showed no phase boundary or any other anomalous optical properties. However, on releasing the pressure slightly below the critical value, critical opalescence and subsequently the appearance of a meniscus was observed in this region. Prior to these observations when helium was being introduced into the tube, it was noted that the evaporation of liquid from the pumped helium II bath increased rapidly because the tube containing liquid helium II and reaching up into the Dewar vessel constituted a very good heat conductor. This fact is of importance for the design of cryogenic apparatus, showing that tubes reaching from higher temperatures into a bath of liquid helium II and containing helium of more than critical pressure will constitute a very serious heat leak.

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The High Latitude North-South Asymmetry of Cosmic-Rays

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THE east-west asymmetry of cosmic rays in latitudes above the knee of the latitude-intensity curve has been explained as a secondary radiation effect by Johnson[1] and Burbury and Fenton,[2] who showed that the deflection of secondary mesons by the earth's magnetic field during their passage through the atmosphere can produce an asymmetry of the value observed. A sea-level north-south asymmetry has recently been observed at Hobart, Tasmania (geomagnetic latitude 51.7 degrees south) for zenith angle 30 degrees under 12 centimeters of lead, the excess being in the north. The value obtained is 0.0056±0.0013 (probable error), clearly different from zero. The east-west asymmetry observed at the same zenith angle and lead thickness is 0.0113 ±0.0043. If the north-south asymmetry can also be explained as a secondary radiation effect, it is still not necessary to invoke any asymmetry in the primary radiation giving rise to the sea-level radiation in high latitudes. The following explaination is suggested:

The magnetic field in the latitude of Hobart is inclined at 18° to the vertical. Particles traveling in the N–S vertical plane will experience a deflecting force normal to this plane, and since the total deflection of secondary mesons is only a few degrees, the path of a particle arriving at sea level at a zenith angle θ may be said to lie in an inclined plane whose line of greatest slope coincides with the final direction of the path. The initial direction of such a particle will be at a greater zenith angle than θ, and if this be denoted by θ', it can be shown simply that

$$\cos\theta' = \cos\theta \cos\delta, \tag{1}$$

where δ is the total deflection of the particle.

In the theory of the east-west asymmetry[2] the deflection of particles arriving at various zenith angles in the east-west vertical plane was obtained by integrating the curvature along a straight line having the final direction of the particle. For the small deflections considered, this approximation is sufficiently good. Since the curvature at any point is proportional to the component of the magnetic field normal to the plane of the trajectory, so is the deflection. Also, since the distribution of air mass along a straight path at a zenith angle θ is independent of azimuth, we may write

$$\delta_N(\theta) = \delta(\theta) H \sin(\theta - 18°)/H \sin 18°, \tag{2a}$$

and

$$\delta_S(\theta) = \delta(\theta) H \sin(\theta + 18°)/H \sin 18°, \tag{2b}$$

where $\delta_N(\theta)$ and $\delta_S(\theta)$ are the deflections of particles arriving from the north and south at zenith angle θ, and $\delta(\theta)$ is the deflection of corresponding particles traveling in the east-west vertical plane. The mean deflection taken over the energy spectrum with lower limits corresponding to 12 and 24 centimeters of lead absorber in the measuring apparatus was computed for the east-west direction at several zenith angles and is denoted by $\bar{\delta}$. Table I gives the values of $\bar{\delta}$ (Burbury and Fenton[2]) and values of $\bar{\delta}_N$ and $\bar{\delta}_S$ calculated from Eqs. (2a) and (2b).

TABLE I. The mean deflection of particles in radians in the east-west, north and south directions as a function of zenith angle and lead absorber thickness.

	$\theta =$	15°	30°	45°	60°
12 cm lead	$\bar{\delta}$	=0.031	0.034	0.037	0.043
	$\bar{\delta}_N$	=0.005	0.023	0.054	0.093
	$\bar{\delta}_S$	=0.055	0.082	0.107	0.136
24 cm lead	$\bar{\delta}$	=0.028	0.031	0.034	0.040
	$\bar{\delta}_N$	=0.005	0.021	0.050	0.087
	$\bar{\delta}_S$	=0.049	0.075	0.098	0.127

TABLE II. North-south asymmetry as a function of zenith angle and lead absorber thickness.

