TABLE II Comparison of slow neutron fission in U^{233}, U^{235}, and Pu^{239}.

	Present experiment U^{233}	Present experiment U^{235}	Deutsch and Ramsey Pu^{239}
Most probable energy of the light fragment (Mev)	91.2	92.7	93
Most probable energy of the heavy fragment (Mev)	55.5	59	65
Ratio of most probable energies	1.64	1.57	1.43
Most probable mass ratio (from an equal ratio interval curve)	1.60	1.485	1.32
Width at half-maximum of high energy peak (Mev)	14	12	12
Width at half-maximum of low energy peak (Mev)	22	20	20
Most probable fission mode: total energy	147.5	151.5	156
Most probable fission mode: mass ratio	1.64	1.57	1.43

position of the gate and conversely. For example, a shift of 25 Mev in the gate position produces a total shift in the mean energy of about 4 Mev and a change of width of the distribution of about 1.5 Mev. Moreover, this shift is such that as the gating energy is increased, the energy of the corresponding distribution maximum also increases. Hence, the usual double-peaked fragment energy curve is not, even approximately, a simple inversion of the double-peaked mass curve.

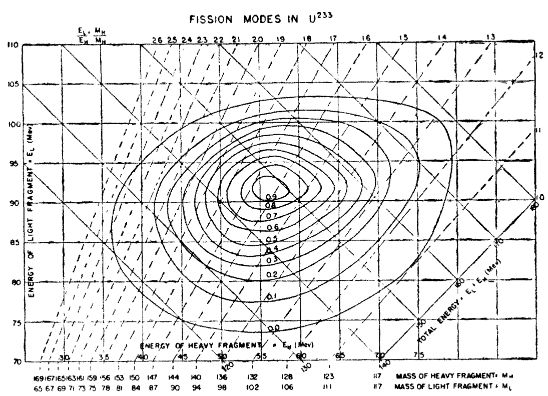

FIG. 2. Contour diagram for the fission modes in U^{233}.

Comparison of the present results on U^{235} with that of previous experiments is given in Table I.

A comparison of slow neutron fission in U^{235}, U^{233}, and Pu^{239} is given in Table II.

The experimental results for U^{235} and U^{233} are presented in the contour diagrams, Figs. 1 and 2. The contour lines represent relative frequency of occurrence of the fission modes. Figure 3 shows the variation of total kinetic energy with mass ratio. Energy calculations from nuclear masses predict a maximum in the total energy (kinetic+excitation energy) for unity mass ratio. Since the kinetic energy decreases as the mass ratio decreases below 1.25, the fraction of excitation energy must be increasing rapidly in this region. In this regard,

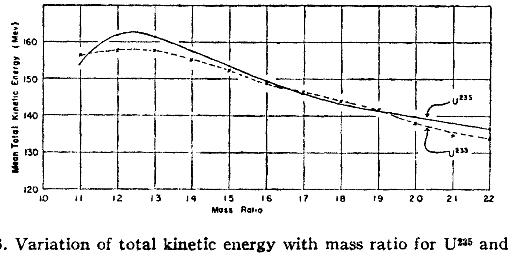

FIG. 3. Variation of total kinetic energy with mass ratio for U^{235} and U^{233}.

Katcoff, Miskel, and Stanley[10] working on the range distributions of plutonium fission fragments have interpreted their results to indicate a decrease in kinetic energy in the vicinity of a ratio of 1.2.

This work will be submitted in greater detail for publication in the Canadian Journal of Research.

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Energies of Heavy Nuclei in Cosmic Rays

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IN Table I we have summarized for fifteen heavy nuclei[1] the velocity on entering plates, nuclear charge, and calculated energy per nucleon at the top of the atmosphere. This latter quantity has been obtained by taking into account the observed angle in the photographic emulsions and the altitude at which the balloon spent the majority of the time. Inasmuch as it usually takes the balloon only about 25 minutes to rise from 70,000 to 90,000 feet and the balloon then remains aloft for three to five hours, we presume that the majority of the measured flux is recorded at the higher altitudes.

