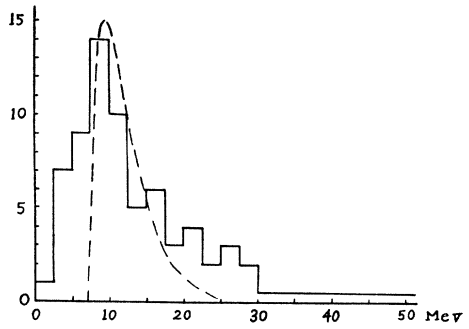

FIG. 1. Energy distribution of protons. The solid line represents the experimental data of Perkins. The dashed line is Weisskopf's distribution.

We may suppose the same circumstances will occur also in the cosmic-ray stars. This seems probable since the proton must go over the barrier. So after the evaporation process, the residual nucleus will be highly unstable, i.e., largely proton excessive. Under these circumstances it may be expected that a proton-decay will occur, analogous to the α-decay of heavy nuclei.

Assuming Geiger-Nuttal's law also to hold for the proton-decay, the lifetime of this new type of decay is estimated to be $10^{-15}-10^{-3}$ sec. for $A=100$ and proton energy $3-1.5$ Mev. This lifetime is much shorter than that of the β^+-decay. α- or γ-decay needs not to be considered because it does not improve the proton-excessive state. Finally, it is unlikely that the fission-like processes suggested by Bragge[6] occur in these nuclear states, because Bohr-Wheeler theory[10] shows that the threshold energy of fission has in our case a very large value ($\sim$40 Mev).

Thus we may conclude that the proton-decay predominates over other evaporation processes, and this will explain the appearance of low energy protons in stars. Also the cloud-chamber picture of Powell[11] seems to support the existence of this new type of decay; i.e., his picture Fig. 7a shows the heavy particle (proton) was emitted a few thousandths of a second after the evaporation process.

The detailed account will be published soon in *Progress of Theoretical Physics*. We should like to express our gratitude to Professor Tomonaga and Mr. Hayakawa for their kind interest taken in this work.

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Pressure Change of Resistance of Tellurium

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BRIDGMAN[1] has observed that the resistivity of tellurium decreases by a factor of more than 600 at a pressure of 30,000 kg/cm². He interprets this large change as a result of the tellurium becoming more metallic with increase in pressure. As shown particularly by work at Purdue University,[2] tellurium is a typical semiconductor with an energy gap between the filled band and the conduction band of about 0.38 ev.

TABLE I. Relative resistance and calculated energy gap in tellerium at a function of pressure.

I	II	III	IV	V
P kg/cm²	$\log_{10}R/R_0$ 23.5° from axis	86° from axis		E_G ev
	30°C	30°C	75°C	
0	0	0	−0.311	0.29 (0.38
2500	−0.280	−0.384	−0.696	0.29 (0.33)
5000	−0.722	−0.739	−1.035	0.275 (0.29)
7500	−1.027	−1.066	−1.330	0.246
10,000	−1.302	−1.360	−1.590	0.214
12,500	−1.547	−1.622	−1.818	0.182
15,000	−1.761	−1.855	−2.020	0.154
17,500	−1.945	−2.063	−2.197	0.125
20,000	−2.110	−2.246	−2.353	0.100
22,500	−2.257	−2.408	−2.490	0.076
25,000	−2.386	−2.552	−2.610	0.054
27,500	−2.499	−2.679	−2.715	0.034
30,000	−2.599	−2.790	−2.806	0.015

The purpose of this note is to point out that the large change of resistivity with pressure is a result of a decrease in the energy gap, the gap becoming very small at 30,000 kg/cm². At a somewhat higher pressure (45,000 kg/cm²) Te undergoes a phase transition.[3] The high pressure modification may well be a true metallic phase.

Shown in the first four columns of Table I are Bridgman's measurements of the pressure change of resistance of a single crystal of tellurium. Measurements were made in two directions making angles of 23.5° and 86° to the axis of the crystal. In the 86° orientation measurements were made at 30°C and 75°C. Bridgman gives values of $\log_{10}R/R_0$, where R_0 is the resistance at 30°C at atmospheric pressure.

