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Indirect-geometry crystal spectrometer Mushroom

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Magnetic systems are a fertile ground for the design of novel quantum and topologically non-trivial states characterized by exotic excitations. Recent examples include spin chain and square-lattice low-dimensional antiferromagnets, quantum spin liquid candidates, spin-ice compounds, and unusual spin textures. These systems are not only of fundamental interest, but may also pave the way to new technologies. For example, skyrmion spin textures open new possibilities for data storage and electronic applications. Key features of the ground state and finite-temperature behavior of a magnetic system are captured by the spectrum of its excitations. All of the aforementioned systems reveal exotic excitations dissimilar to standard magnons that form narrow bands in conventional ferro- and antiferromagnets.

The detection of such exotic excitations is by far more challenging, as they show broad distribution in the energy and momentum space. Complex dispersion relations require long measurement times and great effort when measured on triple-axis spectrometers that can only scan through the (Q, E)-space point by point. Compared to this the proposed indirect-geometry spectrometer Mushroom with a time-of-flight primary chopper spectrometer, a large super-cone crystal analyzer covering the upper part of the instrument and a large flat detector area below the sample position for the secondary spectrometer, can measure the excitations over a broader range in the (Q, E)-space at once. In the presented design nested mirror optics assure the sample illumination with an extremely well defined phase space volume. Thanks to this, the prismatic focusing crystal analyzer provides excellent energy resolution. The versatile chopper system adds flexibility in terms of resolution and bandwidth to this innovative instrument concept.

Mushroom would provide all necessary information within a much shorter time frame, only at the cost of a slightly reduced energy and momentum resolution as compared to a triple-axis spectrometer and significantly better than direct TOF instruments. Furthermore, it can be built relatively compact as the main dimension of the secondary spectrometer is given by the dome of PG crystals above the sample. The accessible wavelength band is 1 −10 Å with an adjustable wavelength resolution of 1%- 5%. The instrument would be in total 20 m long and 4 m wide.

It is worth mentioning that in the current instrument suite of MLZ there is no such instrument for providing the out-of-plane full coverage of (Q, E)- space.

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