θ	15°	30°	45°	60°
12 cm lead	0.0030	0.0070	0.0096	0.0107
24 cm lead	0.0025	0.0055	0.0078	0.0091

The rate of energy loss by ionization in the atmosphere increases rapidly with decreasing altitude, and consequently the bending of the path of a particle is greater near sea level. Thus the radiation arriving at zenith angle θ north or south of the vertical is made up of particles which have traveled through most of the atmosphere at an average zenith angle given approximately by

$$\cos\bar{\theta}_N = \cos\theta \cos\bar{\delta}_N, \tag{3a}$$

or

$$\cos\bar{\theta}_S = \cos\theta \cos\delta_S. \tag{3b}$$

The attenuation of these particle intensities due to decay and energy loss will be approximately the same as that sustained by particles traveling at zenith angles $\bar{\theta}_N$ and $\bar{\theta}_S$ if the magnetic field were absent. Since the zenith distribution of such undisturbed radiation is given by

$$j(\theta) = j_0 \cos^{2.2}\theta, \tag{4}$$

the north and south intensities are given by

$$j_N = j_0 \cos^{2.2}\bar{\theta}_N, \tag{5a}$$

and

$$j_S = j_0 \cos^{2.2}\bar{\theta}_S. \tag{5b}$$

The north-south asymmetry is now

$$\frac{2(j_N - j_S)}{(j_N - j_S)} = \frac{2(\cos^{2.2}\bar{\delta}_N - \cos^{2.2}\bar{\delta}_S)}{\cos^{2.2}\bar{\delta}_N + \cos^{2.2}\bar{\delta}_S}, \tag{6}$$

by Eqs. (3a) and (3b).

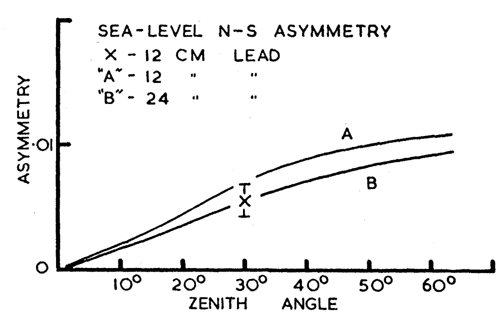

FIG. 1. Sea-level north-south asymmetry as a function of zenith angle and lead thickness.

The computed values are given in Table II, and Fig. 1 shows the asymmetry as a function of zenith angle and lead thickness compared with the result for 30 degrees and 12 centimeters of lead. In view of the approximate nature of the theory the agreement can be regarded as satisfactory.

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Gamma-Radiations from 36.5-hr Rh^{105g}

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INCIDENTAL to our continuing investigations on the radioactivities in technetium there was an occasion to examine the radiations from 36.5-hr Rh^{105}. There has been some question recently as to whether gamma-radiations are emitted in the decay of this radionuclide. Duffield and Langer[1] have reported a magnetic lens spectrometer study in which only one beta-group of 570-kev maximum energy was found. Neither conversion electrons in the neighborhood of 300 kev nor any gamma-radiations were observed. Mandeville and Shapiro,[2] on the other hand, have obtained absorption and beta-gamma coincidence rate data which indicate a 0.3-Mev gamma-ray in approximately 8 percent of the disintegrations.

Purified RuO_2 was irradiated with slow neutrons for 11 hours in the Oak Ridge pile. One mg of rhodium carrier was added, and the ruthenium was separated by distillation with perchloric acid. Two additional distillations were made after adding inactive ruthenium; then the residue was taken up in HCl and the rhodium isolated by reduction to its metal with magnesium. Gamma-ray spectra (Fig. 1) from this source at various times showed photolines at 322±5, 157±5 (very weak), and possibly at 80±5 kev which decayed with a 36-hr half-life. Measurements were conducted with a scintillation counter spectrometer consisting of a 1×2-inch cylindrical, thallium-activated sodium iodide crystal (hermetically packed in powdered MgO) together with a selected RCA-5819 photomultiplier, $A-1$ linear pulse amplifier, and sliding channel differential discriminator.[3] The resolution at 661 kev was about 10 percent with a peak to valley ratio exceeding 30:1.

