

opposite to that shown by the positrons from the μ^+ in (3). The confirmation of these predictions would have paramount importance with respect to a unified classification of the known fundamental particles.

¹ T. Nakano and K. Nishijima, *Progr. Theoret. Phys. Japan* **10**, 581 (1953).

² M. Gell-Mann, *Phys. Rev.* **92**, 833 (1953).

³ R. G. Sachs, *Phys. Rev.* **99**, 1573 (1955).

⁴ *The Proceedings of the Sixth Annual Rochester Conference on High-Energy Physics, 1956* (Interscience Publishers, Inc., New York, 1956).

⁵ Wu, Ambler, Hayward, Hoppes, and Hudson, *Phys. Rev.* **105**, 1413 (1957).

⁶ Garwin, Lederman, and Weinrich, *Phys. Rev.* **105**, 1415 (1957).

⁷ J. I. Friedman and V. L. Telegdi, *Phys. Rev.* **105**, 1681 (1957).

⁸ Coffin, Garwin, Lederman, Weinrich, and Berley, *Bull. Am. Phys. Soc. Ser. II*, **2**, 204 (1957).

⁹ C. S. Wu, *Bull. Am. Phys. Soc. Ser. II*, **2**, 206 (1957).

¹⁰ T. D. Lee and C. N. Yang, *Phys. Rev.* **104**, 254 (1956).

¹¹ T. D. Lee and C. N. Yang, *Phys. Rev.* **105**, 1671 (1957).

Nuclear Quadrupole Moment Ratio of Re^{185} and Re^{187} †

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THE pure nuclear quadrupole resonance spectrum of the natural rhenium isotopes Re^{185} and Re^{187} has been detected in rhenium pentacarbonyl, $\text{Re}_2(\text{CO})_{10}$. Two resonances have been observed for each isotope, corresponding to the $\pm\frac{5}{2} \leftrightarrow \pm\frac{3}{2}$ and $\pm\frac{3}{2} \leftrightarrow \pm\frac{1}{2}$ transitions for spin $I = \frac{5}{2}$. The observed frequencies are listed in Table I.

Since both isotopes have the same spin, the ratio of the nuclear quadrupole moments is given directly by the ratio of the frequencies belonging to the same transition. The mean value of the two ratios is $Q(\text{Re}^{185})/Q(\text{Re}^{187}) = 1.056 \pm 0.005$. This is almost exactly the average of the values 1.085 and 1.020 obtained by Schüler and Korsching¹ from measurements on the hfs of the atomic $^8P_{7/2}$ and $^8P_{5/2}$ levels, respectively. All of the resonances are broad and weak (total sample was only 500 mg), and this factor limits the accuracy attainable in the frequency measurements. The $\pm\frac{3}{2} \leftrightarrow \pm\frac{1}{2}$ transitions were at the limit of observability with oscilloscopic presentation using a super-regenerative spectrometer; the $\pm\frac{5}{2} \leftrightarrow \pm\frac{3}{2}$ transitions were only found with the aid of a lock-in detector and integrating circuit.

TABLE I. Nuclear quadrupole resonance frequencies in Mc/sec of rhenium isotopes in $\text{Re}_2(\text{CO})_{10}$ at room temperature.

Transition	$\nu(\text{Re}^{185})$	$\nu(\text{Re}^{187})$	$\nu(\text{Re}^{185})/\nu(\text{Re}^{187})$
$\pm\frac{5}{2} \leftrightarrow \pm\frac{3}{2}$	28.836 ± 0.030	27.191 ± 0.030	1.060 ± 0.003
$\pm\frac{3}{2} \leftrightarrow \pm\frac{1}{2}$	39.650 ± 0.080	37.730 ± 0.080	1.051 ± 0.006

In most compounds formed by transition metals the metal atom occupies a position of such high symmetry that a quadrupole coupling is precluded. In the dinuclear and polynuclear metal carbonyls,^{2,3} however, one of the six bonds may differ at least in ionic character from the other five. For example, in $\text{Re}_2(\text{CO})_{10}$ each metal atom is octahedrally coordinated by five carbonyl groups and the other metal atom.⁴ Even a small electric field gradient can lead to a significant coupling energy since most of the transition metals appear to have fairly large quadrupole moments. Thus, one might hope to find pure quadrupole resonances in appropriate compounds of iridium, ruthenium, and molybdenum, for example. Although the details of the chemical bonding in such compounds are probably not sufficiently well known to permit an accurate determination of the quadrupole moments themselves, the moment ratios of the isotopes can be unambiguously evaluated.

We wish to acknowledge the loan of the sample of rhenium pentacarbonyl from Dr. L. F. Dahl of this Laboratory. A discussion of the significance of these observations for understanding the bond properties of rhenium pentacarbonyl will appear elsewhere.

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¹ H. Schüler and H. Korsching, *Z. Physik* **105**, 168 (1937).

² J. C. Bailar, *Chemistry of the Coordination Compounds* (Reinhold Publishers, New York, 1956).

³ J. W. Cable and R. K. Sheline, *Chem. Revs.* **56**, 1 (1956).

⁴ Dahl, Ishishi, and Rundle, *J. Chem. Phys.* (to be published).

Radiative Corrections to the Asymmetry Parameter of Low-Energy Positrons in Muon Decay*

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THE distribution of decay positrons from a polarized positive muon, integrated over the entire energy spectrum, is peaked backward with respect to the muon momentum.¹ On the basis of this, the two-component neutrino theory² predicts that the positron distribution should be peaked forward in the low-energy region. Simple calculation shows that the asymmetry parameter can be as large as 0.26 when the spectrum is integrated from 0 to 10 Mev. However, preliminary experimental results³ indicate that the angular distribution of positrons is almost isotropic in this energy range.

The purpose of this note is to report on the radiative correction to the asymmetry of low-energy positrons of μ^+ decay in the two-component neutrino theory. As was discussed before,⁴ the radiative correction is quite large at the lower end of the decay spectrum. Furthermore, it tends to reduce the asymmetry there because some of the low-energy positrons correspond to higher