Very pure samples of Te are in the intrinsic conductivity range at room temperature, the resistance varying as

$$R=R_\infty \exp(E_G/2kT), \tag{1}$$

where T is the absolute temperature. The energy gap can be estimated from resistance measurements, R_1 and R_2, made at two different temperatures T_1 and T_2.

$$E_G=2k\log(R_1/R_2)/[1/T_1-1/T_2]. \tag{2}$$

Using Bridgman's data for the 86° orientation at the two temperatures, values of E_G in ev have been calculated from

$$E_G=0.93[\log_{10}R(30°\text{C})-\log_{10}R(75°\text{C})]. \tag{3}$$

The values are listed in column V of Table I and are plotted in Fig. 1. The sample is not entirely in the intrinsic range at pressures below 7500 kg/cm², at least at the lower temperature. An extrapolation of E_G from Bridgman's data obtained above 7500 kg/cm² to Miss Johnson's value of 0.38 ev at zero pressure is shown by the dotted line. Extrapolated values are given in parentheses in the table.

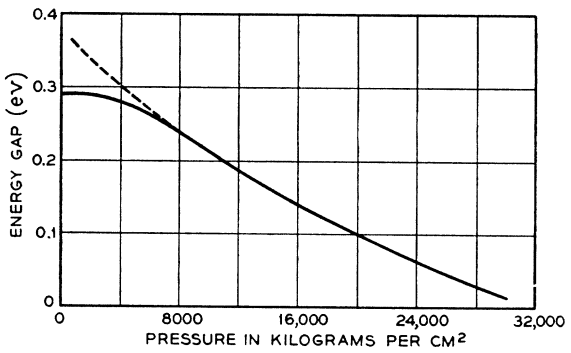

FIG. 1. Energy gap in tellurium as determined from variation of resistance with temperature at different pressures. Solid line; from Bridgman's data. Dotted line; extrapolation to $E_G=0.38$ ev at zero pressure.

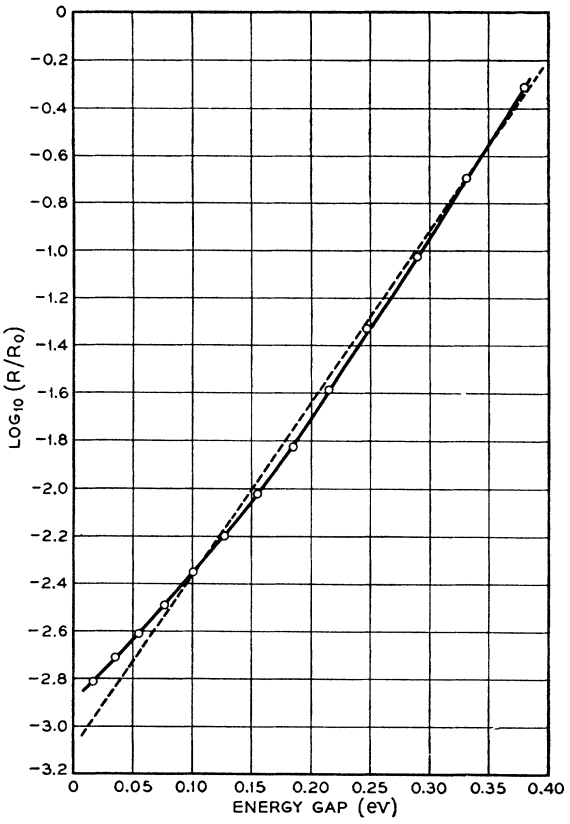

FIG. 2. Relative resistance of tellurium as a function of the energy gap. The dotted line gives the resistance change expected from the change in energy gap alone, other factors remaining constant with pressure.

As may be seen from Eq. (1), a decrease in E_G results in a decrease in R with pressure. When evaluated for $T=348°K$ (75°C), Eq. (1) may be written in the form

$$\log_{10}(R/R_0)=\log_{10}(R_\infty/R_0)+7.3E_G. \quad (4)$$

In Fig. 2 we have plotted $\log_{10}(R/R_0)$ from Bridgman's measurements as a function of E_G, using the extrapolated values of E_G at low pressures, and have shown for comparison a line of slope 7.3. It can be seen that the major cause of the pressure change of resistance is the decrease in the energy gap, E_G, and that changes in R_∞ with pressure are of secondary importance.

