the parity of B^{10} is even and that the low multiplets of Li^7 are odd, as in the simple models. Then the states of the compound nucleus are even, almost all the outgoing alphas have one unit of angular momentum, and Li^7 states as low as $I=3/2$ can be reached if $I_r=5/2$, or as low as $5/2$ if $I_r=7/2$. The strong preference for the transition to the excited state seems thus to exclude the possibility (a) that the excited state is ${}^2P_{1/2}$, and to favor the possibility (b) that the excited state is an unresolved ${}^2F_{7/2,5/2}$ and that the compound state which is most influential at thermal energy has $I_r=7/2$ (Fig. 1).

Thus the simple theory[3] of spin-orbit coupling in light nuclei seems to remain significant in determining the nuclear spins, but the multiplet splittings to which it presumably gives rise are apparently too small to have been resolved by observation of energy groups in nuclear reactions.

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Metastable State of Sc^{46}

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AFTER bombarding Sc, in the form of the oxide, with slow neutrons, an intense activity of 20-sec. half-life period was observed. The decay curve (Fig. 1) was obtained by putting the sample inside an air ionization

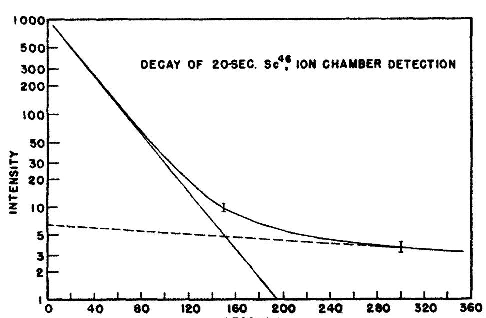

FIG. 1. Decay curve. The error in reading the ion current is negligible in the initial part of the decay curve. The activity remaining after the 20-sec. period had decayed was not investigated further.

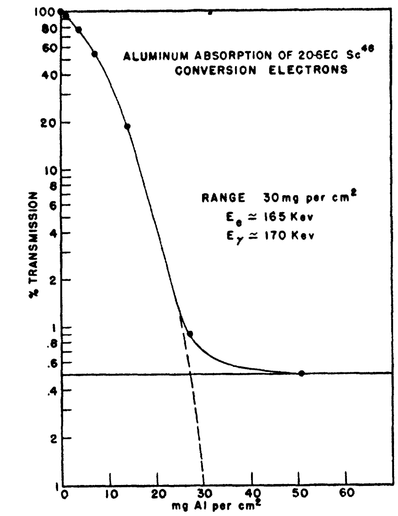

FIG. 2 Absorption of electron component.

chamber. An Al absorption curve (Fig. 2) indicates internal conversion electrons with a range of $\sim$30 mg/cm^2 corresponding to an energy of 165 kev. The small background left indicates that there is little if any β-branching to Ti^{46}. The energy of the metastable state was also obtained by taking a Pb absorption curve of the unconverted γ-rays with a Geiger-Mueller counter (Fig. 3).

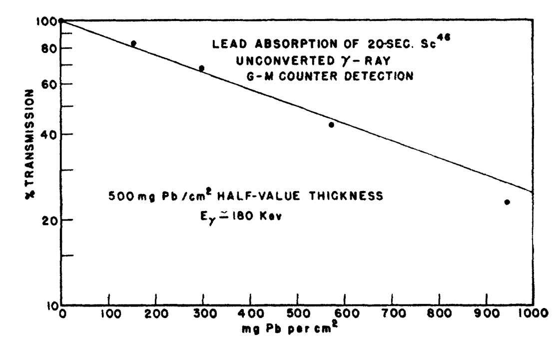

FIG. 3. Absorption of photon component.

From the half-value thickness, 0.50 g/cm^2, we obtain a value of 180 kev for the γ-ray energy. The ratio of internal conversion electrons to γ-rays was found to be of the order 1. This is compatible with a "2^4-pole" isomeric transition.

An approximate absorption cross section of about 10×10^{-24} cm^2 was found for "pile neutrons." A significant fraction of the 85-day ground state, which has a slow neutron capture cross section[1] of 22×10^{-24} cm^2, must therefore be formed indirectly through the metastable state. For the neutrons used, a "$1/v$ absorber" (e.g., Al) shows a Cd ratio of about 39. For the 20-sec. and 85-day Sc activity we find Cd ratios which are approximately equal: 53 and 59, respectively. This indicates that a negative energy neutron level is responsible for the strong absorption of thermal neutrons in Sc.

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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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

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

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.

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