TABLE I. Interval ratios for the line 4238.19A.

Theory spin	Ratio
7/2	1.000:0.800:0.600
9/2	1.000:0.833:0.667
11/2	1.000:0.857:0.714
Experiment	1.000:0.831 ±0.011:0.654 ±0.011

and 5 mm invar separators were used with aluminum-coated quartz interferometer plates. Hyperfine structure patterns were observed in the 30 strongest lines of Tc between 2900A and 5000A.

Up to 8 components were resolved in lines attributed to transitions involving levels with $J\geq 7/2$, thus showing that $I\geq 7/2$. Interval-ratio calculations for the 4-component line 4238.19A($4d^5$ $5s^2$ $^6S_{5/2}-4d^5$ $5s$ (^7S) $5p$ $^6P_{3/2}{}^{\circ}$) are compared with measured interval ratios in Table I. Theoretically, the intervals should be in a ratio $(I+J):(I+J-1):(I+J-2)$, that is, for $J=\frac{3}{2}$, $(I+\frac{3}{2}):(I+\frac{1}{2}):(I-\frac{1}{2})$.

These data indicate clearly that the spin of Tc^{99} is $9\hbar/2$ as predicted by Feenberg and Hammack,[6] and in agreement with the model proposed by Mrs. Mayer.[7] The line 4031.63A ($4d^6$ (^5D) $5s$ $^6D_{9/2}-4d^6$ (^5D) $5p$ $^6D_{9/2}{}^{\circ}$) shows only 6 components resolved, but the end of the pattern is consistent with a spin of $9\hbar/2$.

The magnetic moment of Tc^{99} is now being determined and will be reported soon.

[1] Loaned by the AEC.
[2] W. F. Meggers and B. F. Scribner, J. Opt. Soc. Am. **39**, 1059 (1949).
[3] W. F. Meggers and B. F. Scribner, Oak Ridge Spectroscopy Symposium Abstracts, March 25, 1949.
[4] W. F. Meggers and B. F. Scribner, J. Research Nat. Bur. Stand. (to be published).
[5] W. F. Meggers, J. Research Nat. Bur. Stand. (in preparation).
[6] E. Feenberg and K. C. Hammack, Phys. Rev. **75**, 1877 (1949).
[7] M. G. Mayer, Phys. Rev. **78**, 22 (1950).

Erratum: Nuclear Isomerism and Shell Structure

[Phys. Rev. **79**, 1021 (1950)]

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October 6, 1950

SEVERAL points in Fig. 1 were incorrectly located. This figure should be replaced by the accompanying plot.

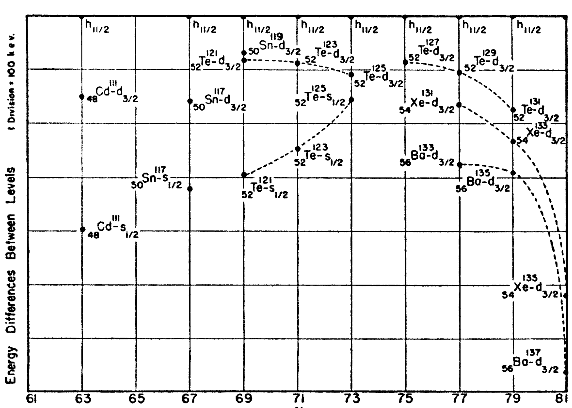

FIG. 1. Plot of level positions against odd neutron numbers for the even-odd isomers of the fifth nuclear shell. Only isomers exhibiting internally converted gamma-ray transitions are shown.

Subsequent to the communication of the letter, another isomer, Xe^{133m}, has been investigated.[1] This new point, $_{54}Xe^{133}-d_{3/2}$, falls accurately on the $Xe-d_{3/2}$ curve and further emphasizes the consistent level trends particularly in this region.

[1] I. Bergström and S. Thulin, Phys. Rev. **79**, 538 (1950).

On the π-Meson Absorption and Emission Mechanisms in Nuclei

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October 10, 1950

TWO groups of Berkeley experimenters[1] have recently reported preliminary results on the pp-interaction producing π^+ mesons which may indicate a high probability to find the resulting proton and neutron in a bound state. In this connection we would like to recall some considerations we made in 1948 which might be still of interest and which stress more precisely a possible analogy between the number of particles involved in the π^- absorption and production processes in nuclei.