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Gamma-Rays from Tantalum 182

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IN an earlier investigation[1] it was found that pure tantalum oxide irradiated in the Oak Ridge pile formed the radioactive tantalum isotope of mass 182, which emitted a profusion of electron groups due to several internally converted gamma-rays. With the increased absolute accuracy and sensitivity now available with our photographic beta-spectrometers this emitter has been reexamined and found to yield several previously unobserved gamma-rays, all fitting into a logical decay scheme. In all, 48 electron lines are observed as shown collectively in column 1, Table I.

TABLE I. Electron energies with their identification.

Electron energy	Possible interpretation	Gamma-energy	Electron energy	Possible interpretation	Gamma-energy
30.2 kev	K_9	99.5	90.0 kev	M_8	92.8
34.1	L_1	46.2		or K_{18}	159.3
37.7	K_{10}	107.0	96.1	M_9	98.9
40.0	K_{11}	109.3	98.2	N_9	98.8
43.3	M_1	46.1	100.0	L_{12}	112.1
	or K_{12}	112.6	102.2	K_{19}	171.5
46.4	L_2	58.5	108.3	K_{20}	177.6
48.4	K_{13}	117.7	109.2	M_{12}	112.0
52.7	L_3	64.8	127.1	K_{21}	196.4
53.4	K_{14}	122.7	137.8	L_{16}	149.9
54.7	L_4	66.8	142.2	K_{22}	211.5
55.3	M_2	58.1	147.2	M_{16}	150.0
56.7	L_5	68.8		or L_{18}	159.3
61.7	M_3	64.5	150.4	K_{23}	219.7
64.1	N_3	64.7	157.7	K_{24}	227.0
	or M_4	66.9	165.3	L_{20}	177.4
	or L_6	76.2	174.2	M_{20}	177.0
66.1	M_5	68.9	176.8	N_{20}	177.4
	or N_4	66.7	184.7	L_{21}	196.8
69.1	K_{15}	138.4	191.3	K_{25}	260.6
71.5	L_7	83.6	208.6	L_{23}	220.7
73.2	M_6	76.0	215.6	L_{24}	227.7
81.2	M_7	84.0	216.7	M_{23}	219.5
	or L_8	93.3	224.0	M_{24}	226.8
	or K_{16}	150.5	232.3	K_{26}	301.6
87.1	L_9	99.2	237.9	K_{27}	307.2
88.6	K_{17}	157.9	250.3	L_{25}	262.4
			259.1	K_{28}	328.4

On applying the K–L–M differences characteristic of tungsten ($Z=74$) following beta-emission from tantalum ($Z=73$), the electron lines give evidence for the existence of 28 gamma-rays, as shown in column 3, Table I, and summarized in Table II. Some of the electron lines as shown in column 2 are subject to alternate or dual interpretation. The subscripts for the number of the gamma-ray are arbitrarily assigned in the order of increasing energy.

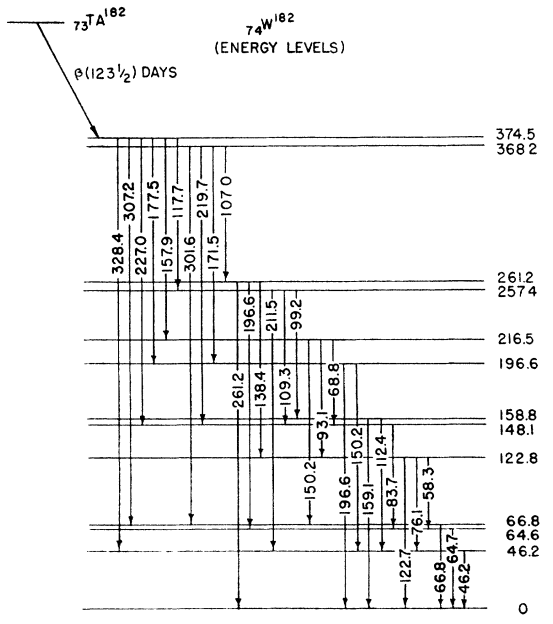

FIG. 1. Energy levels in tungsten 182 following beta-emission from tantalum.