平成 29 年 4 月 5 日

国立研究開発法人理化学研究所
理事　松本洋一郎

平成 28 年度実施 准主任研究員の研究業績レビュー（中間）の結果について

主任研究員、准主任研究員及び上席研究員研究業績評価実施細則(平成 28 年 4 月 28 日細則第 46 号)に基づき准主任研究員の研究レビュー（中間）を実施し、評価結果は以下のとおりです。なお、評価委員の総意のもと、意見を取りまとめた報告書として提出いただいたこと、申し添えます。

１．評価対象：バロン物質ダイナミクス研究室 Alfred BARON 准主任研究員

１）評価体制

実施日：平成 29 年 3 月 10 日（金曜日）
4 名の所外有識者を評価委員とするヒアリングレビューを実施。

評価者：
Alexeï BOSAK, Beam Line Responsible Scientist
European Synchrotron Radiation Facility,France

Hidenori TAKAGI, Director
Max Planck Institute for Solid State Research

Takami TOHYAMA, Professor
Tokyo University of Science

Kazuyoshi YAMADA, Director
Institute of Materials Structure Science,
High Energy Accelerator Research Organization

２）評価結果の概要等

General comments:

Research objectives

The Materials Dynamics Laboratory (MDL) is oriented to the use of inelastic x-ray scattering (IXS) in the studies of lattice and electronic dynamics. Being extremely flux-hungry, in both cases the technique relies on high x-ray flux into target materials and high efficiency of collection of scattered photons by materials. A number of scientific projects in the beamline portfolio couldn’t succeed without major improvements in those aspects. Large part of the resources was devoted to the

construction of new beamline, offering the unprecedented capabilities in the domain of the IXS.

Research results

New beamline BL43LXU designed, built and commissioned by MDL is now offering fantastic performance. The high resolution IXS spectrometer at BL43LXU is by far the best in the world. For example, for given energy/resolution it gains about one order of magnitude compared to the closest competitor. Large 2D array of analyzers provides further gain in terms of simultaneous data acquisition, i.e. collection of whole longitudinal or transverse branch in one shot – or true 2D and 3D mapping.

Many features required significant R&D efforts, to mention the temperature gradient control across the analyzers, allowed significant gain in the resolution. Finally, the capability to study both lattice and electronic dynamics at the same beamline is also rather unique.

Numerous applied studies fully profit from the beamline performance. Geophysics-related projects successfully disclosed the environment in the earth's interior by precisely measuring the sound velocity of candidate materials under pressure. The development of unique high-pressure device optimized for IXS was essential in the success. The high-resolution phonon measurements on high-Tc superconducting cuprates are quite impressive, where the drastic change of the phonon line width below the transition temperature Tc was unambiguously observed for Cu-O bond stretching mode. Newly obtained quantitative (not qualitative) information by BL43LXU should give a clue to understand the origin and role of recently discovered charge density wave in the mechanisms of high-Tc superconductivity. The phonon dispersions of de-twined single crystal of-Fe based superconductors were measured and the detailed analysis including magnetism contributed substantially to identify the importance of magnetic fluctuations in understanding the electronic structure.

Management of the Laboratory

Ambitious project required good coordination of different services, including the modifications on the storage ring side. The number of staff is small but all the involved people are working very hard. To perform the proposed future research plans and obtain fruitful many outcomes, beamline staff complement is definitely recommended, as in

present situation (as of Oct. 1, 2016) there is a strong deficit of staff scientists and postdoc fellows. Furthermore, the MDL is recommended to advertise the new and world-leading instrument, which should merit definitely the community of condensed matter science and ~~to~~ attract many outstanding scientists in the world.

Future research plans

With the completion of beamline, the emphasis is placed on the scientific projects. Plans of the MDL cover strongly correlated systems, lattice dynamics under extreme conditions, and dispersing electronic excitations. We support these plans, which are solid but ambitious.

Single crystal measurement of phonons by using the large 2D analyzer array provides a large amount of information on phonon branches along both high and low symmetry directions. A comprehensive method of analysis of spectra for arbitrary momentum transfers is highly desirable. Also IXS does have an advantage, relative to INS, in that the relative intensity of phonon modes is well defined, as there is no background from incoherent or multiple scattering - this means that the intensity can provide significant useful information. The attempt of such total analysis using all information is very ambitious and important to understand the lattice dynamics and electron-phonon interactions in complex materials. Since the situation is quite similar to spallation pulsed neutron spectroscopy, complementary analysis is recommended in collaboration with neutron people.

Detection of hydrogen phonons in superconducting hydrogen sulfides under high pressure by using the new KB setup, providing a 5**μ**m beam size is very challenging but is well worth trying only for the IXS in BL43LXU beamline. Feasibility study on simpler model system might be useful.

The signal from electronic excitations is much weaker than for phonons, as the cross section for electronic excitations is usually that of only one electron, or less, per unit cell, requiring that one maximize flux. None-the-less the simplicity of the non-resonant cross section, being directly related to electronic orbital shapes via the A^2 term of the Hamiltonian, makes non-resonant experiments attractive. Complementary use with element-selective resonant type of IXS measurements will be required in the near future.

If staff complement is granted, it will allow to extend the scientific program to new subjects (i.e. further classes of complex materials). To make future scientific outputs

more appealing, appointing scientific adviser is recommended, preferably with strong theory background.

Overall assessment

We can clearly state the success of BL43LXU beamline construction and commissioning. Now the portfolio of SPring-8 beamline is enriched by the new instrument with unique performance. The scientific program is ambitious but realistic, and thus laboratory is producing high-impact publications.

以上