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The electronic structure of a liquid Pb film

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Our understanding of the electronic structure of condensed matter in the liquid phase is far from complete. We used angle-resolved photoemission spectroscopy (ARPES) in order to study the evolution of the electronic bands, the Fermi surface and the spectral function of a lead monolayer on Cu(111) as the film went through its melting transition at 568 K [1]. The crystalline copper substrate provides the reciprocal lattice vectors, absent in the liquid state, that are needed in ARPES for wave-number conservation in the excitation process, and the well-resolved copper bands serve as an important reference frame for identifying the dramatic changes in the lead states. Electron spectra and momentum distribution maps of the liquid film reveal three important features: the persistence of a Fermi surface, the filling of band gaps, and the localization of the wave functions upon melting. Distinct coherence lengths for different sheets of the Fermi surface are found, indicating a strong dependence of the localization lengths on the character of the constituent atomic wave functions.

[1] F. Baumberger, W. Auwärter, T. Greber, J. Osterwalder, Science 306, 2221 (2004).