ESRF	**Experiment title:** Elementary excitations in spin-orbit coupled insulating iridates studied by resonant inelastic hard x-ray scattering	**Experiment number**: HE3689
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Report:

Despite its proximity to a metal-insulator transition[1,2], Boseggia et al.[3] found that Sr3Ir2O7 (Sr-327) belongs to the recently discovered class of spin-orbit induced Mott insulators[2]: the SOC splits the t_{2g} orbitals into j_{eff}=1/2 states (two-fold degenerate) and j_{eff}=3/2 states (four-fold degenerate), where j_{eff} denotes the *effective* total angular momentum derived from the large SOC in the presence of a large crystal field. For Ir^{4+} ($5d^5$), the lower j_{eff}=3/2 state is fully occupied and the upper j_{eff}=1/2 state forms an active half-filled energy band. The bandwidth of this half-filled band (lower Hubbard band (LHB)) is much smaller than the original t_{2g} band (when SOC is not taken into account), and thus even small electronic correlations can drive the system into a Mott insulator.
Following the theoretical suggestion of L. J. P. Ament et al.[4], and in close analogy to soft x-ray RIXS in cuprates[5,6], the electronic and magnetic elementary excitations of Sr-214 were studied by means of resonant inelastic x-ray scattering (RIXS) at the L_3 edge of Ir[7,8]. Indeed, $L_{2,3}$ edge RIXS is particularly suited to probe electronic and magnetic excitations and dispersions in correlated systems because it directly accesses the transition-metal *d* states.
In the present experiment, we intended to explore the elementary excitation spectrum of Sr-327 to better assess the its ground state: we therefore explored the dispersion of magnetic excitations over a large range of transferred momenta covering all high-symmetry directions in the Brillouin zone.

From a technical point of view, the experiment was extremely successful: with the use of a Si(844) back-scattering channel cut and a R=1 m Si(844) diced-crystal analyser, the combined energy-resolution was pushed down to 36 meV full-width half maximum.

