Momentum dependent scaling exponents of cuprate strange-metal self energies: ARPES meets semi-holography

S. Smit[1], E. Mauri[2], L. Bawden[1], F. Heringa[1], F. Gerritsen[1], E. van Heumen[1], Y.K. Huang[1], T. Kondo[3], T. Takeuchi[4], N. E. Hussey[5,6], M. Allan[7], T.K. Kim[8], C. Cacho[9], A. Krikun[9], K. Schalm[10], H.T.C. Stoof[2], M.S.Golden[1,11]

[1] Van der Waals - Zeeman Institute, Institute of Physics, University of Amsterdam
[2] Institute for Theoretical Physics and Center for Extreme Matter and Emergent Phenomena, Utrecht University
[3] Institute for Solid State Physics, University of Tokyo
[4] Energy Materials Laboratory, Toyota Technological Institute, Nagoya
[5] High Field Magnet Laboratory (HFML-EMFL) and Institute for Molecules and Materials, Radboud University, Nijmegen
[6] H. H. Wills Physics Laboratory, University of Bristol
[7] Leiden Institute of Physics, Leiden University
[8] Diamond Light Source
[9] NORDITA, KTH Royal Institute of Technology and Stockholm University
[10] Institute-Lorentz for Theoretical Physics, Leiden University
[11] Dutch Institute for Emergent Phenomena (DIEP), 1098 XH Amsterdam

High resolution ARPES enables the precise experimental determination of the electronic self-energy. Here we present high quality data from the strange metal single-layer cuprate $(Pb,Bi)_2Sr_{2-x}La_xCuO_{6+\delta}$, measured over a wide range in w- and T in the nodal direction. Constant energy cuts through the spectral function have a non-Lorentzian lineshape, meaning the nodal self-energy is k dependent. These experimental data provide a new test for aspiring theories.

We go on to show that the experimental data are captured remarkably well by a power law with a k-dependent scaling exponent, smoothly evolving with doping, a description that emerges naturally from AdS/CFT-based semi-holography, putting a spotlight on holographic methods for the quantitative modelling of strongly interacting quantum materials like the cuprate strange metals [1].

[1] arxiv.org/pdf/2112.06576.