

# Understanding the complex states of quantum matter with resonant inelastic x-ray scattering

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Recently resonant inelastic x-ray scattering (RIXS) has positioned itself as one of the main spectroscopic techniques that is used to understand the complex states of quantum matter [1]. In this talk I will give a brief overview of the RIXS technique and describe the experiments which have contributed to such a huge success of RIXS:

In the first part, I will concentrate on the experimental observation of an orbiton —a collective excitation of a solid which carries solely an orbital quantum number —and the concomitant separation of the spin and orbital degrees of freedom of an electron in the quasi-one-dimensional copper oxides [2]. Next, in the second part of the talk, I will discuss how RIXS has observed the collective magnetic excitations in the (doped) copper oxides [3] and how one can understand this phenomenon [4]. I will end the talk by explaining whether this surprising finding could influence the theories of high-temperature superconductivity in these compounds.

[1] L. J. P. Ament et al., *Rev. Mod. Phys.* 83, 705 (2011); C. J. Jia et al, *Phys. Rev. X* 6, 021020 (2016).

[2] J. Schlappa et al., *Nature* 485, 82 (2012).

[3] M. P. M. Dean et al., *Nature Materials* 12, 1019 (2013); W. S. Lee et al., *Nature Physics* 10, 883 (2014); M. Minola, et al., *Phys. Rev. Lett.* 119, 097001 (2017).

[4] C. J. Jia et al, *Nature Communications* 5, 3314 (2014); E. Paerschke et al., *Physical Review B* 99, 205102 (2019).