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$_2$Sr$_2$CaCu$_2$O$_8$) and semimetals (Ta$_2$NiSe$_5$), 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