The values of Ti group: Ti 6.81, Hf 7.3, Th 5.7 volts.

The values of Cr group: Cr 6.71, W 7.6, U 5.7 volts. Moreover in the Al group the values are: Al 5.95, Sc 6.7, Y 6.5, La 5.5, Ac 5.5 volts, into which the values 5.7 of Th and of U fit in.

The ionization potential is doubtless connected with the electrochemical character of the element. The electropositive character increases from above downwards in the main group and decreases in the by-groups. This can be observed at the change in the standard potential, but also roughly at the change of the reaction ability, e.g. in the behavior against acids.

The elements of the by-groups belonging to the sixth period are already noble metals. Thus Th and U which according to their standard potential $\sim+2.0$ and $+1.4$ volts, dissolve readily in diluted acids, cannot be inserted after Zr and Hf or Mo and W respectively. The chemical character of Np and Pu, ensuing from the approximately determined standard potential[1] excludes the possibility of their being considered as higher homologues of such noble metals as Re and Os.

The simpler compounds of Th and of U show many common features with the elements of the III group, especially with the rare earths. UO_2 and ThO_2 have a fluorite structure just like CeO_2 and PrO_2, while MoO_2 and WO_2 have the rutile type. The close similarity of the Ce^{++++} and Th^{++++} compounds has already been stressed by chemists. Th can be precipitated as hydroxide with Al or with La. ThF_4 and UF_4 are insoluble in water like the fluorides of rare earths, while the fluorides of the IV group dissolve in water, in hydrogen fluoride and alkaline fluoride. UF_6 is just as water soluble as the fluoride of Np and Pu in their higher oxidation state. CrO_2Cl_2 is a typical acid chloride, while UO_2Cl_2 has a strongly marked salt character.

Of all elements Cr, Mo, and W are the most inclined to form complexes or iso- and heteropolyacids. U does not show this inclination any more than other acids. It rather forms double salts. A very interesting analogy of uralytricarbonato complexes was also found at Sc.

Consequently it seems right to insert Th and U—of course with Pa as well as the transuranic elements—into a group starting with Ac. *The group should be started with actinium, because the physical and chemical properties of the elements fit into the character of the third column.* One might oppose that these elements have also higher valencies than 3. But this has already occured previously in the cases of C and Pr, not mentioned the cases of Cu and Au belonging to a by-group.

According to this grouping of these elements the arrangement of the electrons can be assumed in the following manner: the *6d* level possesses only 1 electron at Ac, the next electron of Th, however, is bound in *5f* orbit, which further will be filled at Pa by 2, at U by 3 electrons. Thus the higher homologues of La, Ce, Pr and Nd are Ac, Th, Pa and U just as Il and Sm are the foregoing elements of Np and Pu.

Through this arrangement the lines indicating the homologous relations in Bohr's periodic table obtain a more regular figure.

According to our grouping the variation of Goldschmidt's[5] ionic potentials between the corresponding homologues yields far better values than if the actinides would be in their original place, as the ionic potential do not vary between the fourth and sixth groups.

Investigating finally the arrangement of the new group from the geochemical point of view, it can be established that there is no regularity postulating the connection of Cr, Mo, W and U. On the other hand Th and U often occur together with the lanthanides. The frequency of the members of the actinium series follows quite appropriately the change of frequency of the corresponding rare earths.

La	Ce	Pr	Nd	Ac	Th	Pa	U
18.3	46.1	5.53	23.9	3×10^{-3}	11.5	8×10^{-6}	4 g/ton

The author is grateful to Professor A. Koch for discussion concerning the geochemical relations.

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Branching Ratio in Be^7 Decay

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IT was shown by Rumbaugh, Roberts, and Hafstad[1] that Be^7 decays to Li^7 by orbital electron capture, with most of the decays being due to transitions directly to the ground state of Li^7, but with a small fraction going to the 475 kev level of Li^7 and then to the ground state by emission of a gamma-ray. If we define as the branching ratio the fraction of decays that are accompanied by a gamma-ray and let it be represented by R, then the work of Rumbaugh, Roberts, and Hafstad showed that $0.03<R<0.3$. They pointed out, as have others more recently, that inasmuch as the various forms of β-decay theory predict differing values for R, a more accurate experimental determination is desirable.

