Letters to the Editor

BETA AND GAMMA SPECTRA OF Te^{117}

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AN activity with half-life T = 1.17 hours, attributed to Te^{117}, was obtained when irradiating antimony with high energy protons.[1] Some information about the gamma spectrum of Te^{117} was also obtained during investigation of Te^{115},[2] but was not published owing to its preliminary nature.

The isotope Te^{117} was identified from its daughter isotope Sb^{117} (T = 2.8 hours, $E_\gamma = 0.16$ Mev) and obtained from the reaction $Sn^{114}(\alpha, n)Te^{117}$ by irradiating in a cyclotron a target enriched in Sn^{114} (to an abundance of 57%) with alpha particles possessing an energy of about 21 Mev.

The Te^{117} was chromatographically separated from the irradiated target in an anion exchange column containing a 0.1 N solution of ammonium oxalate. The half-life of Te^{117}, measured by a scintillation spectrometer and an end-window counter, was found to be $T = 1.1 \pm 0.1$ hours.

The gamma spectrum of Te^{117} was measured on the scintillation spectrometer and the following gamma lines were found: 0.71, 0.93, 1.10, 1.27, 1.42, 1.70, 1.98, 2.3 Mev, and annihilation radiation. The total intensity of all gamma transitions is about 0.3 of the intensity of the 0.71 Mev gamma line.

The positron spectrum of Te^{117} was studied on a twin-lens spectrometer.[3] The end point of the spectrum is 1.80 ± 0.07 Mev, its Kurie plot is a straight line. Electron lines 0.690 ± 0.003 Mev and 0.719 ± 0.003 Mev were found in the conversion spectrum; these were identified as the K and L conversion lines of the 0.720 ± 0.004 Mev gamma transition. The ratio $K/L = 8.3 \pm 1.0$.

The intensity of the 0.71 Mev gamma line is approximately twice that of the annihilation radiation. If we assume on theoretical grounds that the ratio of the probability of positron decay to that of K capture is on the order of 1, then for the β^+ transition $\log \tau f = 4.3$ and we may conclude that the β^+ transition is allowed. The internal conversion coefficient for $E_\gamma = 0.72$ Mev, calculated under the assumption that the positron decay proceeds to this level, has the value $\alpha_K = 3 \times 10^{-3}$. A comparison with the theoretical value of α_K for this transition at Z = 51 allows us to conclude that the transition multipolarity is M1 or E2.

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[2] Selinov, Vartanov, Khulelidze, Bliodze, Zaĭtsev, and Khalkin, JETP **38**, 1654 (1960), Soviet Phys. JETP **11**, 1191L (1960)

[3] Selinov, Chikhladze, Khulelidze, and Vartanov, Izv. Akad. Nauk SSSR, Ser. Fiz. **25**, 848 (1961), Columbia Tech. Transl., in press.

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POSSIBILITY OF DETECTING GRAVITATIONAL RADIATION UNDER LABORATORY CONDITIONS

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THE intensity of the gravitational radiation that arises on excitation of the characteristic longitudinal elastic vibrations in a body of cylindrical shape is relatively larger than for other macroscopic mechanical radiators.[1] If one synchronously excites the characteristic longitudinal vibration with amplitude of fractional elongation $\xi = 10^{-5}$ in $n = 2 \times 10^4$ identical cylinders of cross section $S = 10^4$ cm^2, density $\rho = 5.5$ g/cm^2, and speed of sound in the material of the cylinders $v_S = 4 \times 10^5$ cm/sec, the power loss to gravitational radiation is $\sim 10^{-25}$ w.[1,2] For this case it is necessary that the axes of the cylinders, along which the elastic vibrations are excited, be parallel, and that the cylinders be located at distances small in comparison with the wavelength of the radiation (the radiated power is proportional to n^2). The total power losses in the excitation of such a system are $\sim 10^6$ w at frequency 10^6 cps.

