

ICC-IMR NEWS

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**International
Collaboration
Center**

Institute for Materials Research
Tohoku University

<http://www.icc-imr.imr.tohoku.ac.jp/>

Welcome to the ICC-IMR

ICC-IMR Director Gerrit E. W. BAUER

Based on the firm belief that science and technology should be a global enterprise, the International Collaboration Center (ICC) was founded by the Institute for Materials Research (IMR) of Tohoku University in April 2008. We are charged to foster top research by facilitating open exchange of ideas and results between the IMR and rest of the world. We welcome applications for joint activities between IMR and overseas researchers, sponsoring junior and senior scientists in the form of integrated projects, guest professorships and shorter research visits, as well as support international workshops. Any of these activities may be initiated by international scientists who seek collaboration with IMR faculty members. With advice from external referees the ICC-IMR Steering Committee prioritizes applications three times per year, whereby quality and impact are the main considerations.

In this ICC-IMR News Bulletin we present a concise summary of activities and exciting results that emerged from the collaborations supported by the ICC-IMR in the past year. We hope that this report will stimulate many new collaborations that will help to better understand nature and to solve the pressing problems our society faces in the near future.



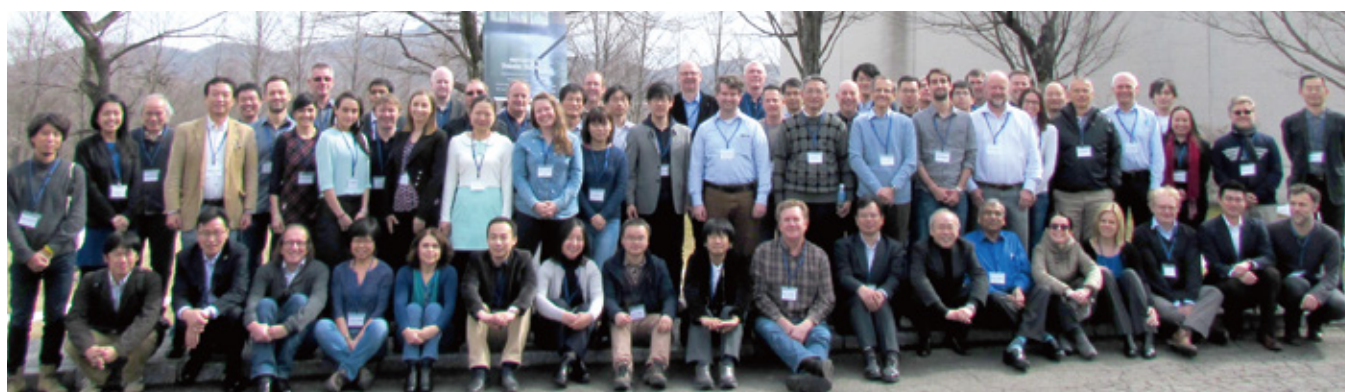
Highlight of International Workshop

10th International Symposium “Hydrogen & Energy” Feb. 21-26, 2016, Zao, Japan, Organizer, S. Orimo, IMR

Hydrogen and metal hydrides are of key importance in designing next-generation energy storage and conversion technologies. Approximately 60 researchers ranging from students to world leading experts in the field of hydrogen energy participated in the 10th International Symposium “Hydrogen & Energy” held in Miyagi Zao, Sendai on February 21–26.

The symposium consisted of invited keynote lectures reviewing the key elements of the hydrogen cycle, i.e. the hydrogen production, hydrogen storage and hydrogen combustion and fuel cells. Furthermore, the conversion technologies of renewable energy in general and novel energy carriers besides and beyond hydrogen were discussed. The world leading experts presented their current research challenges and most important results in invited and contributing talks. Early stage and experienced researchers presented their latest results and the open questions on poster presentations.

