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# $Ca_2RuO_4$: Excitonic Magnetism & the Higgs mode


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Place: Room 525, Science Bldg. 5 (Physics), Kyoto University


Abstract:

$Ca_2RuO_4$ is a *4d*-electron layered antiferromagnet (AFM) that shows a complex interplay between equivalent spin-orbit coupling (SOC) and electron correlation energies, an area of significant interest in recent years. The focus of the talk is our investigation into the role of SOC in the magnetic ground state using inelastic neutron scattering to map out the full excitation spectrum [1]. Our analysis points to a ground state formed by highly spin-orbit entangled pseudospin magnetic moments, in contrast to the generally accepted model of full orbital quenching by the $RuO_6$ crystal field.

In the strong SOC limit the ground state of $Ca_2RuO_4$ can be described in terms of a pseudospin $J_{eff} = 0$ singlet – $J_{eff} = 1$ triplet ground state. While nominally non-magnetic, we show that the $RuO_6$ octahedral distortions split the excited triplet state such that a now comparable superexchange energy enables singlet-triplet excitations to manifest. A Bose-Einstein condensation of this exciton then leads to long range AF order [2,3].

Our results indicate that the magnetic ground state of $Ca_2RuO_4$ exists in close proximity to a quantum critical point, resulting in a key signature of the model: large amplitude fluctuations manifested by an intense, longitudinal excitonic mode, analogous to the Higgs mode in particle physics. I will discuss our polarized neutron spectroscopy approach and our identification of a well-defined feature in the inelastic spectra as the Higgs mode.



[1] Jain, A. et al., Nature Physics **13**, 633–637 (2017).

[2] Khaliullin, G., Physical Review Letters **111**, 197201 (2013).

[3] Akbari, A. & Khaliullin, G., Physical Review B **90**, 035137 (2014).



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