Inspection of Table I shows that a fairly large number of the measured nuclei had the rather low energies of 0.5 to 0.7 Bev upon entering the atmosphere. If we take into account the charge-to-mass ratio of the incoming particles, we find (using Vallarta's[2] curves distributed June, 1948) that no nuclei with energies less than 0.5 Bev/nucleon can enter the earth's magnetic field from the vertical at a latitude less than 51°N magnetic latitude. Shadow effects will presumably have completely disappeared for this energy at about 55°N magnetic latitude. The flights were made from Camp Ripley, Minnesota, i.e., at 55°N magnetic latitude.

Our results, therefore, suggest that the sun's magnetic field does not produce an energy cut-off noticeable at latitudes less than 51° and probably is not cutting off any particles even at the flight latitude of 55°.

Some indirect evidence substantiates this conclusion. The measured total flux of heavy nuclei for Z greater than 10 is $2.1\pm3\times10^{-4}/cm^2\cdot sec.\cdot ster.$ assuming 100 percent detection efficiency of the emulsions for these nuclei. If we compare this flux with the flux given by V-2 rocket data[3] at 41° magnetic

TABLE I. Summary of data on electric charge, entrance velocity, and energy per nucleon at top of atmosphere, for 15 heavy cosmic-ray particles.

Z	$\beta=v/c$ on entering plates	Energy/nucleon at top of atmosphere	Angle with vertical
11	0.63	0.5 Bev/nucleon	15°
14	0.86	1.1	23°
20	0.8	1.1	42°
26	0.85	1.3	27°
17	0.61	0.6	38°
12	0.53	0.8	71°
12	0.69	0.6	24°
41	0.8	1.2	30°
15	0.7	0.71	45°
13	0.7	0.61	35°
19	0.7	0.83	48°
12	0.55	0.54	41°
22	0.6	1.2	68°
10	0.6	0.45	10°
20	0.6	1.0	64°

latitude, we find that there are 450 protons for each nucleus of Z greater than ten. If, on the other hand, we use Harrison Brown's data on natural abundances of the elements to estimate the relative flux of nuclei, we would expect about 2000 protons for each such heavy nucleus. This inconsistency can be removed if we assume that the flux of protons increases between 41° and 55° latitude, rather than remaining constant as would be indicated by the sea level latitude effect or the supposition of a 50-gauss sun's magnetic field.

We have used Millikan's[4] data on the increase of total ionization at high altitudes between 41° and 56°N magnetic latitude to estimate the increase in primary flux. Millikan's[4] data would indicate that the flux increased by a factor of very roughly five in this interval and is consistent with a differential power law with an exponent -2.3. If this interpretation of Millikan's data is correct, then our measured flux of heavies with atomic number greater than ten would be consistent with Harrison Brown's[5] estimates of the relative abundance of the elements.

In order to throw further light on the problem presented here and to definitely exclude the possibility that some of the observed nuclei penetrate the magnetic field only partially stripped of orbital electrons, we plan to make flights at more southerly latitudes.

This work has been supported by the Office of Naval Research.

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Determination of e/m from Recent Experiments in Nuclear Resonance

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January 31, 1949

In a recent experiment reported by H. Taub and P. Kusch,[1] the g value for the proton was measured relative to the atomic g factors of some of the alkali atoms with improved accuracy by the molecular beam method. Their result is $g_H = 30.4211\times10^{-4}\pm.005$ percent. Combining this value with our recent measurement[2] of the absolute value of the gyromagnetic ratio of the proton, which gave a value $\gamma_p = (2.6752\pm.0002)\times10^4$, a more precise value of $e/m = 2\gamma_p/g_H = (1.75878\pm.00016)\times10^7$ is obtained.

