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Neutron diffraction experiments in pulsed magnetic fields

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A high magnetic field is one of the most unique and powerful parameter to tune the states of magnetic compounds. In frustrated anti- ferromagnets, a variety of non-trivial magnetic structures tend to show up by the tuning of systems by strong magnetic fields. In strongly correlated systems, a magnetic field modifies the balance of the duality-localized and itinerant natures of electrons- and produces incommensurate and spin density wave orders with Fermi surface reconstructions. It is essential to combine neutron diffraction techniques with pulsed magnetic fields to explore these interesting phenomena and novel phases.

We have developed pulsed high magnetic fields instruments for neutron diffractions for ten years. The use of pulsed magnets had broken the technical limit of of superconducting magnets and enabled us to access the extremely high magnetic fields of 30-40 T. There are a few different lines of pulsed magnet devices for practical experiments as follows, a compact potable 30 T horizontal solenoid magnet system combined with orange cryostat, a compact 40 T wide-angle horizontal solenoid with special cryostat and a middle size horizontal solenoid 50 T magnet. The temperature as low as 1.7 K is possible for all of those systems. Because of the compactness, the portable system has been used in both reactor and spallation sources including oversea facilities. In reactor sources, a continuous field variation of the peak intensity is monitored by a simple time-resolved technique. In spallation sources, multiple Bragg peaks can be captured by a white beam Laue method. The latter is useful to trace the change of magnetic wave vectors in magnetic field induced phase transitions.

We report the overview of the recent activities examining magnetic phase diagrams of multi-ferroic compounds including MnWO4 and LiNiPO4. The phase diagram of the latter has been investigated up to 41.2 T. We also repost results on URu2Si2 and related compounds. The combination of the compact split-pair magnet with X-ray free electron laser is also briefly introduced.

Keywords: Pulsed Magnetic Fields, Neutron Diffraction, Multi-ferroics