北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Low dimensional magnetism of quasi-1D spin-chain systems and the role of spin-orbital coupling

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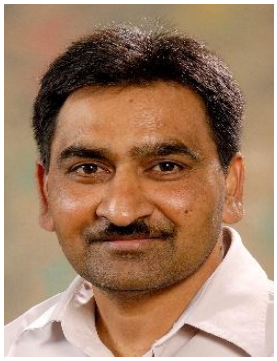

Time: 10:00am, Aug. 27, 2018 (Monday)

时间：2018年08月27日 （周一）上午10:00

Venue: Room W563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Low-dimensional and geometrically frustrated spin systems exhibit some of the most interesting physical phenomena seen in condensed matter physics. Due to the low site connectivity and competing interactions, classical order is often suppressed by quantum and thermal fluctuations, giving rise to novel ground states and quasiparticle excitations. Among the low-dimensional systems, the spin-chain systems with general formula $A_3MM'O_6$ (A = alkaline-earth metal, M/M' = transition metals) have attracted much attention in recent years, due to their reduced dimensionality in the presence of geometrical frustration [1-7]. The crystal structure consists of one-dimensional (1D) chains that are oriented along the *c*-axis and arranged in a triangular lattice in the *ab* plane. Besides the strongly one-dimensional crystal structure these compounds show strong spin anisotropy and the possibility to investigate the role of spin-orbital coupling on the magnetic behaviour. We have been investigating Sr_3NiIrO_6, Sr_3ZnIrO_6 and Sr_3NiPtO_6 using neutron scattering, both elastic and inelastic. Despite the presence of two magnetic phase transitions (T_{N1} = 75 K and T_{N2} = 20 K) in the magnetization of Sr_3NiIrO_6, neutron diffraction study reveals only one long range magnetic ordering below 70 K with antiferromagnetic coupling between Ni^{2+} and Ir^{4+} moment along the *c*-axis. On the other hand, the non-collinear magnetic structure of Sr_3ZnIrO_6 reveals that the moments of Ir^{4+} are tilted away from the *c*-axis, indicating the role of Dzyaloshinskii-Moriya (DM) interaction. Our inelastic neutron scattering study reveals a quasi-1D magnon excitations with a giant spin-gap of 30 meV in Sr_3NiIrO_6. The analysis of the spin wave spectrum reveals a strongly coupled Ising-like chains ($J_z >> J_{xy}$) along the *c*-axis that are weakly coupled into a frustrated triangular lattice in the *ab*-plane. The magnetic excitations survive up to 200 K well above the magnetic ordering temperature of $T_N \sim 75$ K, also indicating a quasi-1D nature of the magnetic interactions in Sr_3NiIrO_6. Our microscopic model is in agreement with *ab*-initio electronic structure calculations [8] and explains the giant spin-flip field observed in bulk magnetization measurements. We will compare the magnetic excitations observed in Sr_3NiIrO_6 with that of Sr_3ZnIrO_6 and Sr_3NiPtO_6 and discuss the nature of spin-liquid ground state in Sr_3NiPtO_6 [9].

[1] S. Rayaprol *et al.*, *Solid State Commun.*, **128**, 79 (2003). [2] E.V. Sampathkumaran *et al.*, *Phys. Rev. B* **70**, 0144372004 (2004). [3] T. Basu *et al.*, *Sci. Rep.* **3**, 3104 (2013). [4] A. D. Hillier *et al.*, *Phys. Rev. B* **83**, 024414 (2011). [5] E. Lefrancois *et al.*, *Phys. Rev. B* **90**, 014408 (2014). [6] S. Toth *et al.*, *Phys. Rev. B* **93**, 174422 (2016). [7] P. McClarty *et al.*, *Phys. Rev.*, submitted (2017): arXiv:1610.00038v1 [8] X. Ou and H. Wu, *Sci. Rep.* **4**, 4609 (2014); E. E. Gordon, H. Xiang, J. Köhler, and M.-H. Whangbo, *J. Chem. Phys.* **144**, 114706 (2016). [9]. D.T. Adroja *et al.*, unpublished (2018).

About the speaker

Dr Adroja is a senior scientist at the ISIS facility and is responsible for the MERLIN spectrometer and he is also a visiting professor at Johannesburg University, South Africa. His research programme is focused on strongly correlated electron systems with more than 24 years of experience in neutron scattering and muon spin rotation technique. Dr Adroja obtained his Ph.D. from IIT Bombay (in 1991), India, and then worked as a research fellow at Southampton, Hiroshima (JSPS fellowship 1997), St Andrews universities before joining ISIS in 1999. Since 2001, he work at ISIS as an instrument scientist in Excitations group, then from 2007 to present, he become a Senior Scientist at ISIS. He was the pioneer in discovering the Kondo insulator CeRhS, and the related materials Ce(NiCo)Sn and CePdSb. Recently he has made significant contributions to the field of spin and charge gap formation in strongly correlated electron systems and published two review papers on this topic. He has published over 290 papers in peer-review journals.