Spin Dependent Exchange Scattering from Ferromagnetic Materials

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Abstract

The insights of our recent work [1,2] on the local density approximations to the exchange and correlation potentials have been used to find an improved potential for the elastic scattering of electrons from ferromagnetic materials. Hara exchange coupled with a Hedin-Lundqvist electron-gas-type correlation potential joined to an adiabatic polarization potential gives good predictions for differential cross sections. The spin asymmetry parameter S and the differential cross sections have been calculated. Comparison of predictions with observed spin dependent scattering intensities in amorphous magnetic alloys will give insight into surface magnetization in these systems.

Electron collision with atoms is one of the fundamental processes in nature and has been attracting interests both experimentally and theoretically for a long time. In previous work on elastic scattering of slow electrons from closed shell targets, Ne, Ar, Kr, and Xe atoms [3,4] and from open shell targets [5], in which we employed various local-density approximations to the exchange and correlation potentials , we concluded that Hara exchange [6] coupled with a Hedin-Lundqvist electron-gas-type correlation potential [7] joined to an adiabatic polarisation potential gives excellent predictions for phaseshifts and differential cross sections for closed-core rare-gas-atom systems with well defined atomic radii and open shell targets. Are such potentials appropriate for solids?

Out to distances of order of the atom size exchange and correlation are likely to be similar in atoms and solids, but beyond an atomic radius an electron in a solid senses the potential of many atoms and, within the muffin-tin approximation, this is simulated by a constant potential between atoms. The long range polarization potential, which is important in describing low energy electron scattering, will tend to be averaged out in the interatomic region. A spin polarised scattering from atoms in solids with net spin is a more direct test of the exchange potential, e.g. in Ni and Fe of the first transition series. The elastic scattering intensities $I_{\uparrow\uparrow}$ ($I_{\uparrow\downarrow}$) differ according to whether the incident electron spin is parallel or anti-parallel to the atomic spin direction. The spin asymmetry parameter S is then defined as : $S = (I_{\uparrow\uparrow} - I_{\uparrow\downarrow}) / (I_{\uparrow\uparrow} + I_{\uparrow\downarrow})$.

References

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