We note that to register or measure an electrical or mechanical signal with power 10^{-25} w under ordinary laboratory conditions is extremely difficult. This is due to the fact that the main obstacle in principle to the registration of weak signals is thermal noise. For a sinusoidal signal of known phase and frequency the minimum power that can be detected with reliability α is given by

$$P_{min} = 2kT\theta^2(\alpha, m) M / \tau(m-1). \quad (1)$$

Here T is the absolute temperature of the source of the signal, k is Boltzmann's constant, τ is the time of a single measurement, m is the number of measurements, $\theta(\alpha, m)$ is the tabulated reliability index of the result for a set of m measurements, α is the degree of reliability of the result of the measurements, and M is the "quality factor" of the measuring apparatus as a whole. For an ideal measuring apparatus M = 1. Let us take an example based on experimental data:[3] for $\alpha = 0.990$, $T = 300°K$, $\tau m = 6 \times 10^3$ sec one would detect a power of 4×10^{-23}w, which corresponds to $M \approx 5$. Assuming that τm can be increased to 6×10^5 sec (about 8 days) and $M \approx 1$, we get $P_{min} = 10^{-25}$ w. Thus if there should exist an acceptable device that completely absorbed the gravitational radiation, it would be possible to accomplish the detection for the example given above. Owing, however, to the extremely weak interaction of gravitational radiation with matter, it can be shown[1] that to detect the absorption (that is, the conversion into other forms of energy) a power 10^{12} to 10^{15} times the value of 10^{-25} w would be required.

There is a possible type of indirect experiment for the detection of gravitational radiation by the use of the radiating system described above. Let us suppose that we have at our disposal two groups of n identical cylinders, placed close together and with their axes parallel. If we excite vibrations in these groups of cylinders in synchronous phase, then, as has been indicated, the power of the gravitational radiation will be about four times that from one of the groups. If, on the other hand, we excite the vibrations of the two groups with opposite phases, without changing the distances and orientations, then there will be only the octupole radiation, which is much smaller than the quadrupole radiation from a single group. Thus by changing the phase shift of the vibrations in one group of cylinders by π, one can cause synchronous changes of the radiative losses from the second group. For the values of S, n, ξ, ρ, and v_S given above the depth of the modulation of the power expended in the excitation will then be 2×10^{-25} w. Such a direct effect of modulation of the power can be measured. The minimum value of the depth of modulation that can be measured can be calculated by means of the relation (1), since the frequency and phase of the modulation are fixed for the observer.

By changing the mutual orientation of the cylinders one can produce a supplementary control modulation, by using the well known directional pattern of quadrupole radiators.

In arranging the experiment, careful electrostatic and acoustical screening of the two groups of cylinders is necessary.

One can use as the material for the cylinders the ferroelectric substance $BaTiO_3$, and can produce the excitation of the vibrations by means of an alternating voltage, using the inverse piezoelectric effect. If one determines the depth of the modulation of the power associated with the radiation in one group of cylinders by detecting the amplitude of the voltage applied to the cylinders synchronously with changes of phase in the other group, then besides the ordinary thermal noise there are large additional disturbances owing to amplitude fluctuations of the supply generator and the amplifying systems. According to the results of Bershteĭn[4] and Malakhov,[5] for excitation of a system of cylinders at frequency 10^6 cps, with phase modulation at frequency 10^3 cps and power 10^6w expended in the excitation, one must expect that the spectral density of the power associated with the amplitude fluctuations will be $10^{-9} - 10^{-10}$ w/cps, which is equivalent to a noise temperature $T \approx 3 \times 10^{13}$ °K. Therefore it is necessary to use narrow-band symmetrical band-elimination filters at frequencies $10^6 \pm 10^3$ cps with total attenuation of the order of 110 to 130 db. This should lower the noise temperature to $\approx 300°$K. The filters must be connected between the amplifier stages and between the amplifiers and the supply generator.

For the values that have been given, radiated power 10^{-25} w, power expended in excitation 10^6w, at excitation frequency 10^6 cps, and $\xi = 10^{-5}$, the volume of $BaTiO_3$ required is ≈ 40 m^3. Owing to the fact that the power of the gravitational radiation is proportional to $n^2S^2\xi^2$ and the expenditure of power in the excitation of the vibrations in the system is proportional to $nS\xi^2$, one can decrease the amount of power expended for the same radiated power by decreasing ξ and increasing S or n, i.e., at the expense of an increase of the volume of the system.