This symposium provided an excellent opportunity for researchers to share their latest ideas and findings, and forge new partnerships. It was enthusiastically received by many of the participants. We would like to thank all those who involved in this symposium and indispensable support from ICC-IMR.



Comments from Visitors

Pallavi Dhagat, Oregon State University (USA)

2015.6.23-2015.7.23

Research Proposal: Characterizing Magnetostriction in FePtPd Thin Films.

My stay in Sendai as a visiting professor to IMR in July 2015 was a highlight both professionally and personally. I had the honor of collaborating with Prof. Koki Takanashi and his group members, who made my short stay most productive with meticulous research planning and also most comfortable with a touching hospitality that for me has become synonymous of Japan. Our project focused on measuring magnetostriction in FePtPd films of varying Pd content. Working alongside Seki-san and graduate students, Weinan Zhou and Satoru Kikushima, I learnt immensely about the sputter deposition and physical characterization of these films. In turn, I brought complementary expertise in measuring magnetostriction. We implemented custom fixturing in



the physical properties measurement system (PPMS), available at IMR, to measure the magnetostriction coefficient of the films via the bending of cantilevered samples upon applying a magnetic field. While the films exhibited magnetostriction, quantification of their magnetostrictive response as a function of Pd content proved challenging due to experimental errors introduced by lack of control of sample alignment with respect to applied field direction. With learning gained from my experience at IMR, we are now developing more robust magnetostriction measurement techniques in my laboratory and hope to have publishable results soon.

Outside of the laboratory, I enjoyed the KINKEN beer party and the Japanese Culture Day at my four-year old son's pre-school (he attended the Horizon International School during my stay) – both of these events were a memorable window to Japanese culture, values and lifestyle.

Benedikt Hartmann, Goethe University Frankfurt (Germany)

2015.5.18-2015.7.18

Research Proposal: Investigation of Low-Frequency Charge and Spin Dynamics in Correlated π -Electron Systems with Multi-Degrees of Freedom

The Fellowship for young researcher by the ICC-IMR provided a beneficial scientific and a joyful personal experience. It gave me the opportunity to research on current topics in the field of strongly correlated electron systems together with very talented and knowledgeable colleagues in the Low-Temperature Condensed State Physics, Sasaki Laboratory. Besides fruitful scientific discussions I have received a warm welcome and became a part of the research group. I really enjoyed the friendly atmosphere with my colleagues and I am deeply thankful for introducing me to Japanese culture and especially its cuisine. During my stay I also had the wonderful opportunity to actively participate in a project the IMR organizes to get pupils interested in



science. The IMR environment and its link to the Tohoku University and many other institutes made it always easy to exchanged ideas with other scientists outside my research group, who are experts in related research fields. I thank everybody for this great experience, which enriched my life personally and scientifically.

Highlight of Research Project

High Pressure Studies of Strongly Correlated Electron Systems

PI: G. Knebel (CEA Grenoble) and D. Aoki (Actinide Materials Science Div., IMR)

The coexistence of ferromagnetism and superconductivity attracts much attention because the unconventional superconductivity may be realized. Under the strong internal field owing to the ferromagnetism, the conventional superconducting Cooper pair with spin-singlet state cannot survive, thus the spin-triplet state with equal spin pairings is only the possible channel. Surprisingly, when the field is applied along the hard-magnetization axis in the ferromagnetic superconductors, the field-induced (field-reinforced) superconductivity appears at high fields, exceeding extremely the Pauli limit. These unusual properties are detected in uranium compounds, that is, URhGe and UCoGe, where the strong spin-orbit interaction and the dual (itinerant/localized) nature of 5f electrons are realized.

