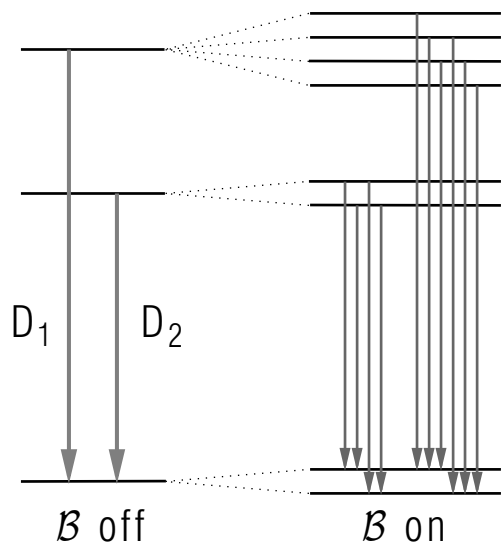


## ANOMALOUS ZEEMAN EFFECT AND THE LANDÉ $g$ -FACTOR



## ANOMALOUS ZEEMAN EFFECT AND THE LANDÉ $g$ -FACTOR

by  
J. H. Hetherington

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

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Evaluation: Stage B0

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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New authors, reviewers and field testers are welcome.

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by

**J. H. Hetherington**

### 1. Study Program

1. Work Problems 7-32 and 7-33 in WSM.<sup>1</sup>
2. Read supplementary material (Sec. 9-16) from SA.<sup>2</sup>  
This may help you work Problem 7-32 above.
3. Read SA, Section 8-16.
4. Determine the Zeeman splitting of the  $2^1P_1 \rightarrow 1^1S_0$  line in He and the  $2^3P_1 \rightarrow 1^1S_0$  line in He.
5. Determine the splitting in the  $3^3D_2 \rightarrow 3^3P_1$  line in Ca.
6. Determine the splitting in the  $3^2D_{3/2} \rightarrow 3^2P_{1/2}$  line of Na.

### Acknowledgments

Preparation of this module was supported in part by the National Science Foundation, Division of Science Education Development and Research, through Grant #SED 74-20088 to Michigan State University.

## 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.

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<sup>1</sup>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*.

<sup>2</sup>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*.

## 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  $3^2P_{3/2} \rightarrow 3^2S_{1/2}$  line of Na in a weak magnetic field of magnitude  $B$ .

### Brief Answers:

1. There are 6 components of the original line,  $\nu_0$ :

$$\nu_1 = \nu_0 + \Delta\nu$$

$$\nu_2 = \nu_0 - \frac{1}{3}\Delta\nu$$

$$\nu_3 = \nu_0 + \frac{5}{3}\Delta\nu$$

$$\nu_4 = \nu_0 - \frac{5}{3}\Delta\nu$$

$$\nu_5 = \nu_0 + \frac{1}{3}\Delta\nu$$

$$\nu_6 = \nu_0 - \Delta\nu$$

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  $3^2P_{3/2} \rightarrow 3^2S_{1/2}$  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.