Measuring the Zeeman Effect

November 16, 2016

Abstract

1 Introduction

1.1 Historical Background

1.2 Theory of the Zeeman Effect

2 Methods and Procedures

The Pasco Scientific Model SE-9654 Zeeman Effect Experiment was used to make all observations. The experiment consisted of two large solenoids oriented along the same axis with an air gap between them in which a mercury lamp was placed. An optical rail was used to align a polarizing filter, a collimating lens, an interference filter, a Fabry-Perot interferometer, and a CMOS camera. The basic experimental technique consisted of imaging the interference pattern of the 546.1 nm mercury spectral line through the polarizer and Fabry-Perot interferometer. Figure

To study the Zeeman effect, observations of a mercury lamp were made first with no magnetic field and 90 deg polarization, then with an approximately $1T$ magnetic field. Observations with a magnetic field included:

- 90 deg (field-perpendicular) polarization
- 0 deg (field-parallel) polarization
- No polarization
- Axial B-field at polarization varying from 90 deg to 0 deg

Figure 3 shows the perpendicular and axial configurations of the magnetic field used for the observations.

The observations and results of each of these field configurations will be presented and discussed in Section 3.

2.1 Method Description

3 Data and Results

3.1 Spectra Through a Perpendicular Magnetic Field

3.1.1 Spectra with Field-Perpendicular Polarization

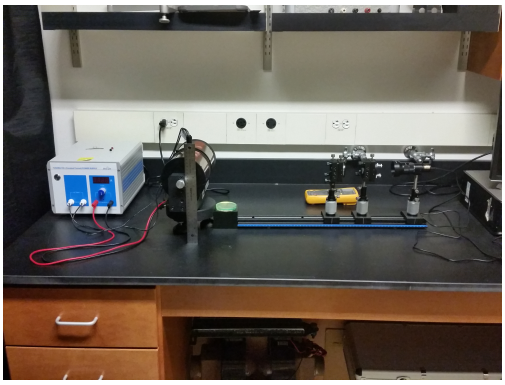
3.1.2 Spectra with Field-Parallel Polarization

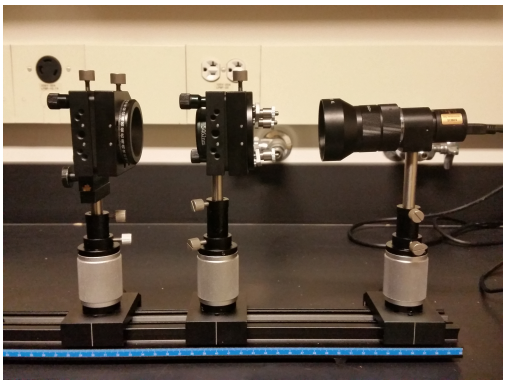
3.2 Spectra Along an Axial Magnetic Field

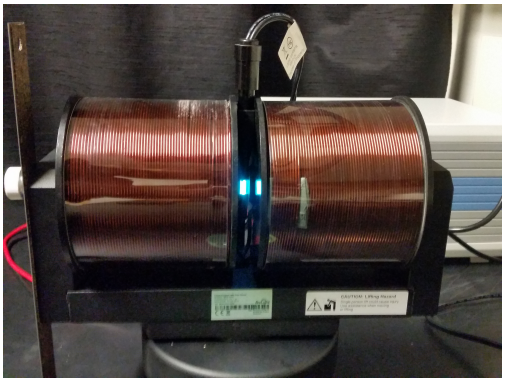
3.3 Measurement of the Bohr Magneton

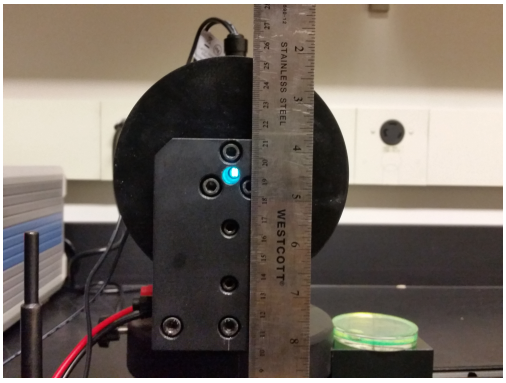
With the precise measurement of spectral line splitting in the presence of the perpendicular magnetic field, it was possible to measure the value of the Bohr magneton.

4 Conclusion





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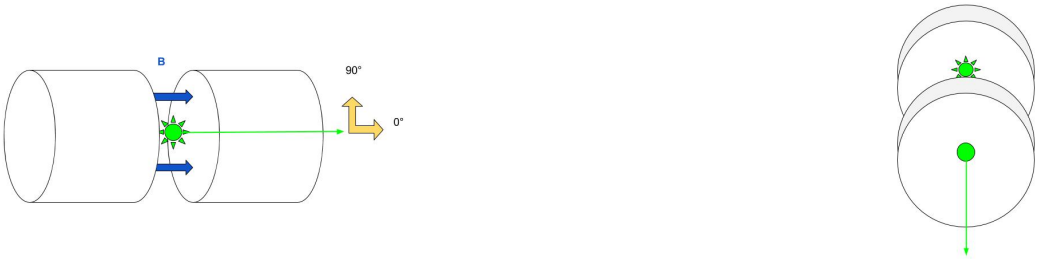

(a) Perpendicular field configuration.

(b) Axial field configuration.

Figure 3: The two magnetic field configurations observed. In (3a), the magnetic field is oriented perpendicularly to the path of the observed light from the mercury lamp. 90 deg polarization is defined to be perpendicular to the field lines, while 0 deg polarization is parallel to the field lines. In configuration (3b), light from the lamp travels along the magnetic field lines down the center of one of the solenoids through a sight hole.