After a preliminary analysis of σ-stars we concluded[2] that the most probable process of the primary act of π^- absorption in a nucleus was not a radiative one but the emission of a high energy neutron, the momentum being balanced by a recoil aggregate (nucleon, H^2, H^3, He^4 or more, depending on their instantaneous presence in the absorption spot). These primary particles could afterwards heat the residual nucleus and give rise to an evaporation process. The hypothesis was worked out by Heidmann and Leprince-Ringuet[3] and was found to be in accordance with experimental results, however with poor statistics. Further experimental data by Perkins[4] indicated a considerable probability of ejection of pairs of nucleons. Later studies agreed that emitted particles could be divided in two main groups, an analysis[5] showed that a peculiar scheme in which a neutron and a recoil triton were produced was close to the truth as for the relative number of high energy protons of σ-stars found in β-sensitive emulsions.

An extensive analysis performed recently by the Bristol group[6] gives strong support to the hypothesis of fast neutrons in the primary act for light elements. In the heavy component, as the authors find a ratio of fast protons lower than that predicted by Tamor[7] in the nucleon-nucleon model, mainly in light elements, they conclude that the process is not likely. The argument may be not so serious as appears at first sight because we have found[8] that fast particles of $|e|$ charge ($E>25$ Mev) are ejected in Berkeley plates exposed to 80-Mev neutrons in only 10 percent of the stars, this ratio being lower for light elements. These are also the approximate figures found in σ-stars. However, in these plates a phenomenological study of the number of prongs as a function of the known incident energy (free from the uncertainty arising in the classification of stars) indicates a higher excitation energy for σ-stars ($\sim$70 Mev for the heavy emulsion component) than do 80-Mev neutrons ($\sim$50 Mev for the same component).

As the ratio (3 prong/4 prongs) is very sensitive in the 100-Mev region and lies between 80- and 150-Mev neutrons, it is likely that recoils of $M>1$ are sometimes involved. It seems then that the Bristol excitation value for evaporation stars in BrAg (100 Mev) is overestimated, Fujimito's model which they use does not appear to fit with current evaporation calculations.[9]

Protons of $\sim$100 Mev as occasionally found suggest cases in which the effective recoil is at least a Be^8 clustering balancing the moment of a neutron of about 125 Mev. Deuterons, tritons, and even α-particles with energies well above the mean temperature have also been detected.

It has commonly been assumed hitherto that mesons arise in nuclei by nucleon-nucleon collisions, the threshold energy of production being lowered by the internal dynamics of the systems.[10] For such threshold calculations Barkas[11] has given an ingenious method similar to that used in nuclear physics. Such an analogy between nuclear dynamics and meson production seems, however, to be somewhat strained. In an ordinary nuclear reaction, as the whole nucleus contributes to the excitation which is given up to the products much later, we are entitled to consider only the initial and final states.

In a meson production at threshold incident energy the residual nucleus, if any, is generally heated after the π-emission by the reacting particles at rest in the c.m. system. It appears then that some definite hypothesis must be made for the primary event, as the available energy in the c.m. system for meson creation will depend on the masses of the interacting particles and not on the final state of the more or less excited nucleus.

We propose to introduce for this primary stage a clustering process similar to this used in the absorption process: the incident nucleon would interact with a nucleon, H^2, H^3, $He^4\cdots$ depending on either their probability of existence or the possibility that a minimum volume of the nucleus would be involved in large transfers of energy. Without taking account of the internal dynamics which would decrease the figures, thresholds would be obtained with heavy clusters. For effective π-production if we start with He^4 as a safe limit, we get values a little higher than Barkas'. Nuclei showing α-structure like C^{12} would give low thresholds. The excitation curve below the pure nucleon-nucleon threshold would give the relative proportions of clusters in $\sim 10^{-22}$ sec. Extensive statistics of stars emitting π-mesons in light elements at known incident energies would give evidence on this mechanism. With 260-Mev neutrons, the cross section is too low to draw conclusions from our Berkeley plates.

Association at high energies could explain too the high probability of (n,d) and (n,T) reactions with or without π-emission.[12]

Finally, we recall[13] that neutron-hydrogen experiments with defined neutron beams, similar to those performed with protons, would give definitive evidence on the di-neutron.

We wish to take this opportunity of thanking warmly Drs. Bradner and Gardner, and Professor Lattes who very kindly have given to our group the possibility of studying some high energy events.