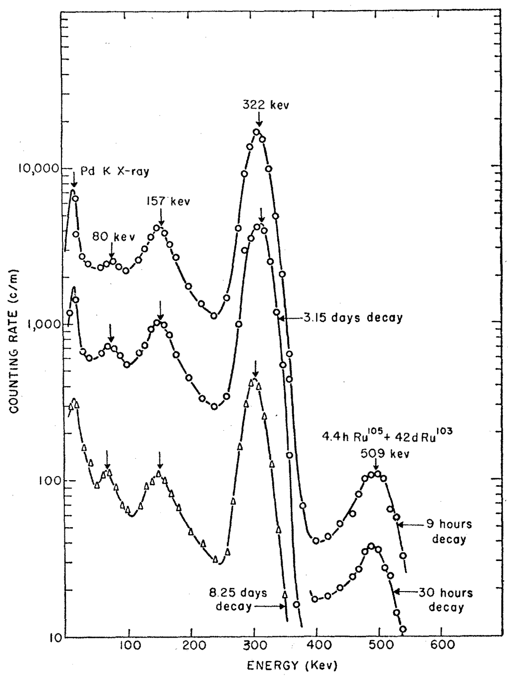

FIG. 1. Gamma-ray spectrum of 36-hr Rh^{105g} taken at varying times with a Tl+NaI scintillation counter spectrometer.

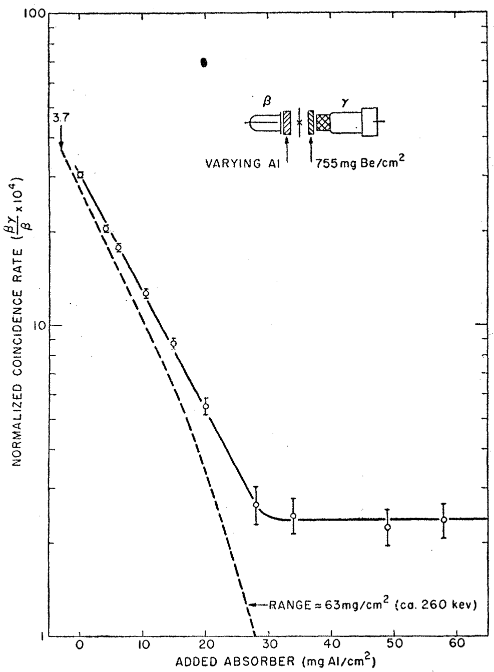

FIG. 2. Coincidence rate absorption measurements taken on 36-hr Rh^{105g} after 57-hours decay.

Energy-dependent beta-gamma coincidences were also observed, (Fig. 2) suggesting that the beta-spectrum was complex. A mica end-window beta-proportional counter and a 1×1-inch Tl+NaI crystal for gamma-rays together with a coincidence detector[4] set at a resolving time of 1.6 μsec were employed for these measurements. Absorption of the coincidences in aluminum gave a range of 63-mg Al/cm^2 corresponding to a maximum beta-energy of about 260 kev. This energy added to that of the coincident gamma-ray (320 kev) gives 580 kev in satisfactory agreement with the energy of the main beta-transition. A comparison of the normalized coincidence rate extrapolated to zero total absorber with the rate for 2.69-day Au^{198} counted in the same geometry indicated that 10±2 percent of the 36.5-hr Rh^{105g} disintegrations go through the 320-kev gamma-ray, assuming the latter is not appreciably delayed nor converted.

Logft values for the 570- and 250-kev beta-groups are 5.7 and 5.6, respectively, so that both transitions are empirically allowed. Spin values of 5/2 ("most probable") and 3/2 ("possible") for Pd^{105g} have been reported recently.[5] If, therefore, Pd^{105g} is $d_{5/2}{}^+$, then Rh^{105g} should be $(7/2)^+$ and the 320-kev level may be $g_{7/2}{}^+$. It is of interest to note that other levels in Pd^{105} have been observed[6] in the decay of 45-day Ag^{105}.

The interest of our colleague, Dr. A. R. Brosi, is gratefully acknowledged.

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