A method frequently employed for a rapid calculation of Zeeman patterns will be given briefly as follows. The separation factors mg, for both the initial and final states, are first written down in two rows with equal values of m directly below or above each other. For a $^2D_{\frac{5}{2}}$–$^2P_{\frac{3}{2}}$ transition they are:

$m =$	$\frac{5}{2}$	$\frac{3}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{3}{2}$	$-\frac{5}{2}$
mg initial state	$\frac{15}{5}$	$\frac{9}{5}$	$\frac{3}{5}$	$-\frac{3}{5}$	$-\frac{9}{5}$	$-\frac{15}{5}$
mg final state		$\frac{6}{3}$	$\frac{2}{3}$	$-\frac{2}{3}$	$-\frac{6}{3}$	

In this array, the vertical arrows indicate the p components, $\Delta m = 0$, and the diagonal arrows the s components, $\Delta m = \pm 1$. The differences expressed with a least common denominator are as follows:

Vertical Differences p Components	Diagonal Differences s Components
$+\frac{3}{15}, +\frac{1}{15}, -\frac{1}{15}, -\frac{3}{15}$	$\pm\frac{15}{15}, \pm\frac{17}{15}, \pm\frac{19}{15}, \pm\frac{21}{15}$

In short these may be abbreviated,

$$\Delta\nu = \frac{(\pm 1), (\pm 3), \pm 15, \pm 17, \pm 19, \pm 21}{15} L \text{ cm}^{-1},$$

the four p components being set in parentheses, followed by the eight s components (see Fig. 10.9).

A simple qualitative rule for the intensities has been given by Kiess and Meggers as follows: If the j values of the two combining terms are equal, the vertical differences at the end of the scheme, and the diagonal differences at the center, give the strongest p and s components respectively. If the j values are not equal, as in the case shown above, the vertical differences in the middle of the scheme and the diagonal differences at the ends give the strongest p and s components, respectively.

Problems

1. Compute the Zeeman pattern (separations and intensities) for the doublet transition $^2G_{9/2}$–$^2H_{11/2}$.

2. Find the total width in wave numbers of the Zeeman pattern of Prob. 1 in a weak field of 5000 gauss.

3. Compute the weak- and strong-field energies for a diffuse-series doublet, and tabulate them as in Table 10.2. Plot the initial and final states, as shown in Fig. 10.1[illegible], and indicate the allowed transitions by arrows.

4. Plot, as in Fig. 10.14, the field-free lines, the weak-field lines, and the strong-field lines of the above example. [NOTE:—Certain components of the forbidden transition $^2P_{1/2}$–$^2D_{5/2}$ appear in strong fields and should be indicated (see Fig. 13.14).

5. What field strength would be required to carry the first member of the principal series of sodium over to the Paschen-Back effect where the separation of the resultant normal triplet (see Fig. 10.14) is four times the fine-structure separation of the field-free doublet?