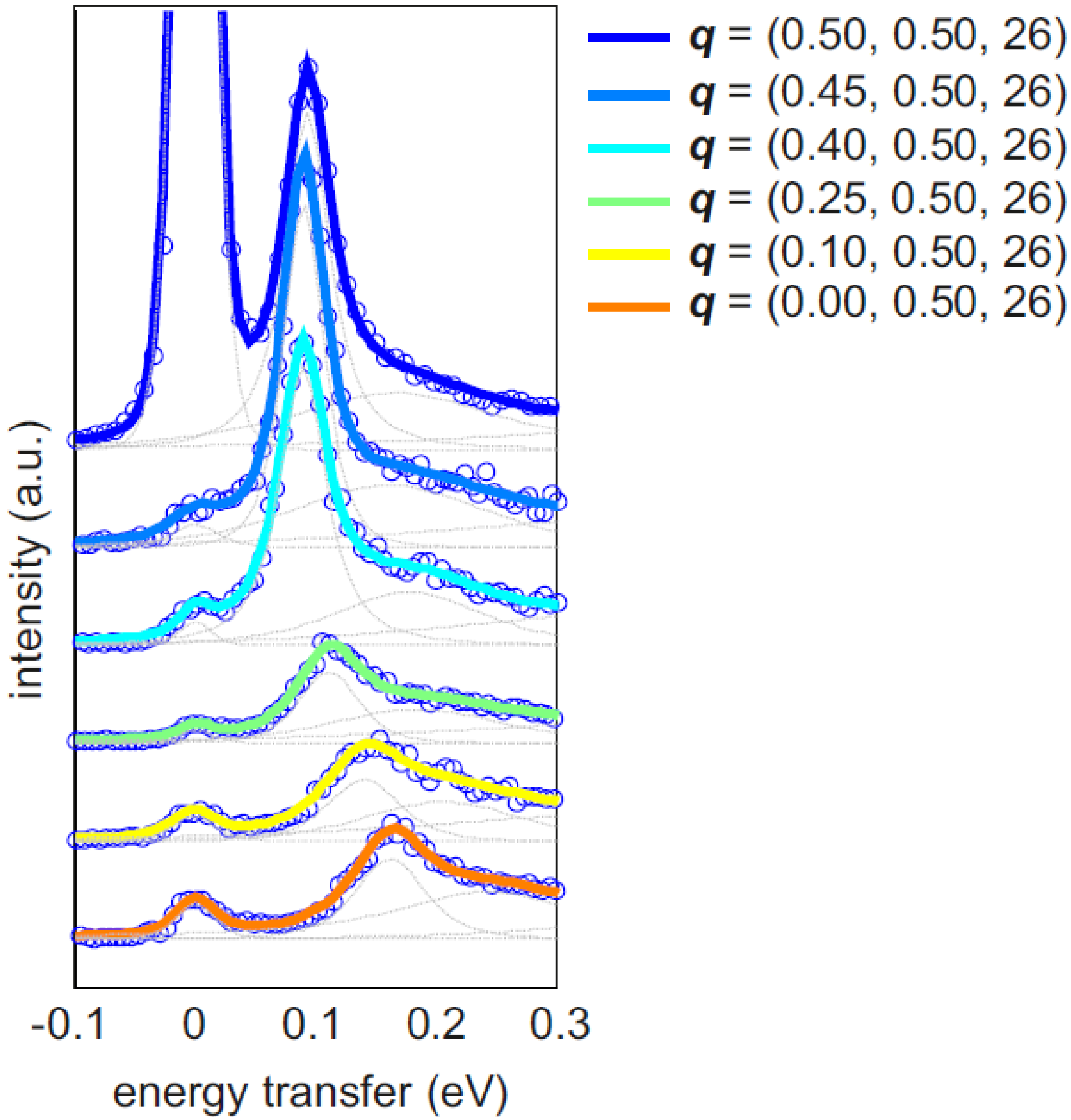

Fig. 1: Ir L3 edge RIXS spectra of Sr-327 as a function of transferred momentum

A sampling of Ir L_3 edge RIXS spectra is shown in Fig.1: at zero energy-transfer is the elastic line, which merges into the magnetic Bragg peak at (π,π); the feature at approximately 100 meV energy-transfer is, instead, identified as the magnetic excitation. The latter shows a sizeble dispersion as the transferred momentum is varied. Beside the (0,π)-to-(π,π), similar spectra have been taken also along the (0,0)-to-(π,π) and (0,0)-to-(0,π) directions. Furthermore, the bi-dimensionality of the system under study was verified by checking the (in)dependence of the magnetic mode versus the out-of-plane component of the trasnferred momentum, for L = 25.5, 26, 28, and 28.5 r.l.u..

The result of the measured dispersion curves is summarised in Fig.2, in terms of energy position, intensity and full width half maximum of the magnetic mode (the red dashed line represents the energy resolution of the experiment).

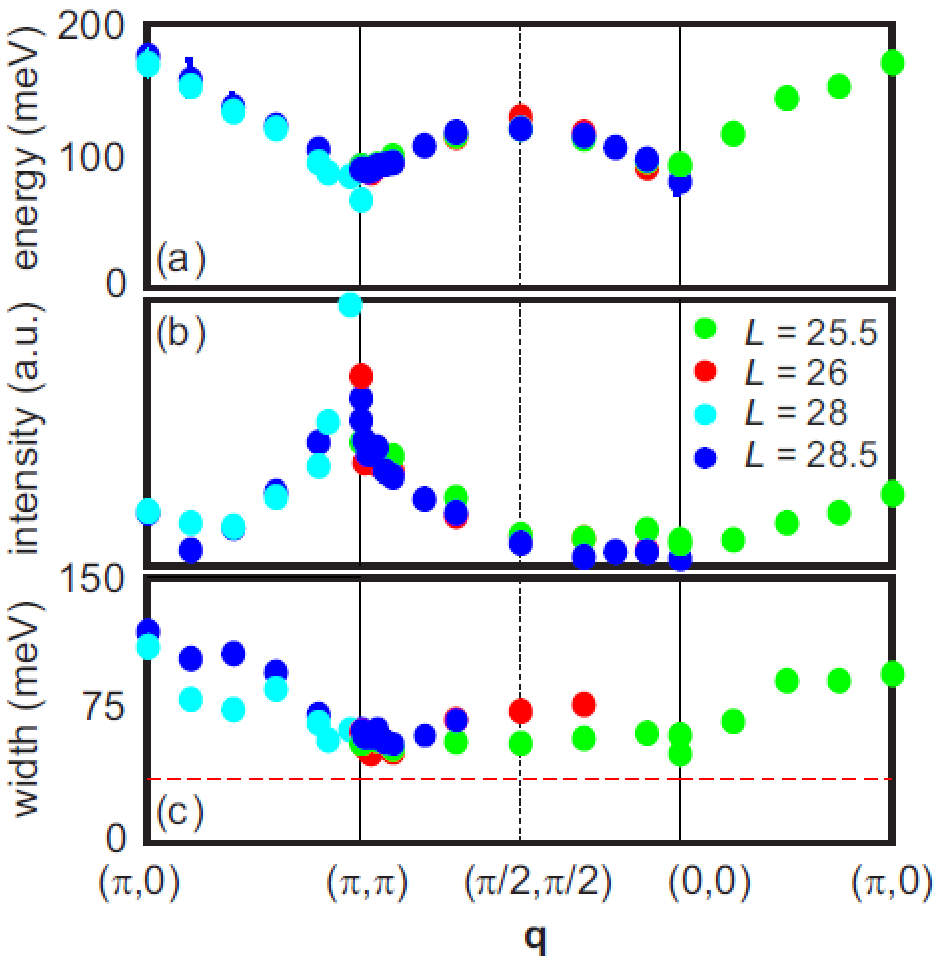

Fig. 2: Dispersion of magnetic excitations as a function of transferred momentum along high-symmetry directions in the Brilluoin zone.

The striking features are:

- <u>lacking of the acoustic magnetic mode</u>, and
- <u>large optical magnon gap (approx. 95 meV)</u>.

Recently, similar results have been interpreted by Kim et al. [9] in terms of a model hamiltonian including Dzyaloshinsky-Moriya, bond-directional pseudo-dipolar, and long-range exchange interaction terms, both in- and out-of-plane. Although the interpretation looks convincing, we are working on a different interpretation of the experimental findings, and are collaborating with theoretical groups to provide an alternative explanation for this, and other experimental findings.

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