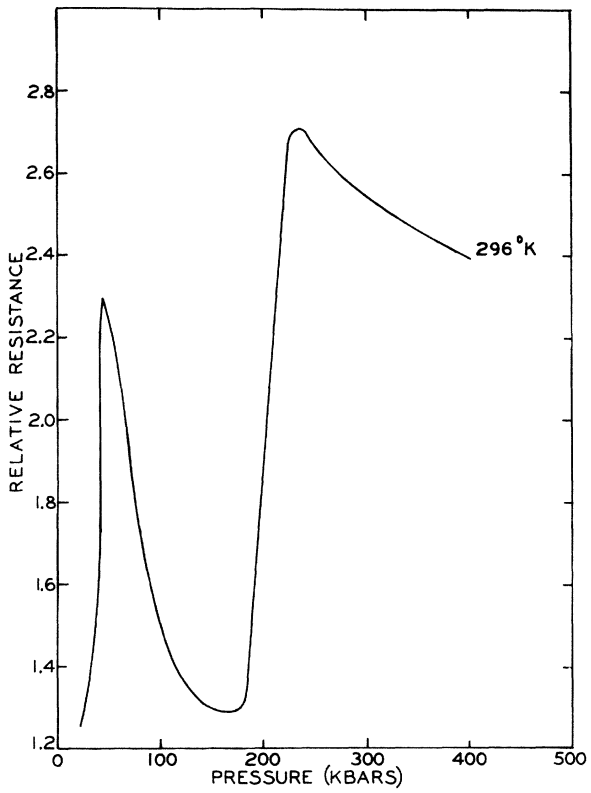

FIG. 1. Resistance of cesium vs pressure—composite of 12 runs at 296°K.

drift with time except in this region.) The maximum always occurred at the same pressure relative to the minimum, and always at a resistance higher than that of the first cusp. All of the features occurred on release of pressure as well as on application of pressure. A number of runs were also made at 77°K. The features occurred at about the same pressures, and were similar in character except that the rise initiating at 175 kilobars was somewhat more sluggish.

It is clear that Sternheimer's calculations require some expansion and refinement. The second rise might be explained in terms of overlap with another branch of the split "5*d* band." In view of Ham's calculations and of new data on other alkali metals (e.g., the maximum resistance of rubidium and the sharp rise of resistance of potassium[9]), a rather complete reanalysis of the theory is desirable. It would be most useful to have x-ray measurements of the structure of the high-pressure phases. Room-temperature measurements on cesium in our high-pressure x-ray apparatus[10] have not proved feasible. Efforts are being made to extend the high-pressure x-ray technique to low temperature where cesium gives much better x-ray patterns.

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NUCLEAR MAGNETIC RESONANCE OF Gd^{155} AND Gd^{157} IN THE CUBIC FERROMAGNET GdN†

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We wish to report the observation of the nuclear resonance of the two naturally occurring isotopes of gadolinium which have a nuclear moment. This experiment is of some interest in two respects: First, to our knowledge this is the first observation of nmr of gadolinium, and second, there is no quadrupole interaction observed in contrast with isoelectronic divalent europium nuclear resonance.

The host lattice was the material GdN which has the rock salt structure. The GdN was prepared by reacting molten gadolinium metal

Table I. nmr frequencies of Gd^{155} and Gd^{157} compared with some similar data.

Isotope	Ion	Lattice	Temp (°K)	nmr freq	Δf (kc/sec)	Quadrupole interaction
Gd^{155}	Gd^{3+}	GdN	4.2	44.090	100	None observed
Gd^{155}	Gd^{3+}	GdN	2.2	44.204	100	None observed
Gd^{157}	Gd^{3+}	GdN	4.2	58.500	200	None observed
Gd^{157}	Gd^{3+}	GdN	2.2	58.700	200	None observed
Gd^{155}	Gd^{3+}	ThO_2	290	41	...	...[a]
Gd^{157}	Gd^{3+}	ThO_2	290	56	...	...[a]
Eu^{151}	Eu^{2+}	EuS	4.2	331.82	1500	...
Eu^{153}	Eu^{2+}	EuS	4.2	146.550	5 peaks 450 kc/sec apart	~6 Mc/sec

[a]Data calculated from epr resultsof Low and Shaltiel (see reference 2).

(purity 99.9%) contained in a tantalum crucible with flowing nitrogen (99.996% purity) at 1400°C. The nitrogen content of the product, determined by a modified Kjeldahl method, was 95% of theoretical. The lattice constant was found to be 4.99 Å by the powder method. The Curie temperature is reported as 60°K.[1] Table I gives the pertinent data concerning the resonance. Included in Table I are the electron paramagnetic resonance (epr) results of Low and Shaltiel[2] and the results of an nmr experiment on the europium in EuS.[3] We may extract one number which compares directly with the data of Low and Shaltiel; that is, the ratio μ^{155}/μ^{157}, our number being 0.753 ± 0.005, theirs being 0.744 ± 0.007.

The line shape is the most interesting point of this study. The trivalent gadolinium ground state is $^8S_{7/2}$ which is the same as that of divalent europium. The crystal structure of GdN and EuS are the same with only a difference in lattice parameter (5.00 Å for GdN[4] and 5.96 Å for EuS[5]). EuS is nominally an insulator while GdN is an intermetallic compound ($\rho = 1 \times 10^{-4}$ Ω cm at room temperature).[6] Both materials should be nearly cubic. The two gadolinium isotopes have a quadrupole moment of about 1 barn,[7] while Eu^{153} has a quadrupole moment of about 2.5 barns.[8] In the nmr experiment on EuS, the resonance of the Eu^{153} had five peaks ~450 kc/sec apart, which indicated a quadrupole interaction since I for this isotope was 5/2. Neither of the two resonances for the gadolinium resolved a quadrupole interaction in the way that the europium did, and we may place an upper limit of 300 kc/sec for the quadrupole interaction, e^2qQh^{-1}, for Gd^{155} from the line shape. Nothing can be said for Gd^{157}. Indications are that in both cases, EuS and GdN, the nuclear resonance is due to the usual domain wall enhancement[9] mechanism. It would seem on this basis that the ferromagnet GdN is the more nearly cubic, hence the more perfect from a theoretical point of view than EuS.

In keeping with the smaller ionic radius, the hyperfine interaction for Gd^{3+} is ~370 kOe as compared with 340 kOe for Eu^{2+} on the basis of the data of Table I.

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