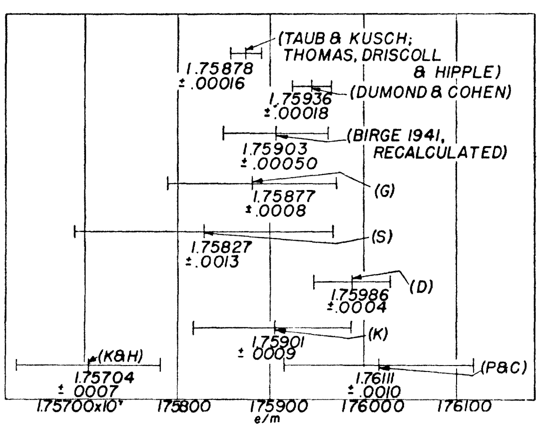

FIG. 1. Experimental determination of e/m. The values reading from top to bottom are: 1. The value reported here. 2. Least square fitted value (DuMond and Cohen). 3. Recalculated Birge value (1941). 4. Goedicke (1939). 5. Shaw (1938). 6. Dunnington (1933, 1937). 7. Kirchner (1931, 1932). 8. On left. Kinsler and Houston (1934). Correcting for the new value of the electron moment (P. Kusch and H. M. Foley, Phys. Rev. **73**, 412 (1947); J. Schwinger, Phys. Rev. **73**, 415 (1948)), this value is revised to $1.75908\pm.0007$ which is in agreement with the other values. 9. On right. Perry and Chaffee (1930).

A comparison of this value with other experimental values summarized by DuMond and Cohen[3] is shown in Fig. 1. Work is proceeding to improve the accuracy of the proton gyromagnetic ratio which will, in turn, lead to a more precise value of e/m.

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Erratum: Acoustical Birefringence

[Phys. Rev. 74, 1889A (1948)]

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Further consideration has shown that in ammonium dihydrogen phosphate a transverse mode with wave normal in the 011 direction and polarization in the 100 directional will travel in a direction lying in the X plane and making an angle of 7° with the wave normal. In the above abstract it was stated erroneously that this mode should travel along the wave normal. With this present consideration it follows that all three modes with wave normals in the 011 direction of ADP travel in directions making angles different from zero with the wave normal.

"Cross-Over Transitions" in Cl^{38}, Co^{60}, Br^{82}, and Sb^{124}

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January 17, 1949

The threshold reactions of photo-disintegration of Be^9 and D^2 provide a convenient method for detecting weak high energy gamma-rays in the presence of intense gamma-radiation of lower energy. It is possible to detect gamma-rays that occur with a frequency of as low as 10^{-6} photon per disintegration. Such weak gamma-rays may arise either from a weak beta-ray branch or from high energy radiation from known excited levels.

TABLE I. Cross-over energy and transition probabilities for Cl^{38}, Co^{60}, Br^{82}, and Sb^{124}.

Source	Cl^{38}	Co^{60}	Br^{82}	Sb^{124}
Target material	D_2O	D_2O	Be	D_2O
Half-life	37 min.	5.3 yr.	34 hr.	60 days
Ratio to Na^{24} of photo-neutrons/curie	4×10^{-4}	$<2\times10^{-6}$	9×10^{-4}	2×10^{-4}
Photons/disintegration*	$<3\times10^{-4}$	$<2\times10^{-6}$	1.4×10^{-3}	5×10^{-4}
Measured energy	—	—	1.7–2.0	2.2–2.5
Cross-over energy E_c(Mev)	3.75	2.4	2.90	2.3
Cascade energies E_1(Mev)	1.60	1.1	1.35	1.7
E_2(Mev)	2.15	1.3	0.55	0.6
Transition probabilities $\frac{E_c(l+1\text{ pole})}{E_1(l\text{ pole})}$	1×10^{-1}	4×10^{-2}	3×10^{-3}	5×10^{-3}
Transition probabilities $\frac{E_c(l+2\text{ pole})}{E_1(l\text{ pole})}$	6×10^{-5}	1×10^{-5}	1×10^{-6}	2×10^{-6}

* Corrected for change of photo-disintegration cross section with energy