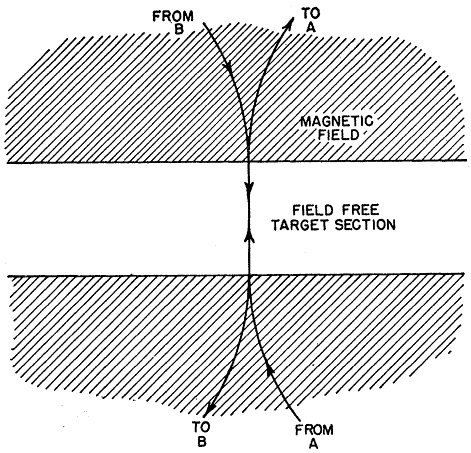

FIG. 1. The target straight section. B and A can be adjacent or concentric fixed-field alternating-gradient accelerators.

the necessary number, N, of particle groups. Assume for simplicity that synchrotron and betatron phase space are separately conserved, so that for the former

$$(\Delta p)_f(\Delta S)_f = N(\Delta p)_i(\Delta S)_i,$$

where ΔS and Δp are the arc length and momentum spread at injection and final energy. Then, employing the fact that $P\sim R^{k+1}$, where R is the radius and k is the field index, one obtains

$$N = 2(k+1)(\Delta R/R)(p_f/p_i)(\Delta S_f/\Delta S_i)(E_i/\Delta E_i).$$

Using typical numbers such as

$$(p_f/p_i)\sim 100, \quad k\sim 100, \quad R\sim 0.5 \text{ cm},$$
$$R\sim 10^4 \text{ cm}, \quad (\Delta E_i/E_i)\sim 10^{-3},$$

one finds that there is room for $N\sim 10^3$ frequency-modulation cycles.

The betatron phase space available is so large that it cannot be filled in one turn by the type of injectors used in the past which can inject 10^{11} particles. Thus there is the possibility of attaining and exceeding the yield used for this example by improving injection.

The more difficult problem of whether one can, in fact, use all of the synchrotron and betatron phase space depends in detail upon the dynamics of the proposed scheme and this is presently under study.

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[3] We are indebted to Professor E. Wigner who pointed out to us the importance of this consideration.

Nuclear Spins of Mo^{95} and Mo^{97}

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IN a recent publication[1] Murakawa concludes from optical hfs data that the nuclear spins of Mo^{95} and Mo^{97} are each $I=7/2$. On the other hand, previous optical data[2,3] and nuclear resonance data[4] have led to the value $I=5/2$, in agreement with the predictions of the nuclear shell model. All of these estimates depend on relative intensity measurements and may be to some extent uncertain. We wish to confirm that the nuclear spins of these isotopes are in fact $I=5/2$, as measured by the paramagnetic resonance method.[5] There is no uncertainty since one has only to count the $2I+1=6$ hyperfine lines in the spectrum (Fig. 1).

The measurements were made on crystals grown from an HCl solution containing the colorless diamagnetic salt $K_3(InCl_6)\cdot 2H_2O$ and the pink paramagnetic salt $K_3(MoCl_6)$ with Mo:In$\sim$1:100. Under suitable conditions it could be arranged that the molybdenum in the mixed crystal was either in a trivalent state (Mo^{3+}, $4d^3$, $S=\frac{3}{2}$, color pink), or in a five-valent state (Mo^{5+}, $4d^1$, $S=\frac{1}{2}$, color green). It is probable that the latter state resulted from oxidation and the formation of molybdyl ions, $(MoO)^{3+}$. Both types of ion gave a similar six-line hfs in its paramagnetic resonance spectrum, and below we give details of the simpler spectrum from Mo^{5+}. In this case, there is a single unpaired electron, $4d^1$, and the lowest energy levels can be described by the spin-Hamiltonian

$$\mathcal{H} = g_{\parallel}\beta H_z S_z + g_{\perp}\beta(H_x S_x + H_y S_y) + A_{\parallel} S_z I_z + A_{\perp}(S_x I_x + S_y I_y);$$

where $S=\frac{1}{2}$, and $I=0$ for the even isotopes of Mo (relative abundance 74.9%), $I=5/2$ for the odd isotopes Mo^{95}(15.7%) and Mo^{97}(9.45%). The spectrum showed that there are two inequivalent types of Mo^{5+} ion (I and II) present with slightly differently oriented axes of symmetry. The values of the constants in the Hamiltonian measured at 20°K using wavelengths $\lambda\approx 3.0$ cm and 1.2 cm were found to be

$$\text{I:}\quad g_{\parallel}=1.951\pm 0.005,\quad g_{\perp}=1.939\pm 0.006,$$
$$A_{\parallel}=0.0079\pm 0.0002 \text{ cm}^{-1},$$
$$A_{\perp}=0.00385\pm 0.0002 \text{ cm}^{-1},$$

$$\text{II:}\quad g_{\parallel}=1.959\pm 0.004,\quad g_{\perp}=1.939\pm 0.006,$$
$$A_{\parallel}=0.0077\pm 0.0002 \text{ cm}^{-1},$$
$$A_{\perp}=0.00385\pm 0.0002 \text{ cm}^{-1}.$$

The tracing of the spectrum shown in Fig. 1 is for the magnetic field H directed fairly close to the z-axes of both ions, and using $\lambda=3.0$ cm. The spectrum of I is

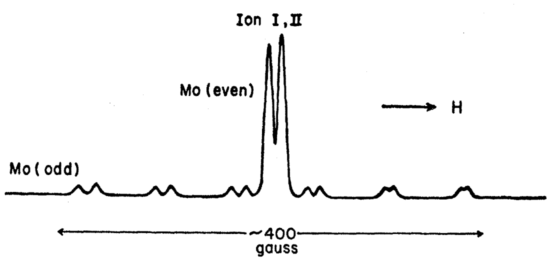

FIG. 1. Tracing of the paramagnetic resonance spectra from the two Mo^{5+} ions, which are nearly superimposed (see text). The large central lines are from Mo (even) and the satellites are from Mo^{95} and Mo^{97}.

slightly separated from that of II because $g(\mathrm{I})\neq g(\mathrm{II})$, and this separation is seen to vary along the pattern because $A(\mathrm{I})\neq A(\mathrm{II})$ for this direction of H. The line width is too great to allow resolution of separate lines from Mo^{95} and Mo^{97}; this is not surprising since the nuclear magnetic moments[4] differ by only 2%.

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