High resolution inelastic neutron studies on spin systems

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Chopper spectrometers are one of the standard ways of studying dynamics in materials by using an intense pulsed neutron source. We are now building the High Resolution Chopper Spectrometer (HRC) at J-PARC and we are trying to realize $\Delta E/E_i$ = 1% on HRC in the energy range of neutrons from meV to eV region. On HRC, three types of experiments can be considered: (1) high resolution experiments in the conventional energy momentum space, (2) experiments in the 1st Brillouine zone by using polycrystalline samples, and (3) experiments for sub-EV or eV excitations.

As an example for (1), from my experience, definite conclusions on quantum fluctuations in spin dynamics in one-dimensional antiferromagnets can be obtained by a single experiment with high resolutions.

One of the advantages of the sub-eV or eV neutrons is to extend energy momentum space to a lower Q region (less then 1 $Å^{-1}$) at several 10 meV. Such energy momentum space is accessible at the scattering angle around 1° with sub eV or 1 eV neutrons. This is an example for the experiments (2). It is possible to measure the dispersion relation of magnons at low Q within the 1st Brillouine zone from a polycrystalline sample, dependently on the symmetry of the crystal, because a possible Q vector is limited with the small Q. In the early stage of investigations where a large single crystal cannot be grown, this technique is effective to study the spin dynamics.

Another possibility is to observe excitations in the eV region (experiments (3)). The Q resolution is strongly dependent on the energy resolution. Even to observe dispersion relation in high energy excitations, a conventional Q resolution for inelastic neutron scattering experiments is required. To realize such a resolution for eV neutrons, high energy resolutions are indispensable.

By using these techniques, we will promote to study the dynamics in spin systems.