Orbital angular momentum transfer in angle resolved resonant Auger electron emission

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Resonant Auger electron spectroscopy (RAES) combines features of X-ray absorption and Auger emission. Through the absorption process, it is sensitive to ground state properties such as valence, bonding and magnetic moment, whereas the Auger electron angular distribution contains structural information. In photoelectron diffraction, 3D holographic imaging is possible with circular polarized light [1]. In view of extending the holography technique to RAES, a crucial question is to what extend the photon angular momentum is transferred to the Auger electrons [2]. Here we present a theoretical study of 2p3d3d-RAES of transition metals in a ligand field multiplet model. Figure 1 shows the energy distribution of the emitted electrons of a free Ni2+ ion. “PES” (black) is the non-resonant photoemission spectrum and L3-RAES (red) corresponds to the 2p3/2-3d resonance. The RAES is dominated by the 1G multiplet final state, in agreement with experimental data. Figure 2 shows the orbital angular momentum <Lz> of the emitted electrons as a function of the angle Θ between the light incidence and the electron emission direction for (+) circular polarized light. This calculation was done in zero magnetic field and artificially switched off 3d spin-orbit coupling such that the ground state is fully unpolarized. It is seen that for non-resonant PES, <Lz> is always positive and so the helicity of the photon is transferred to the orbital moment of the photoelectrons as expected. For RAES in contrast, <Lz> can be positive and negative depending on the final state multiplet. While the dominant, singlet 1G peak has the usual Lz > 0 behavior, the triplet 3F state has Lz < 0, i.e. the Auger electrons have opposite orbital moment than the photons. Such reversed angular moment transfer has recently been observed in 2p3p3d resonant Auger electron diffraction [2] and is related to the interplay between core-hole spin-orbit coupling and exchange decay [3].

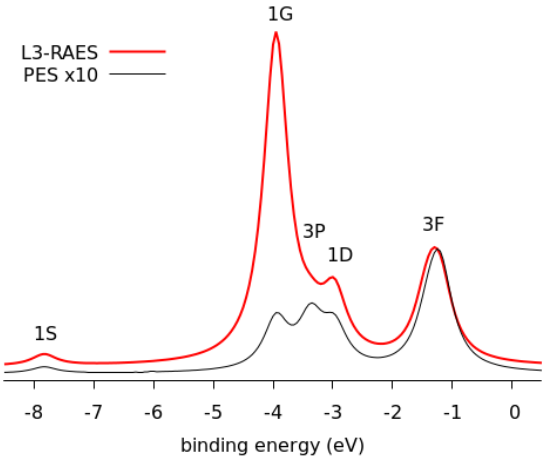

Fig.1

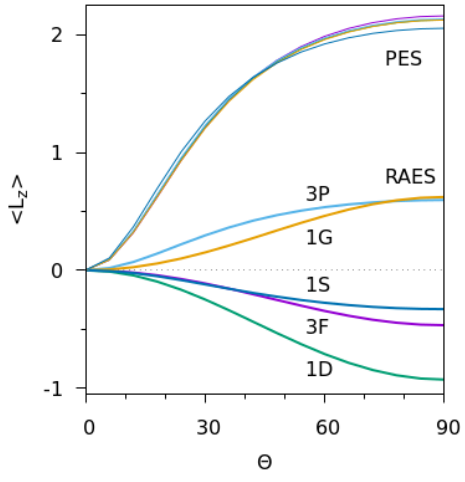

Fig.2

[1] H. Daimon, Phys. Rev. Lett. 86, 2034 (2001). [2] F. Matsui et al., Phys. Rev. B 97, 035424 (2018). [3] F. da Pieve and P. Krueger, Phys. Rev. Lett. 110, 127401 (2013).