Angle resolved photoelectron spectroscopy on simple metal clusters

B.v. Issendorff

Fakultät für Physik, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg, Germany

bernd.von.issendorff@uni-freiburg.de

Photoelectron spectroscopy is a powerful technique for studying the electronic structure of metal clusters and nanoparticles. Continuous improvements in cluster production, cooling, mass selection and photoelectron characterization in recent years now allow highly resolved measurements on free particles over a very broad size range. A wealth of materials has been studied. A special class here are the simple metals, i.e., alkaline and (to a lesser extent) noble metals, the electronic structure of which is dominated by shell effects. Nevertheless the measurements on such clusters reveal a clear influence of their ion lattice structure, which in combination with DFT calculations in many cases allows an unambiguous determination of the geometric structures of the clusters. Even more detailed information can be obtained by angle-resolved photoelectron spectroscopy. As the angular distribution should depend on the angular momentum of the bound state of the emitted electron, this technique in principle allows a characterization of the electronic wavefunctions. For free, cold, size-selected sodium clusters surprisingly diverse angular distributions have been found, with very similar behaviour for the substates of given electron shells. This demonstrates that lattice-induced mixing between different angular momentum states is not very pronounced. More importantly, it shows that electron emission is a fully coherent process, even for the case of the largest cluster studied (Na_{147}). This makes simple metal cluster interesting model systems for the study of coherent many particle dynamics.

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