In order to elucidate the mechanism, we perform the low temperature experiments at high field and at high pressure, using the high quality single crystals of uranium compounds, which are grown both in Japan and in France. Firstly it is found that the longitudinal ferromagnetic fluctuations are sensitive to the magnetic field, and it develops strongly at high field where the re-entrant superconductivity is observed. Secondly, we found that the Fermi surface instabilities play also an important role for superconductivity. The Fermi surface instabilities are detected as a consequence of “Lifshitz transition”. In the heavy fermion system, especially low-carrier system with heavy electron mass, the Fermi surface can be easily reconstructed by the magnetic field, because the effective Zeeman energy is relatively low. Indeed, the multiple “Lifshitz transitions” are detected in the thermopower and the Shubnikov-de Haas experiments in URhGe and UCoGe.

High pressure studies are also performed at high fields and at low temperatures in UCoGe in order to clarify the interplay between ferromagnetic quantum criticality and superconductivity. It is found that the upper critical field for the field along hard-magnetization axis is very sensitive to the applied pressure, and the ferromagnetic fluctuations still remain above the ferromagnetic critical pressure. The pressure studies are currently extended to the uniaxial stress, which induces more drastic change of the ground state.

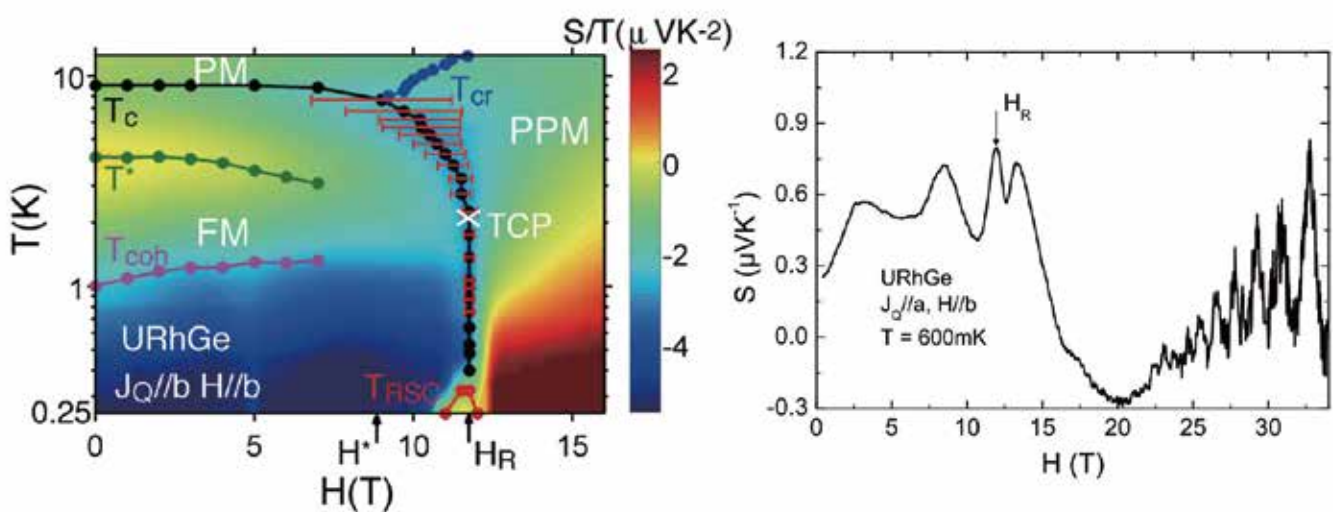


Figure: Contour plot of thermopower and the quantum oscillation in URhGe

Activities in FY 2015

Research Projects

High Pressure Studies of Strongly Correlated Electron Systems (FY2013-2015)

PI: G. Knebel (CEA Grenoble, France) and D. Aoki (Actinide Materials Science Division, IMR)

Investigation of Magnetic and Charge Dynamics by Combining Pulsed Neutron-X-ray Sources and Pulsed High Magnetic Fields (FY2015-2016)

PI: P. Manuel (ISIS-RAL, UK) and H. Nojiri (Magnetism Division, IMR)

Development of the Next Generation Detector for High Energy Physics (FY2015-2016)

