al appear to validate the cross section, Eq. (1). Further new data obtained following the scanning of plates in Pb and in balloons have increased the precision of our previous measurements. The data are summarized in Table I.

The cross section in air was evaluated from the number of stars observed at the Laboratorio della T.G. (3500 m) and the number of those observed in plates which have been flown in balloons. The evaluation of σ in air was made assuming an exponential absorption and then averaging on the range of pressures during the flights. We find an absorbtion thickness $L_a = 135 \pm 4$ and following

$$\sigma_{\text{air}} = 0.177 \cdot 10^{-24} \text{ cm}^2.$$

From such a value and from the data collected in Table I we can argue that the general absorption law of the nucleonic component is indicated by Eq. (1). This conclusion may be stressed observing the numbers listed in Table II. We have given in the first column the experimental values of σ and in the second the values σ' obtained from Eq. (1) putting $k = 2.95$.* The excellent agreement between the data in the first and second columns is certainly a happy case, but we believe that Bernardini *et al.*[1] express roughly the effective cross section for nucleons of high energy ($T \gtrsim Mc^2$) with nucleus. It appears to be proportional to the geometrical cross section, *but smaller* by a factor of 2 or 3.

Table I. Summary of data on star production.

Thickness of absorber in g/cm²		0	13.5	23.4	61	104	152
stars / (cm³ day)	Al	15.3 ±0.8	12.8 ±0.7		10.7 ±1.0	8.4 ±0.7	
	Pb			18.0 ±0.8		13.1 ±1.0	9.7 ±1.0

Table II. Values of σ and σ'. L is the absorption thickness.

	$\sigma \cdot 10^{24} = \frac{A}{N} \cdot \frac{1}{L} \cdot 10^{24}$	$\sigma' \cdot 10^{24} = 2.95 \cdot A^{\frac{2}{3}} \cdot 10^{-2}$
Pb	1.07	1.05
Al	0.27	0.26
Air	0.18	0.18

Considering the stars as "indicators" of nucleonic component, another, perhaps interesting, result appears from our plates. Lattes, Occhialini, and Powell[2] deduced a relation between the total number of mesons which are stopped by the emulsion and the number of mesonic tracks which have a projection longer than a definite length t. We have employed such a relation to compare the number, N_s, of stars at different altitude with the number, N_m, of slow mesons. For this purpose we have considered the stars having at least three prongs. Besides we have also taken into account the results of Lattes, Occhialini, and Powell[2] at Pic du Midi. We find that the ratio N_m/N_s increases strongly at high altitude (near 20 km high). In the plates which were flown to 22 km the value of such ratio is about 7 ± 1 times larger than the corresponding values at 2800 m (Pic du Midi) and at 3500 m (Laboratorio T. G.).**

The observed mesons were generally "ρ" mesons, i.e., they do not give rise to stars. That is understandable if we consider that they were effectively "μ" mesons whose mean-life is much longer than the mean-life of "π" mesons. However, taking into account the low density of air at high altitude, we argue that the greater part of the mesons observed in such balloon plates arose from a "local generation." (In the balloon ship, near the plates, there are the storage batteries, etc.) On the contrary, in the low atmosphere the number of slow mesons appears to increase with the altitude more slowly than the nucleonic component,[3] and G. Morpurgo[4] demonstrated that from sea level to 4000 m high most of such slow mesons are the residue of μ-mesons coming from the upper layer of the atmosphere. Hence we deduce that in the meson generation the number of mesons increases strongly when their energy decreases. Considering that at 22 km high the atmospheric depth is about $\frac{1}{3}L_a$, our results appear to give support to the "multiple" generation hypothesis.

On 22 tracks of mesons and protons of rather long length (at least 600 microns) we have made a grain count. We find several tracks demonstrating an intermediate mass between 200 and 2000, but similar tracks were found in the plates which remained at sea level and at the Laboratorio T. G., and we believe that they are probably "old" protons. Our opinion is perhaps supported by the fact that such "heavy" tracks appear to end in the emulsion without giving rise to any nuclear process.

We wish to express our warm thanks and appreciation to Professor Marcel Schein of the University of Chicago

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[1] G. Bernardini, G. Cortini, and A. Manfredini, Phys. Rev. 74, 845 (1948).
* Corrected from the stars generated at sea level.
[2] C. M. G. Lattes, G. P. S. Occhialini, and C. F. Powell, Nature 160, 486 (1947).
** For further details see G. Cortini, A. Manfredini, and A. Persano, Nuovo Cimento, in press.
[3] Bruno Rossi, Rev. Mod. Phys. 20, 537 (1948).
[4] G. Morpurgo, Nuovo Cimento 5, 285 (1948).

Evidence for a Complex Disintegration of I^{131} *

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The negatron spectrum of I^{131}, obtained from Oak Ridge as a chemically separated decay product of Te^{131}, has been studied. This study was initiated because of a discrepancy reported by Miskel[1] between two methods of determining the absolute disintegration rate of I^{131}.