A measurement of R is being made by the following method, which is capable of somewhat better accuracy than that obtained by Rumbaugh, Roberts, and Hafstad. The proton beam from the Van de Graaff electrostatic generator is used to produce samples of Be^7 and C^{11} by means of the $Li^7(p,n)Be^7$ and $B^{11}(p,n)C^{11}$ reactions. The Li^7 and B^{11} targets are surrounded during bombardment by a manganese bath which absorbs the neutrons emitted. The activity induced in the bath by the neutrons is directly proportional to the number of active atoms produced, and hence we have the relation,

$$N_{Be^7}/N_{C^{11}}=A_{Be^7}/A_{C^{11}}, \tag{1}$$

where N_{Be^7} and $N_{C^{11}}$ are respectively the numbers of Be^7 and C^{11} atoms produced in runs with lithium and boron targets while A_{Be^7} and $A_{C^{11}}$ are the neutron induced activities in the manganese bath for these runs.

If the Be^7 and C^{11} samples are geometrically identical and are counted in identical geometry with respect to a Geiger counter with sufficient absorber between the samples and counter to convert all the positrons from C^{11} decay to annihilation quanta, we can write,

$$C_{Be^7}=N_{Be^7}\cdot\lambda_{Be^7}\cdot E\cdot R \tag{2}$$

and

$$C_{C^{11}}=N_{C^{11}}\cdot\lambda_{C^{11}}\cdot E\cdot 2 \tag{3}$$

where C_{Be^7} and $C_{C^{11}}$ are the observed counting rates for Be^7 and C^{11}, respectively, N_{Be^7} and $N_{C^{11}}$ are the respective numbers of Be^7 and C^{11} atoms, λ_{Be^7} and $\lambda_{C^{11}}$ the respective disintegration constants, E is the efficiency of the Geiger counter for the gamma-rays being counted and the geometry used, and R is the branching ratio. The factor 2 appears in Eq. (3) because each positron gives two annihilation quanta. It is assumed that E is the same for annihilation quanta and Be^7 decay quanta, since the difference in energy is small. Taking the ratio of (2) to (3),

$$\frac{C_{Be^7}}{C_{C^{11}}}=\frac{N_{Be^7}}{N_{C^{11}}}\frac{\lambda_{Be^7}}{\lambda_{C^{11}}}\frac{R}{2}. \tag{4}$$

Solving for R and substituting from (1),

$$R=\frac{C_{Be^7}}{C_{C^{11}}}\cdot\frac{\lambda_{C^{11}}}{\lambda_{Be^7}}\cdot\frac{A_{C^{11}}}{A_{Be^7}}\cdot 2. \tag{5}$$

Hence R is given in terms of other ratios and does not involve an absolute calibration of the manganese bath or an absolute determination of the counter efficiency.

Results to date, while still of a preliminary nature, indicate that $0.10<R<0.13$. Final results will be reported in more detail at a later date.

This paper is based on work performed under the auspices of the AEC.

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Exchange Phenomena of the Nucleons That Generate Penetrating Showers

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RECENTLY G. Cocconi performed measurements on the absorption of ionizing PSPR* (which are believed to be protons) in Pb, Fe, C, and air.[1] He finds that this absorption is not exponential in the condensed absorbers and that the mean range of ionizing PSPR in the atmosphere increases with the lead thickness above the penetrating shower detector. These results are not compatible with an exponential absorption of the PSPR which was verified by Tinlot and Gregory[2] in Pb and Fe and by Wataghin[3] and Tinlot[4] in the atmosphere.

The fundamental difference between the experimental arrangement of Cocconi and those of the other authors, is that a proton of the PSPR appears as absorbed in any material situated in position Σ (Fig. 1 of Cocconi's paper[1]), not only when it generates a penetrating shower, but also when it emerges from Σ in the form of a neutron.