PI: M. Niki (Inst. of Phys, CAS, Czech Republic) and A. Yoshikawa (Advanced Crystal Engineering Division, IMR)

Visiting Professors

P. Badica, National Institute of Materials Physics, Romania, May 1-June 4, 2015

"Joints of Superconducting Tapes: Fabrication and Characterization"

J. Müller, Institute of Physics, Goethe-University Frankfurt am Main, Germany, Sep. 17-Dec. 15, 2015

"Investigation of Low-Frequency Charge and Spin Dynamics in Correlated π -Electron Systems with Multi-Degrees of Freedom"

V. N. Nemykin, University of Minnesota Duluth, USA, June 23-July 26, 2015

"Theoretical Investigation of the Electronic Structure and Spectroscopy of Organometallic and Transition-metal Nanostructures"

P. Dhagat, Oregon State University, USA, June 23-July 22, 2015

"Characterizing Magnetostriction in FePtPd Thin Films"

L. T. Baczewski, Institute of Physics, Polish Academy of Sciences, Poland, Nov. 9-Dec.8, 2015

"Structural and Magnetic Studies on L₁₀-type FeNi Ordered Alloys"

International Workshop

The 10th International Workshop on Biomaterials in Interface Science

(Innovative Research for Biosis-Abiosis Intelligent Interface Summer Seminar 2015), Aug. 4-5, 2015

Spin Energy Materials, Dec. 3-4, 2015

JSPS 161/186 Committee and ICC-IMR International Joint Workshop –Crystals and their Applications into Radiation Devices–, Jan. 7-8, 2016

10th International Symposium "Hydrogen & Energy" , Feb. 21-26, 2016

12th Materials Science School for Young Scientists (KINKEN-WAKATE 2015), "Spintronics & Spin Current" , Sep. 24-25, 2015

Major Publications

Y. Tokunaga, D. Aoki, H. Mayaffre, S. Krämer, M.-H. Julien, C. Berthier, M. Horvatić, H. Sakai, S. Kambe, and S. Araki, "Reentrant Superconductivity Driven by Quantum Tricritical Fluctuations in URhGe: Evidence from ⁵⁹Co NMR in URh_{0.9}Co_{0.1}Ge", Phys. Rev. Lett. 114 (2015) 216401

