

# Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Introduction</b>   | <b>1</b>  |
| <b>2</b> | <b>Background</b>   | <b>7</b>  |
| 2.1      | Magnons in localized moment systems . . . . .                   | 7         |
| 2.1.1    | The quasi-classical counterpart of a magnon . . . . .           | 7         |
| 2.1.2    | A magnon in quantum mechanics . . . . .                         | 10        |
| 2.1.3    | Magnons in thin ferromagnetic films . . . . .                   | 12        |
| 2.2      | Stoner excitations in itinerant-electron ferromagnets . . . . . | 16        |
| 2.3      | Electron scattering . . . . .                                   | 18        |
| 2.3.1    | Low-energy inelastic electron scattering . . . . .              | 18        |
| 2.3.2    | Spin-dependent effects in elastic electron scattering . . . . . | 19        |
| <b>3</b> | <b>Experimental techniques</b>                                  | <b>23</b> |
| 3.1      | Spin-polarized electron energy loss spectroscopy . . . . .      | 23        |
| 3.1.1    | Spin polarized inelastic electron scattering . . . . .          | 23        |
| 3.1.2    | Principles of SPEELS . . . . .                                  | 25        |
| 3.2      | The experimental setup . . . . .                                | 27        |
| 3.2.1    | The ultra high vacuum system . . . . .                          | 27        |
| 3.2.2    | SPEEL-spectrometer . . . . .                                    | 28        |
| 3.2.3    | The GaAs-photocathode . . . . .                                 | 30        |
| <b>4</b> | <b>Results</b>  | <b>33</b> |
| 4.1      | The Co/Ir(001) system . . . . .                                 | 33        |
| 4.1.1    | Sample preparation and characterization . . . . .               | 33        |
| 4.1.2    | MOKE measurements . . . . .                                     | 36        |
| 4.1.3    | SPEELS measurements . . . . .                                   | 40        |
| 4.2      | The Co/Cu(001) system . . . . .                                 | 49        |
| 4.2.1    | SPEELS measurements . . . . .                                   | 49        |
| 4.3      | The Co/Pt(111) system . . . . .                                 | 53        |
| 4.3.1    | Sample preparation and characterization . . . . .               | 53        |
| 4.3.2    | MOKE measurements . . . . .                                     | 54        |

|          |   |           |
|----------|---|-----------|
| 4.3.3    | SPEELS measurements . . . . .                               | 55        |
| <b>5</b> | <b>Discussion</b>   | <b>63</b> |
| 5.1      | Film structure and substrate dependence . . . . .           | 63        |
| 5.1.1    | “Acoustic” magnons in Co and Fe films . . . . .             | 63        |
| 5.1.2    | Confined magnon modes in the 3 ML Co films . . . . .        | 67        |
| 5.2      | Confined magnon modes in the Heisenberg model . . . . .     | 71        |
| 5.3      | Layer-dependent exchange parameters . . . . .               | 76        |
| 5.4      | Impact of the electronic structure on the magnons . . . . . | 85        |
| 5.5      | The magnon lifetime . . . . .                               | 89        |
| 5.5.1    | “Acoustic” magnons in Co and Fe films . . . . .             | 89        |
| 5.5.2    | Confined magnon modes . . . . .                             | 92        |
| <b>6</b> | <b>Conclusions and outlook</b>                              | <b>95</b> |
| <b>A</b> | <b>Description of spin-polarized electrons</b>              | <b>99</b> |