9.8: Zeeman Components

In this section I give $\mathcal{S}(\mathrm{C})$, the relative strengths of Zeeman components within a line.

I consider first lines for which J changes by 1, and then lines for which J does not change.

$$\underline{\text{Lines connecting } J \text{ to } J-1.}$$

Components connecting M to $M-1$:

$$\mathcal{S}(\mathrm{C}) = (J+M_>)(J+M_<) \tag{9.8.1}$$

Components connecting M to $M+1$:

$$\mathcal{S}(\mathrm{C}) = (J-M_<)(J-M_>). \tag{9.8.2}$$

Components in which M does not change:

$$\mathcal{S}(\mathrm{C}) = 4(J+M)(J-M). \tag{9.8.3}$$

In these equations J is the larger of the two J-values involved in the line; $M_>$ and $M_<$ are, respectively, the larger and the smaller of the two M-values involved in the component. Note that these formulas are not normalized to a sum of unity. In order to do so, the strength of each component should be divided by the sum of the strengths of all the components – i.e. by the strength of the line.

Example 9.8.1

Consider the Zeeman pattern of figure VII.1. The strength factors for each of the nine components, reading from left to right in the figure, will be found to be

0 2 6 12 16 12 6 2 0

Normalized to unity, these are

0.0000 0.0357 0.1071 0.2143 0.2857 0.2143 0.1071 0.0357 0.0000

As described in section 7.27 in connection with figure VII.1, the components within each group of three are unresolved, so the relative strengths of the three groups are $\frac{1}{7}$ $\frac{5}{7}$ $\frac{1}{7}$.

Consider also the Zeeman pattern of figure VII.2. The strength factors for each of the six components, reading from left to right in the figure, will be found to be

2 6 8 8 6 2

or, normalized to unity,

$$\tfrac{1}{16}\ \tfrac{3}{16}\ \tfrac{4}{16}\ \tfrac{4}{16}\ \tfrac{3}{16}\ \tfrac{1}{16}.$$

$$\underline{\text{Lines for which } J \text{ does not change.}}$$

Components for which M changes by ± 1

$$\mathcal{S}(\mathrm{C}) = (J+M_<)(J-M_>). \tag{9.8.4}$$

Components for which M does not change:

$$\mathcal{S}(\mathrm{C}) = 4M^2. \tag{9.8.5}$$

Example 9.8.2

For a line $J-J=2-2$, the relative strengths of the components are

M'	M''	$\mathcal{S}(\mathrm{C})$
-2	-2	16
-2	-1	4
-1	-2	4
-1	-1	4
-1	0	6
0	-1	6
0	0	0
0	1	6
1	0	6
1	1	4
1	2	4
2	1	4
2	2	16

(9.8.6)