The present investigation was conducted with a semicircular uniform field magnetic spectrometer having a radius of curvature of 5.7 cm. The dimensions of the vacuum chamber, however, are quite large with relation to the usual chamber size for an instrument having this radius of curvature such that it is believed that scattering within the instrument is small. The interior of the vacuum chamber is constructed of Aquadag coated Lucite.

The G-M counter utilized a thin window which passed electrons above 3 kev, this window being made of composite films of Formvar and Zapon. These films, after being placed over the exit slit, were dried under a lamp. Windows prepared in this manner appear to be more satisfactory than those prepared only of Formvar or Zapon.

Three sources were used in this investigation; a thin source of 0.18 mg/cm² mounted upon a 0.25-mil Al backing, a second source of 0.32 mg/cm² mounted upon a 0.06 mg/cm² Zapon backing, and a fairly thick source of 0.79 mg/cm² mounted upon a 0.25-mil Al backing. The thickness of the 0.32-mg/cm² source was determined by weighing and that of the others was in turn determined by comparison of relative intensities. The results are derived from a combination of the data from the two thinner sources. The thickest source, with its correspondingly higher counting rate, was used to confirm the existence of the low intensity peaks.

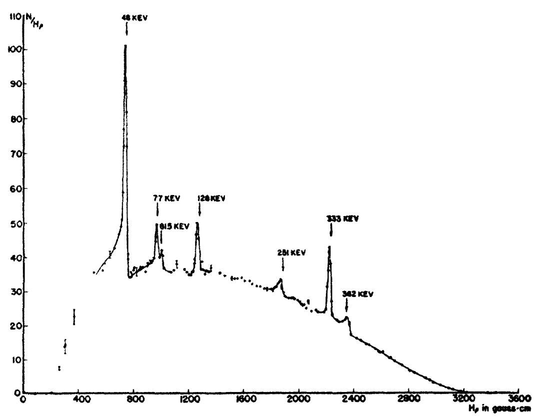

FIG. 1. Momentum distribution of the negatrons from I^{131}. Energies shown are those of the internal conversion lines. Sample statistical errors are indicated for selected points within the several regions of the spectrum. Other points within the same region have approximately the same statistical error.

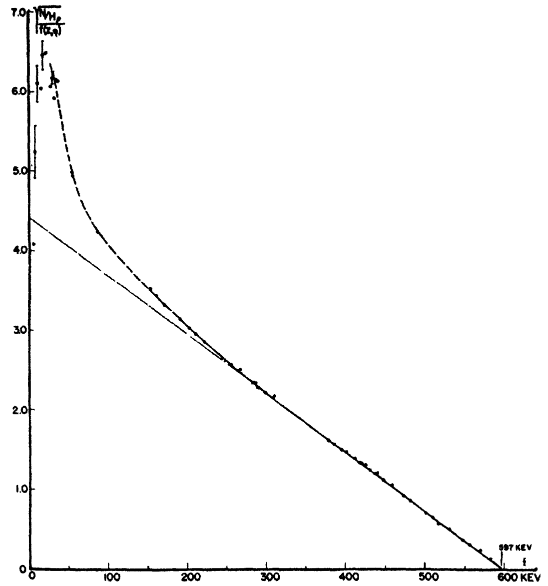

FIG. 2. Kurie plot of the negatron spectrum of I^{131}. $f(Z,\eta)$ is here the Fermi relativistic function rather than the Kurie non-relativistic approximation. The internal conversion line regions are not plotted.

Figure 1 shows the negatron momentum spectrum of I^{131}. In addition to the internal conversion lines at 48 kev and 334 kev reported by Downing, Deutsch, and Roberts,[2] several weaker lines have been found in the current investigation. One of these, at 251 kev, was found by the M.I.T. group in their internal conversion, beta-coincidence data.

If one assumes a gamma-ray whose energy is 83 ± 2 kev then the lines at 48, 77, and 81.5 kev correspond, respectively, to this gamma's K, L, and M conversion lines. Likewise the lines at 333 and 362 kev correspond to the K and L lines for a gamma whose energy is 368 ± 7 kev. Assuming that the other conversion lines are produced in the K shell of Xe, energies can be ascribed to the associated gamma-rays of 163 ± 3 kev and 286 ± 6 kev. Consistent fluctuations within 85–120-kev and 260–320-kev regions suggest the possibility of more low intensity conversion peaks, but with the present arrangements these are too weak to be accurately determined.

The Kurie plot is shown in Fig. 2. Here the true Fermi relativistic Coulomb function is used rather than the more commonly used Kurie non-relativistic approximation. Extrapolation of the higher energy data gives a maximum beta-energy of 597 ± 5 kev. The internal conversion peaks have been omitted from the plot.