Let us discuss Cocconi's results by taking into account the phenomenon described above. We shall make the following hypothesis: (1) The absorption of nucleons through production of penetrating showers is exponential in all materials and is independent of their charge as well as of the altitude of the point of observation. (2) The probability of a transformation of a proton into a neutron is equal to that of the reverse process. (3) At Echo Lake (708 g/cm^{-2}) the number of protons is already equal to the number of neutrons in the PSPR. Indeed, if this were not so, Cocconi should have found a mean range for the ionizing PSPR in the atmosphere (without any absorber above the detector) smaller than the mean range of the total PSPR determined by Wataghin and Tinlot. Thus varying the absorber thickness at position Σ' in Cocconi's experiments[1] and the absorber thickness in the arrangement of Tinlot and Gregory,[2] it is only necessary to consider the exponential absorption due to the production of penetrating showers.

Following this interpretation one deduces easily from Cocconi's measurements the values of the mean range λ for the production of penetrating showers in different absorbers:

$$\lambda_{Pb}=345\pm37 \text{ g/cm}^{-2},$$
$$\lambda_{Fe}=240\pm27 \text{ g/cm}^{-2},$$
$$\lambda_{C}=100\pm12 \text{ g/cm}^{-2},$$
$$\lambda_{Air}=113\pm7 \text{ g/cm}^{-2},$$

in good agreement with the values given by other workers.[2-4] A short calculation yields for the mean range μ for charge exchange the values

$$\mu_{Pb}=247\pm61 \text{ g/cm}^{-2},$$
$$\mu_{Fe}=300\pm121 \text{ g/cm}^{-2},$$

at Echo Lake (708 g/cm^{-2}). For μ_C we obtain a larger value than the preceding ones, but the statistical errors are too important to allow a precise determination. However this result is not surprising since charge exchange and shower production are competititive processes. It is then reasonable to expect that μ should increase if λ decreases. At Ithaca (1007 g/cm^{-2}) μ is found to be several times larger, but a precise determination is impossible.

We see that the exchange properties of the PSPR explain Cocconi's results consistently with the results of other authors. On the other hand we wish to point out that the energy loss of the protons by ionization has been neglected, and this might not be very accurate in the case of the rather low energy events recorded by Cocconi[1] and by Tinlot and Gregory.[2] However, we think that this factor could at most alter somewhat the numerical values of the mean ranges.[5]

* We use the abbreviation PSPR for Penetrating Shower Producing Radiation.

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The Nuclear Spin and Quadrupole Moment of I^{129}

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THE nuclear spin and quadrupole moment of I^{129} have been determined from measurements on the $J=2\rightarrow3$ rotational transition of CH_3I^{129}, which occurs in the 6.75 millimeter wave region. As is apparent from observation of Fig. 1, the spin of I^{129} is unquestionably 7/2. The very large number of absorption lines which are found in the hyperfine structure make it impossible to fit the theoretical pattern of any other spin to the observed data. The theoretical plots shown include only first order theory.

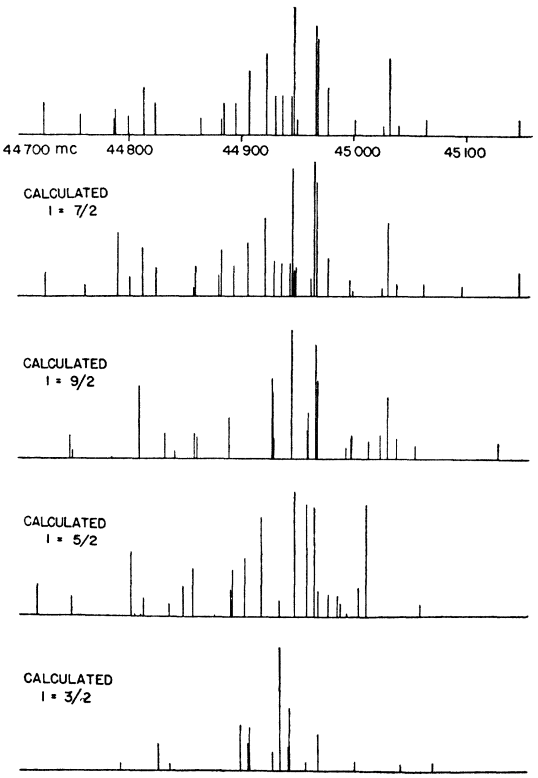

FIG. 1. Observed and calculated hyperfine structure for the $J=2\rightarrow3$ transition of CH_3I^{129}.