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THE NUCLEAR SPIN OF 12.6-HOUR IODINE-130

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The nuclear spin of 12.6-hr I^{130} has been measured by means of an atomic-beam magnetic-resonance experiment and found to be 5. The apparatus used to make this measurement was designed for the observation of the nuclear spins and hyperfine structure of the radioactive halogen isotopes and has been described elsewhere.[1]

The I^{130} was produced in the Berkeley 60-inch cyclotron by bombarding powdered tellurium metal with 12-Mev protons, by the use of the reaction $Te^{130}(p,n)I^{130}$. The radioactive iodine was evaporated from the target material in an electric furnace and collected upon a cooled platinum disc. The iodine was washed from the disc with sodium hydroxide solution containing sodium iodide carrier, and the mixture of radioactive and natural iodine was precipitated in acid solution by $NaNO_2$ oxidizing agent. After the iodine was extracted into carbon disulfide containing additional iodine carrier, the solution was evaporated to dryness under vacuum and introduced into the apparatus through a heated platinum tube to dissociate the I_2 molecules to iodine atoms. The beam was collected upon buttons previously sprayed with evaporated silver, and then counted in continuous-flow methane proportional counters.

The nuclear spin of the radioactive sample was measured by the method described in Reference 1. For normal ordering of the hyperfine levels in atoms such as the halogens, with $^2P_{3/2}$ electronic ground state, two "flop-in" resonances are observable at each value of the magnetic field. For spin $I \geqslant 1$ these may be denoted as

$$\alpha: (F = I + 3/2,\ M_F = -I + 1/2) \rightarrow (F = I + 3/2,\ M_F = -I - 1/2)$$

and

$$\beta: (F = I + 1/2,\ M_F = -I + 3/2) \rightarrow (F = I + 1/2,\ M_F = -I + 1/2).$$

Both resonances have been observed in I^{130} at three different magnetic fields of 2.86, 8.56, and 14.24 gauss. Fig. 1 exhibits two typical resonances obtained at a

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field of 8.56 gauss. Positive identification of the isotope was made by means of its decay half-life, and by analysis of its gamma-ray spectrum using a 100-channel pulse-height analyser.

The value of 5 for the nuclear spin of I^{130} is consistent with the single-particle shell model of the nucleus.[2] The spins of I^{129} and I^{131}, both with an even number of neutrons, are known to be 7/2. If in I^{130} the odd proton is assigned to the $1g_{7/2}$ level and the odd neutron to the $2d_{3/2}$ level, Nordheim's weak rule applies, and the observed spin results from a coupling of j_n and j_p to their maximum permissible value. If on the other hand the odd neutron is assigned to the neighboring $1h_{11/2}$ level, Nordheim's strong rule applies and a spin of 2 can be expected.[3] It is thus likely that the odd neutron in I^{130}, as in ${}_{54}Xe^{131}_{77}$ occupies the $2d_{3/2}$ level.

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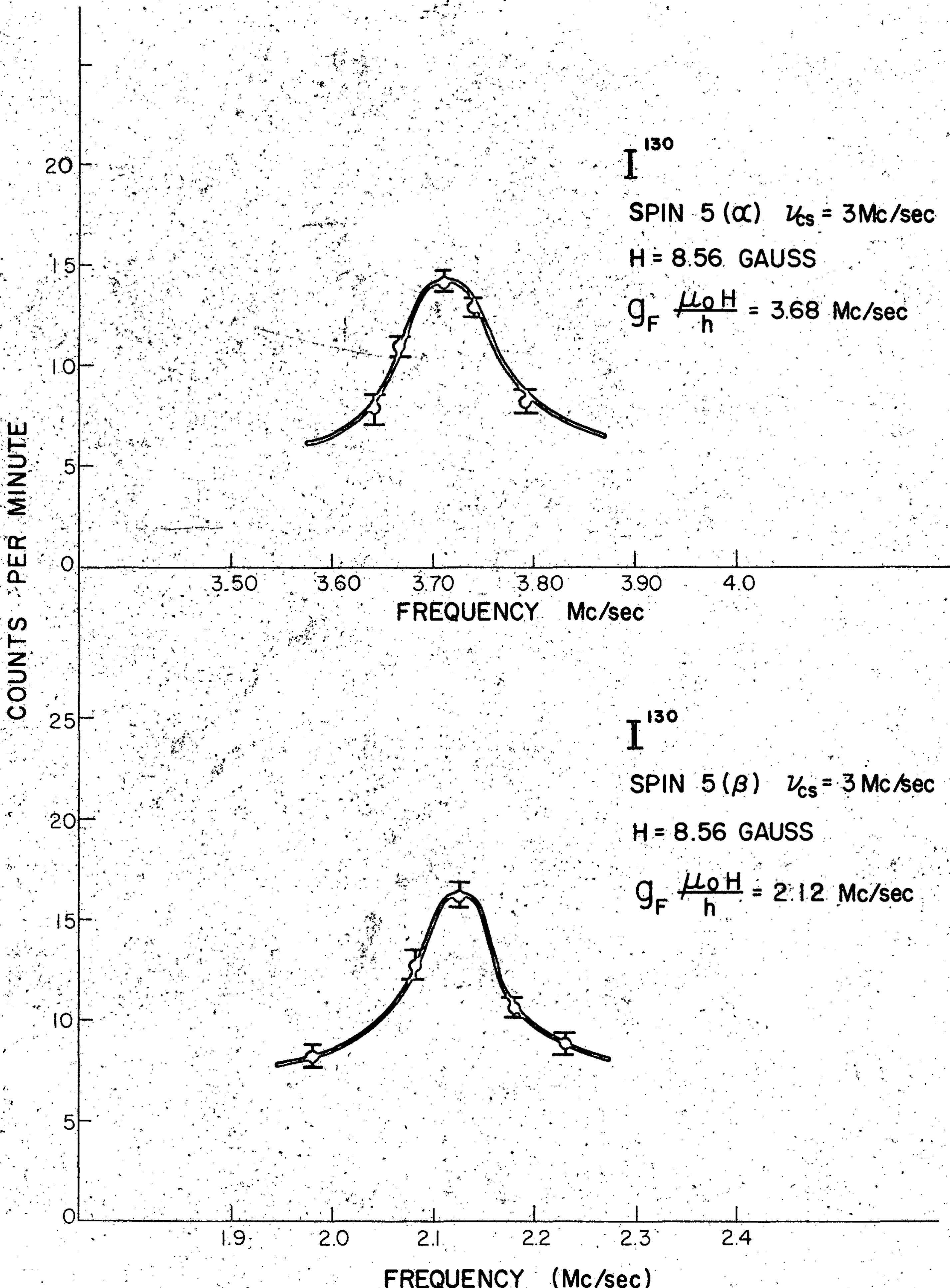
Fig. 1. Spin 5(α) and 5(β) resonances in I^{130}.



COUNTS PER MINUTE
I 130
SPIN 5 (α) ν cs = 3 Mc/sec
H = 8.56 GAUSS
g F μo H / h = 3.68 Mc/sec
FREQUENCY Mc/sec
I 130
SPIN 5 (β) ν cs = 3 Mc/sec
H = 8.56 GAUSS
g F μo H / h = 2.12 Mc/sec
FREQUENCY (Mc/sec)
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