

X-ray and neutron experiments in high magnetic fields for developing advanced materials

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Period of research 2008.10.01-2010.3.31

The project is aiming at the international collaboration on X-ray and neutron experiments in high magnetic fields in developing these advanced techniques and the application for advanced materials such as multi-ferroic compound, martensitic metal, and so on. The most important advantage of such international collaboration is the inter-availability of our instruments at the world-class facilities such as SPring8, J-PARC, ILL, ESRF, APS and SNS. The exchange of advanced techniques and the mutual collaboration have been very successful to establish this emerging new field. The achievement is summarized as follows.

- (1) Establishment of the world record of pulsed magnetic field neutron diffraction in 30 T at ILL, which is the world center of the neutron science. The results are published in two articles in Physical Review Letter. It shows the intrinsic coupling between the spin and lattice in frustrated spinel antiferromagnet and shows a new type of spin structure causing magnetization quantization. It is also selected as the highlight of ILL annual report. The developed Tohoku magnet is displayed at ILL instrument showcase as the first case from Japan, showing the presence of IMR in this scientific field. The results are also broadcasted in news paper.
- (2) Technical transfer of Tohoku method has been successfully made to APS in Argonne. The result is published in Review of Scientific Instrumentation, which is also selected as the cover story. The spin-lattice effect in spin liquid state is investigated.
- (3) The Tohoku system is also introduced into the SNS in Oakridge, which is the world strongest pulsed neutron source. New magnetic structures in the high magnetic field phase in multi-ferroic compound  $\text{MnWO}_4$  have been found, which is only resolved by neutron diffraction. Successful results will be displayed in the international review committee of the institute as one of the recent important activities.
- (4) International collaboration experiments have been also made at J-PARC and SPring8. The first 40 T XMCD experiment is published in Physical Review Letter. The international workshop was held at SPring8 in March 2009, which is co-organized with JAEA and priority area: high magnetic field spin science in 100 T. It is the best opportunity to show the contribution of IMR in this field.

To be summarized, the project brings the large progress in this new field and the IMR contributions are widely recognized.

## List of Publications and others

- [1] Neutron Diffraction Study on the Multiple Magnetization Plateaus in  $TbB_4$  under Pulsed High Magnetic Field  
S. Yoshii, K. Ohoyama, K. Kurosawa, H. Nojiri, M. Matsuda, P. Frings, F. Duc, B. Vignolle, G. L. J. A. Rikken, L.-P. Regnault, S. Michimura, and F. Iga  
Phys. Rev. Lett. **103**, 077203 (2009).
- [2] X-Ray Magnetic Circular Dichroism of a Valence Fluctuating State in Eu at High Magnetic Fields  
Y. H. Matsuda, Z. W. Ouyang, H. Nojiri, T. Inami, K. Ohwada, M. Suzuki, N. Kawamura, A. Mitsuda, and H. Wad.  
Phys. Rev. Lett. **103**, 046402 (2009).
- [3] Universal Magnetic Structure of the Half-Magnetization Phase in Cr-Based Spinel  
M. Matsuda, K. Ohoyama, S. Yoshii, H. Nojiri, P. Frings, F. Duc, B. Vignolle, G. L. J. A. Rikken, L.-P. Regnault, S.-H. Lee, H. Ueda, and Y. Ueda  
Phys. Rev. Lett. **104**, 047201 (2010).
- [4] Magnetic-Field Induced Phase Transitions in a Weakly Coupled  $s=1/2$  Quantum Spin Dimer System  $Ba_3Cr_2O_8$   
M. Kofu, H. Ueda, H. Nojiri, Y. Oshima, T. Zenmoto, K. C. Rule, S. Gerischer, B. Lake, C. D. Batista, Y. Ueda, and S.-H. Lee  
Phys. Rev. Lett. **102**, 177204 (2009).
- [5] A portable high-field pulsed-magnet system for single-crystal x-ray scattering studies  
Zahirul Islam, Jacob P. C. Ruff, Hiroyuki Nojiri, Yasuhiro H. Matsuda, Kathryn A. Ross, Bruce D. Gaulin, Zhe Qu, and Jonathan C. Lang  
Rev. Sci. Instrum. **80**, 113902 (2009)

## Other achievements

- [1]Ref. [5] is selected as the cover story of Rev. Sci. Instrum.

The image is a screenshot of the AIP Review of Scientific Instruments website. The page features a navigation bar with links for Home, Browse, About, Authors, Librarians, Interactive Features, Purchase Content, Advertisers, Citation, and AIP Journals. A search bar is located at the top right. The main content area is divided into several sections: 'Current Issue' with a 'Submit Manuscript' button and 'Top 20 Most Downloaded' articles; 'Announcements' with a 'NEW! Research reader for iPhone and iPod touch' article; 'Research Highlights' featuring three articles with images and text. The first highlight is about an array of piezoelectric microcantilevers for detecting Bacillus anthracis spores. The second is about a portable high-field pulsed-magnet system for x-ray scattering studies. The third is about a new method for detecting explosives. There are also 'Article Packs' and 'SCITATION C3' promotional banners on the right side of the page.

- [2]Ref. [5] is selected as the Argonne Today





[5]Ref. [3] are published in Nikkankogyo Shinbun and Nikkei Shinbun

日刊工業新聞  
平成 22 年 1 月 25 日(月) 28 面

**三角構造の不安定磁性体**

**磁場中で共通磁気構造**

東北大・東大 中性子回折法で解明  
原子力機構

東北大学、日本原子力研究開発機構、東京大学の共同研究チームは、中性子回折法を用いた実験を行い、分子構造が三角構造の不安定磁性体が磁場中で共通磁気構造を持つことを突き止めた。これは磁気構造の不安定な状態を安定化し、中性子回折法を用いた実験で初めて確認された。これまでは実験が困難であった三角構造の不安定磁性体の構造が明らかになることで、材料の性能向上に役立つと期待されている。

実験は、超小型パルス中性子発生装置「超小型パルス中性子発生装置」を用いて行われた。持ち運びができる「超小型パルス中性子発生装置」は、従来の中性子発生装置に比べて、中性子発生装置のサイズが小さく、中性子発生装置の出力も高いため、実験の効率が高くなる。また、中性子発生装置の出力が高いため、中性子回折法の測定精度も向上する。この研究成果は、材料の性能向上に役立つと期待されている。

日経産業新聞  
2010年2月3日(木)

フラストレート磁性体  
スピンの並び方普遍  
東北大、元素変え解明

決める。フラストレート磁性体では様々な磁気状態が混在し合っており、外からの磁気に反応して電気的性質などが変わります。構成する元素の違いで、材料の構造がどう変わるかを調べるのがポイントだ。

東北大学日本原子力研究開発機構などは、主成分のクロムにカドミウムを混ぜたフラストレート磁性体の構造を調べる。約100℃という高温での磁性変化を調べた。中性子回折法を用いて、スピンの並び方が変わることが分かった。従来知られていたクロムフラストレート磁性体の構造と異なっていた。

磁性体では材料中の多数の電子のスピンの振る舞いが物質全体の性質を

[6]Ref. [2] is published in Nikkankogyo Shinbun  
日刊工業新聞 (2009年8月26日付) に紹介

