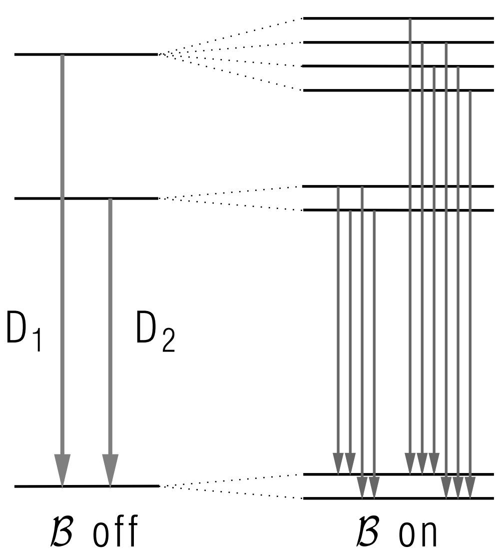
MISN-0-315

ANOMALOUS ZEEMAN EFFECT AND THE LANDÉ g-FACTOR



Project PHYSNET Physics Bldg. Michigan State University East Lansing, MI

ANOMALOUS ZEEMAN EFFECT AND THE LANDÉ g-FACTOR

by

J. H. Hetherington

Title: **Anomalous Zeeman Effect and the Landé g-Factor**

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Length: 1 hr; 8 pages

Input Skills:

1. Vocabulary: angular momentum quantization, Bohr magneton, energy level splitting, (MISN-0-251); total angular momentum (MISN-0-244); atomic transition (MISN-0-215).
2. Determine the energy of a magnetic dipole in a magnetic field (MISN-0-251).
3. Be familiar with electron spin and spectroscopic notation (MISN-0-244).

Output Skills (Knowledge):

K1. Derive the Landé g-factor.

K2. Compare the anomalous Zeeman effect to the normal Zeeman effect.

Output Skills (Problem Solving):

S1. Given a particular transition in terms of spectroscopic notation, determine the number of Zeeman components and their splittings in a weak magnetic field.

External Resources (Required):

1. R. T. Weidner and R. L. Sells, *Elementary Modern Physics*, alt. 2nd ed., Allyn and Bacon, (1973). For access, see this module's *Local Guide*.
2. H. Semat and J. R. Albright, *Introduction to Atomic and Nuclear Physics*, 5th ed., Holt, Rinehart, Winston (1972). For access, see this module's *Local Guide*.

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1. Study Program

1. Work Problems 7-32 and 7-33 in WSM.[1]
2. Read supplementary material (Sec. 9-16) from SA.[2]

   This may help you work Problem 7-32 above.
3. Read SA, Section 8-16.
4. Determine the Zeeman splitting of the $2^1\mathrm{P}_1 \rightarrow 1^1\mathrm{S}_0$ line in He and the $2^3\mathrm{P}_1 \rightarrow {}^1\mathrm{S}_0$ line in He.
5. Determine the splitting in the $3^3\mathrm{D}_2 \rightarrow 3^3\mathrm{P}_1$ line in Ca.
6. Determine the splitting in the $3^2\mathrm{D}_{3/2} \rightarrow 3^2\mathrm{P}_{1/2}$ line of Na.

Acknowledgments

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[1] R. T. Weidner and R. L. Sells, *Elementary Modern Physics* 3rd ed., (Allyn and Bacon, Boston: 1980. For access, see this module's *Local Guide*.

[2] H. Semat and J. R. Albright, *Introduction to Atomic and Nuclear Physics*, 5th ed. (Holt, Rinehart, Winston, New York, 1972. For access, see this module's *Local Guide*.

LOCAL GUIDE

The readings for this unit are on reserve for you in the Physics-Astronomy Library, Room 230 in the Physics-Astronomy Building. Ask for them as "The readings for CBI Unit 315." Do **not** ask for them by book title.

PROBLEM SUPPLEMENT

Note: The problem below also occurs on this module's *Model Exam*.

1. Determine the number of Zeeman components and splittings in the $3^2\mathrm{P}_{3/2} \to 3^2\mathrm{S}_{1/2}$ line of Na in a weak magnetic field of magnitude B.

Brief Answers:

1. There are 6 components of the original line, ν_0:

$$\begin{aligned}
\nu_1 &= \nu_0 + \Delta\nu \\
\nu_2 &= \nu_0 - \frac{1}{3}\Delta\nu \\
\nu_3 &= \nu_0 + \frac{5}{3}\Delta\nu \\
\nu_4 &= \nu_0 - \frac{5}{3}\Delta\nu \\
\nu_5 &= \nu_0 + \frac{1}{3}\Delta\nu \\
\nu_6 &= \nu_0 - \Delta\nu
\end{aligned}$$

where $\Delta\nu = eB/4\pi m$; e is the charge of an electron and m is the mass of an electron.

MODEL EXAM

1. See Output Skills K1-K2 in this module's *ID Sheet*.
2. Determine the number of Zeeman components and splittings in the $3^2\mathrm{P}_{3/2} \to 3^2\mathrm{S}_{1/2}$ line of Na in a weak magnetic field of magnitude B.

Brief Answers:

1. See this module's *text*.
2. See this module's *Problem Supplement*, problem 1.