7 Hydrogen Project
– Observation of the quantum nature of hydrogen in materials –

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Hydrogen plays important roles in material and life sciences and bridges fundamental science and engineering. There are many unsolved issues related to hydrogen: hydrogen bonding, hydrogen induced properties such as magnetism, superconductivity, embrittlement, thermal conductivity, hydrogen absorption/desorption mechanism on material surfaces, activation of hydrogen near the surface of photocatalysts, and so on. Isotope effects and/or quantum effects are dominant for these properties, such as the inverse isotope effects on the superconductivity of palladium.

Quantum beams such as neutron, X-ray and muon beams are expected to be useful for observing the position of hydrogen, bonding of hydrogen with surrounding atoms, and so on. However, none of these beams can observe the entire nature of hydrogen in materials: a neutron beam can observe the proton of hydrogen but not electrons; an X-ray beam can observe electrons but not protons, and a muon beam can observe the excitation state of hydrogen but not muon-trapped sites. This project involves specialists in neutron, synchrotron and muon beams for observing hydrogen and aims to clarify the quantum nature of hydrogen in materials through the exchange of information on state-of-the-art techniques and projects with external funds. The core members of this project are: T. Otomo (neutron, IMSS/KEK), S. Ikeda (neutron inelastic measurements, IMSS/KEK), K. Ikeda (*in-situ* neutron diffraction, IMSS/KEK), H. Ohshita (*in-situ* neutron diffraction, IMSS/KEK), O. Yamamuro (neutron quasi-elastic, ISSP/Tokyo Univ.), H. Abe (*in-situ* XAFS, IMSS/KEK), A. Machida (synchrotron under high pressure, QUBS/JAEA), Y. Harada (high-resolution X-ray emission spectroscopy, ISSP/Tokyo Univ.), D. Sekiba (ion beam, Tsukuba Univ.) and K. Shimomura (muon, IMSS/KEK). Project members will be added flexibly when each sub-project is formed.

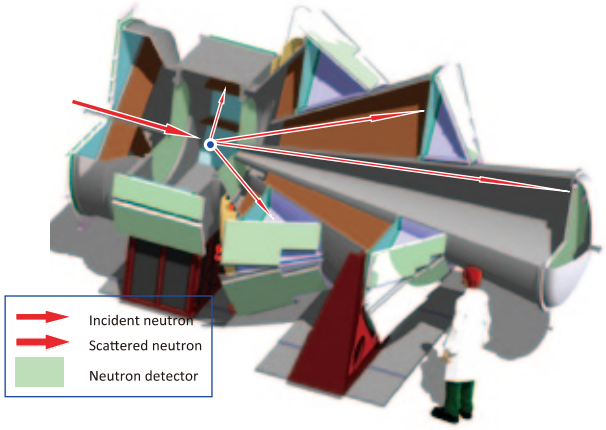

Fig. 1: High intensity total diffractometer (NOVA) at J-PARC. NOVA enables various structural analyses of crystalline materials including liquid & glass materials. In-situ hydrogen-gas atmosphere experiments are on-going.