# Challenging experiments for cuprate superconductors

K. Yamada
WPI, Tohoku University, Sendai

Concerning the mechanism of high-$T_c$ superconductivity there still remain several fundamental issues. Three main issues corresponding to the different doping regions are as follows.

(1) *How do Mott insulators become metals by dilute doping ?*
(2) *How do the doped metals become superconductors in underdoped region ?*
(3) *How do the superconductors disappear by overdoping?*

In this symposium, I would like to propose several experiments for the above issues.
In high-$T_c$ cuprates, undoped Mott insulators are antiferromagnetic insulators. Upon carrier doping the antiferromagnetic order (AFO) is quickly destroyed in the case of single-layered $La_{2-x}Sr_xCuO_4$ or double-layered $YaBa_2Cu_3O_{6+y}$. For the former, incommensurate spin density modulation (SDM) is found to precipitate in the AFO and in the underdoped superconducting phase another incommensurate SDM coexists or phase separates to the superconductivity. On the other hand, recent NMR experiments for 5-multilayered cuprates discovered a metallic AFO which appears upon dilute doping and extends up to near the optimally doped superconducting phase. It is very important to clarify the relation and difference between the incommensurate SDM in $La_{2-x}Sr_xCuO_4$ and the metallic AFO in multilayered cuprates from a viewpoint of carrier localization.
Understanding the origin of pseudogap in underdoped region is one of the important issues in high-$T_c$ cuprates. Recent neutron scattering experiments discovered a magnetic order which develops below the pseudogap temperature. On the other hand, several experiments suggest the existence of preformed superconducting pairs in the pseudogap state. Search for dynamical vortex or heterogeneous field distribution by neutron scattering in this state is one of challenging experiments to reconcile the conflicting results.