A study of a J=1→J=1 system in Samarium with resonant laser radiation at 686 nm

by

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Contents

Abstract

An J=1$\rightarrow$J=1 atomic system in Samarium with incident laser resonant radiation has been investigated. A linearly polarized laser at 686nm excites atoms from the level $4f^6 6s^2\ {}^7F_1$ to a excited level $4f^6 6s6p\ {}^9F_1$ via the process of optical pumping. When an external magnetic field is applied to the atom-laser interaction and the decay fluorescence collected, a level-crossing profile appears. Theoretical predictions of the level-crossing profile can be made using spherically irreducible tensors to describe the density matrix which take advantage of the symmetry of the atomic system. By comparing theory with experimental data, a discussion is made of the various parameters and external factors that can affect this system, which show that Doppler broadening is the major influence. An additional investigation is made into the evolution of the J=1$\rightarrow$J=1 atomic system with increasing laser exposure. Comparisons of the experimental data with theoretical predictions are made by analyzing the FWHM of the overall level-crossing profile, the FWHM of the dip about $B = 0$ and the relative depth of the dip. By charting the progress of these parameters with increasing laser exposure, it can be seen that the theory and experimental data agree qualitatively.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any University or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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List of Symbols

Throughout this thesis, several symbols will be used repeatedly to represent specific quantities or parameters, the following is a list of these symbols and short descriptions for the reader's convenience. Wherever possible standard symbols and notation have been used which appear in major references.

J	Angular momentum quantum number	p. 1
m	Magnetic quantum number	p. 2
ΔB	Width of the Hanle curve at half maximum	p. 5
$\hbar$	Planck's constant	p. 5
τ	Lifetime of the excited state	p. 5
μ_B	Bohr Magneton	p. 5
g_J	Landé factor of the excited state	p. 5
$E(t)$	Electric field	p. 12
Γ_J	Relaxation rate	p. 12
ω_0	Angular frequency	p. 12
t	Time	p. 12
t_0	Initial time of excitation	p. 12
i	Imaginary number $\sqrt{-1}$	p. 12
ω_{La}	Larmor angular frequency	p. 13
$\mathbf{v}$	Velocity of electron	p. 13