Polarisation and Alignment Studies in Electron Scattering From Rubidium

by

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“Deep in the human unconsciousness is a pervasive need for a logical universe that makes sense. But the real universe is always one step beyond logic.”

Paul 'Muad Dib' Atreides, from Dune by Frank Herbert
This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

.......................................

William Edward Guinea
Abstract

Measurements have been made of the $A_2$ spin asymmetry in the scattering of polarised electrons from rubidium atoms. Results have been taken at an incident energy of 15, 20, 30, 50 and 80eV for elastic scattering, and at 15, 20, 30 and 50eV for 5S to 5P excitation where the fine structure has not been resolved. The measurements covered the angular range 30° to 110°. Results were taken using a crossed beam type experiment, with a hemispherical electrostatic detector. Polarised electrons were provided by a conventional gallium arsenide spin-polarised electron source. The R-matrix and relativistic distorted wave calculations available demonstrate good agreement with the experimental results, though there are some clear discrepancies between the magnitudes and positions of the extrema as predicted by theory. These $A_2$ results follow on from those taken by Went (2003).

A study of the autoionisation resonances of rubidium has also been undertaken. This consisted of first measuring the angular variation of the autoionisation resonances in the angular range 30° to 130°, at an incident energy of 1keV. A crossed beam method was also used for these results, though electrons were provided by a conventional electron gun. Significant relative angular variation between sets of autoionisation resonances was observed. The results taken represent the first experimentally determined values of the alignment parameter, $A_{20}$ and $R_0$, the isotropic distribution ratio for the leading autoionisation doublet of rubidium. The experimentally determined values of $A_{20}$ and $R_0$ were not inconsistent with the theoretical values available for comparison.

Finally an attempt was made to measure a circular dichroism in the angular distribution of autoionised electrons due to stepwise laser/electron impact excitation (CPDAD). The experimental detection of such a circular dichroism would be the very first of its kind. Such a measurement would also help validate the theoretical approach that predicted its existence. Preliminary investigation requires identification of an autoionisation resonance that is enhanced with the stepwise excitation procedure. A crossed beam experiment identical to the procedure immediately above was undertaken using a conventional electron gun. Laser light resonant with the D2 line of
rubidium was provided by a titanium-sapphire laser, while a diode laser was used to repump the dark state. Measurements were taken at incident energies of 250, 450, 700 and 1000eV at ejected electron angles of 75°, 75°, 90° and 90° respectively. No enhancement was visible with the stepwise process for any of the observed autoionisation resonances, so it was not possible to study CPDAD.
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