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ASYMMETRY IN ANGULAR DISTRIBUTION OF NEUTRONS EMITTED IN THE CAPTURE OF NEGATIVE MUONS IN CALCIUM

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FROM a measurement of the asymmetry coefficient of the angular distribution of neutrons from the reaction

$$\mu^- + A \rightarrow A' + n + \bar{\nu} \qquad (1)$$

evidence about the nonconservation of parity and about the components of the weak interaction between a μ^--meson and a nucleon can be obtained. For the case of parity nonconservation, the angular distribution of the neutrons emitted by the nucleus in the direct process, bypassing the compound nucleus stage, is of the form[1]

$$N(E_n, \theta) \sim 1 + a\cos\theta, \qquad a = P_\mu \beta(E_n)\tilde{\alpha}, \qquad (2)$$

where $\tilde{\alpha}$ is the asymmetry coefficient of neutron emission on capture of fully polarized μ^- mesons by the nucleus, a coefficient dependent only on the interaction constant of a μ^- meson with a nucleus; P_μ is the residual polarization of the μ^- meson in the K orbit of the mesic atom: $\beta(E_n)$ is a coefficient that takes the nuclear properties into account; E_n is the energy of the emitted neutron and Θ is the angle between the spin direction of the μ^- meson and the direction of emission of the neutron.

In the present note we report on preliminary results of measuring the asymmetry coefficient $\tilde{\alpha}$ on absorbing μ^- mesons in calcium. μ^- mesons with momentum 250 Mev/c (from the synchrocyclotron of the Joint Inst. for Nuc. Res.) were brought to rest in a calcium target of thickness 12 g/cm^2 placed in a magnetic field. The neutrons were recorded for 0.67 μsec, allowing 0.1 μsec after the passage of a μ^- meson, by a threshold scintillation layer detector, insensitive to γ quanta, similar to that described by us previously.[2]

Evaporated neutrons could be excluded from the count by choosing a 7-Mev threshold of neutron counting, and only neutrons from the direct process were detected with sufficient efficiency. The background of chance coincidences was measured simultaneously with the effect, with the same energy threshold.

A telescope of three scintillation counters recorded the disintegration electrons on stopping μ^- mesons in calcium in order to determine P_μ. The asymmetry in the angular distribution of neutrons and disintegration electrons was measured by the method of spin precession of a μ^- meson in a magnetic field, counting for two opposite directions of the magnetic field.

In spite of the four-layer magnetic shielding there was a slight influence of the coil magnetic field in the presence of the leakage field of the accelerator on the amplification coefficient of the photomultipliers of the neutron detector (FÉU-24), which was equivalent to a change in the working threshold by (2.95 ± 0.11)%. The effect of the field was carefully measured, and taking this into account we found

$$A_{\mathrm{Ca}} = P_\mu P_\gamma P_n \bar{\beta} \tilde{\alpha}_{\mathrm{Ca}} = -(0.067 \pm 0.022). \qquad (3)$$

where $P_\gamma = 0.96$ and $P_n = 0.94$ are coefficients that take account of the recording of an insignificant fraction of γ quanta and evaporated neutrons produced in the capture of a μ^- meson; $\bar{\beta}$ is the mean of the quantity $\beta(E_n)$[1] averaged over the recorded part of the spectrum of primary neutrons and $P_\mu = 0.135 \pm 0.019$. From this $\tilde{\alpha}_{\mathrm{Ca}} = -(0.93 \pm 0.33)$.

As a control experiment we measured A_{Al} for μ^--meson capture in aluminum, where there is no asymmetry in view of the complete depolarization of μ^- mesons.[3] The measurements gave $A_{\mathrm{Al}} = -(0.015 \pm 0.015)$.

There have recently been reports[4,5] on the measurement of the asymmetry of neutron emission on the capture of μ^- mesons in magnesium and sulfur. The authors limited themselves to presenting the value of A and did not take the re-