Breaking a metal by low dimensional fluctuations

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Transitions between metals, superconductors and insulators have taken the center stage of solid state research since the dawn of quantum mechanics. Most metal-to-insulator and metal-to-superconductor transitions are so dramatic that some symmetries need to be broken in the material. But it need not be so, especially at low dimensions. Combining ARPES and x-ray scattering techniques, we show that superconducting fluctuations and phonon fluctuations are massively enhanced in low dimensional metals ($Bi_2Sr_2CaCu_2O_8$) and semimetals (Ta_2NiSe_5), which readily change the electronic behaviors therein. These wild fluctuations make metals highly sensitive to external tuning, without needing to break any global symmetry. I will also discuss how to exploit the rich information encoded in these fluctuating states via ever-improving photoemission spectroscopy and data mining methods.

References

[1] He, Chen, Li et al., Phys. Rev. X 11, 031068 (2021)
[2] Chen, Chen et al., arXiv: 2203.06817
[3] Sobota, He, and Shen, Rev. Mod. Phys. 93, 025006 (2021)