1 Cartwright, Richman, Whitehead, and Wilcox, Phys. Rev. **78**, 823 (1950). V. Z. Peterson, Phys. Rev. **79**, 407 (1950).
2 P. Cüer and M. Morand, Comptes Rendus **226**, 649 (1948).
3 J. Heidemann and L. Leprince-Ringuet, Comptes Rendus **226**, 1719 (1948).
4 D. H. Perkins, Phil. Mag. **40**, 601 (1949).
5 W. Cheston and L. Goldfarb, Phys. Rev. **78**, 683 (1950).
6 Menon, Muirhead, and Rochat, Phil. Mag. **41**, 583 (1950).
7 S. Tamor, Phys. Rev. **77**, 412 (1950).
8 P. Cüer, and L. Van Rossum, C. R. congrès de Côme (1949).
9 W. Horning and L. Baumhoff, Phys. Rev. **75**, 378 (1949).
10 W. G. MacMillan and E. Teller, Phys. Rev. **72**, 1 (1947).
11 W. H. Barkas, Phys. Rev. **75**, 1109 (1949).
12 Cüer, Morand, and Van Rossum, Comptes Rendus **228**, 481 (1949).
13 Morand, Cüer, and Moucharafyeh, Comptes Rendus **226**, 1974 (1948).

Noise Temperature of a D.C. Gas Discharge Plasma

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IN a discharge tube, noise is generated from the cathode fall and the plasma. To pick up the noise of the plasma, a floating probe was inserted near the anode. The fluctuation of the voltage between the probe and the anode was observed by a narrow band amplifier of 14 Mc/sec. The discharge tubes used, of which the diameter is 3 cm and length 7.8 cm, were filled with argon at a pressure of 1 to 3 mm Hg, whereas the tubes filled at higher pressures frequently showed some oscillations.

The noisiness of the plasma is expressed by the noise temperature T_n, which is defined by the formula

$$\langle e^2\rangle_{Av}=4kT_nR,$$

where $\langle e^2\rangle_{Av}$ is the mean square voltage fluctuation per cycle and R is the resistance between the probe and the anode. The mean square voltage was determined by comparison with the shot noise of a diode with the aid of a square law detector. The resistances were deduced from the characteristic curves of the probe.

The measurements were performed at various electron temperatures, varying the applied voltage of the discharge tubes. The electron temperature was more easily determined by the double-probe[1] than the single-probe method. The relations between the electron temperature T_e and the noise temperature T_n were studied with tubes A and B. The results are shown in Fig. 1.

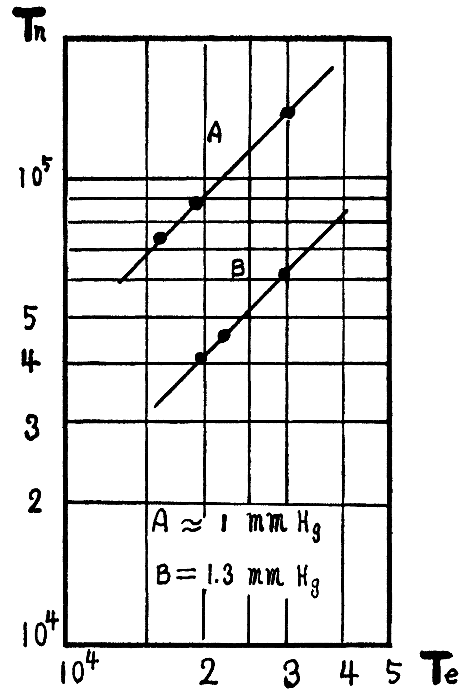

FIG. 1. Relation between the noise temperature T_n and the electron temperature T_e.

This shows that the noise temperature agrees with the electron temperature as far as orders of magnitude are concerned and that they are in a proportional relation.

The noise of the plasma, as discussed by Parzen and Goldstein,[2] consists of the thermal noise, which depends on the electron temperature, and of the current noise, which depends on the d.c. current. The latter shows a frequency dependence, but the former does not. A preliminary experiment[3] with an amplifier of 600 kc/sec. indicated that the noise temperature at this frequency is nearly equal to that at 14 Mc. Therefore, the observed noise is mainly thermal noise. This explains the approximate agreement between the noise temperature and the electron temperature.

1 E. O. Johnson and L. Malter, Phys. Rev. **76**, 1411 (1949).
2 P. Parzen and L. Goldstein, Phys. Rev. **79**, 190 (1950).
3 Kojima, Takayama, and Shimanuchi (to be published.)

Fluorescent Decay of Scintillation Crystals

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IN order to clarify recent observations of the behavior of organic fluors which scintillate under gamma-ray bombardment, measurements have been made of the decay time of fluorescence under ultraviolet excitation. The technique employed is similar to one suggested by Tumerman[1] and involves a measurement of the phase shift between incident modulated ultraviolet light and the resultant modulated fluorescence of a fluor whose mean lifetime for excited states is τ. The decay of excited states is assumed to be of the form $e^{-t/\tau}$. The exciting ultraviolet light is modulated by passage through a quartz crystal oscillating at about 5 Mc/sec., the resultant light being modulated at about 10 Mc/sec. It is easily shown that the phase shift is related to the mean lifetime of the fluor by the relation $\tan\phi=2\pi f\tau$, where ϕ