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The Art of Photoelectron Spectroscopy, from Micro to Nano[1]

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Angle-resolved photoemission spectroscopy (ARPES) was developed for the determination of the electronic bandstructure of solids. In the last 20 years, ARPES has become nearly unlimited with respect to instrumental resolution, and therefore able to illuminate more subtle electronic aspects, such as ground-state symmetry breaking and the many-body interactions (MBIs) that characterize ground states such as superconductivity. These MBIs involve exchange of momentum among electrons or with excitations such as phonons, and can therefore couple to nanoscale structures. By controlling the structure at the nanoscale, we can therefore hope to control or enhance the ground state properties of materials through nanoscale engineering. This dream has motivated the development of nanoscale ARPES (nanoARPES) machines that are now coming online worldwide. After a brief overview, I will show the latest results from the new nanoARPES endstation at the MAESTRO facility (Microscopic and Electronic Structure Observatory), a new user beamline commissioned this year at the Advanced Light Source (ALS). We achieved routine operation at spatial resolution around 120 nm, and expect improvement down to 50 nm or better. Examples will include graphene and 2D-metal-chalcogenide heterostructures. I will also discuss the prospects for dramatic improvements expected as new diffraction-limited light sources such as the ALS-U project are realized.

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