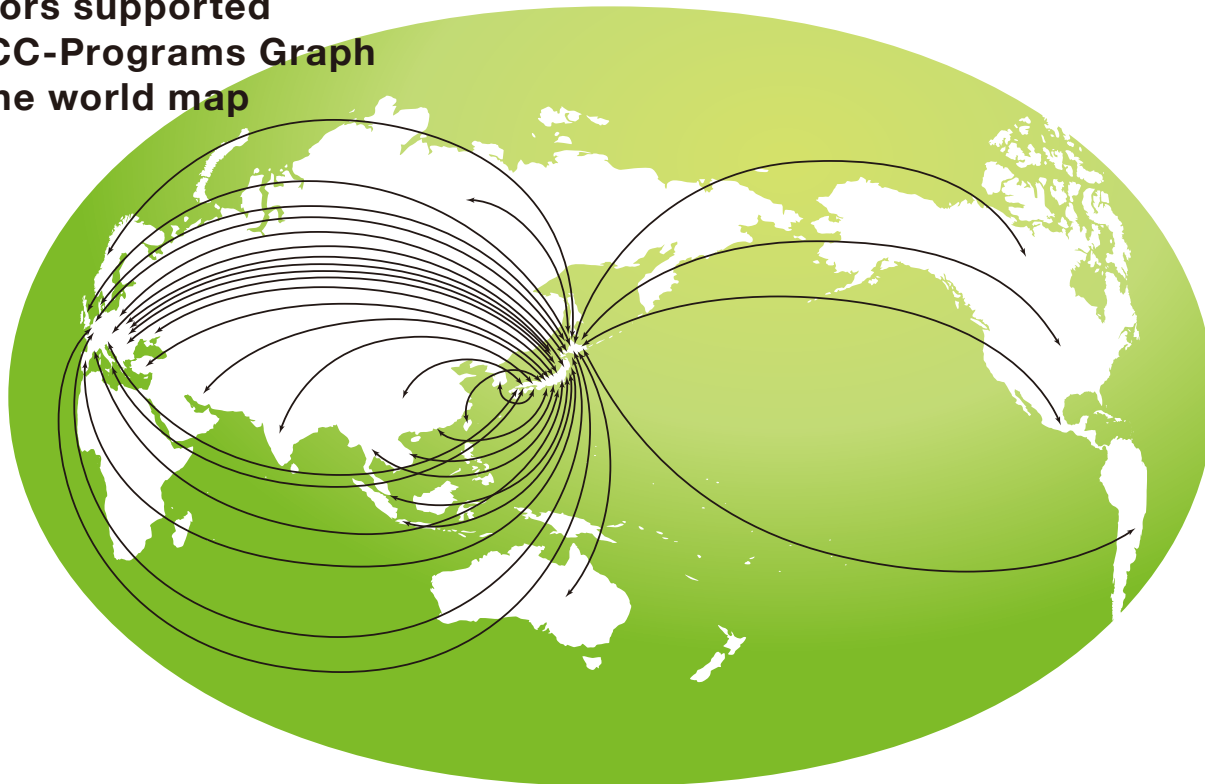
H. Fukunaga, T. Yoshino, H. Sagayama, J. Yamaura, T. Arima, W. Kosaka and H. Miyasaka, "A Charge-Disproportionate Ordered State with $\delta=0.75$ in a Chemically Sensitive Donor/Acceptor D^{δ+}₂A^{2δ-} Layered Framework", Chem. Commun. 51 (2015) 7795-7798

M. Pregelj, A. Zorko, O. Zaharko, H. Nojiri, H. Berger, L. C. Chapon and D. Arčon, "Spin-Stripe Phase in a Frustrated Zigzag Spin-1/2 Chain", Nature Commun. 6 (2015) 7255

B. Z. Rameshti; Y. S. Cao, G. E. W. Bauer, "Magnetic Spheres in Microwave Cavities", Phys. Rev. B 91 (2015) 21443

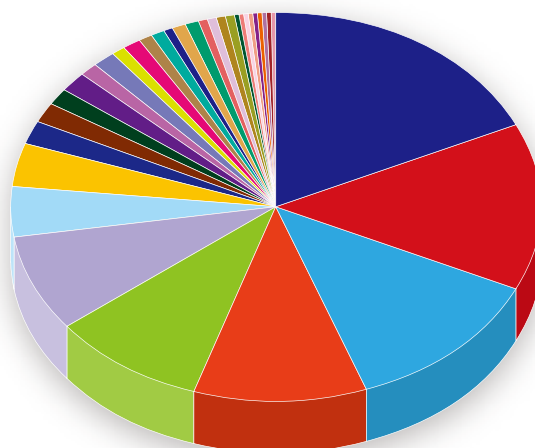
O. Zavorotynska, S. Deledda, G. Q. Li, M. Matsuo, S. Orimo, B. C. Hauback, "Isotopic Exchange in Porous and Dense Magnesium Borohydride", Angew. Chem. Int. Edit. Engl. 54 (2015) 10592-10595

Visitors supported by ICC-Programs Graph on the world map



Visitors 2009 - 2015

USA	74	Norway	5	Czech Republic	2
China	57	Poland	5	Thailand	2
Germany	51	Taiwan	4	Argentina	1
Korea	43	Spain	4	Austria	1
France	39	Hong-Kong	4	Belgium	1
UK	32	Italy	3	Indonesia	1
Netherlands	17	Mexiko	3	Rumania	1
Russia	15	Singapore	3	Slovakia	1
India	8	Australia	3	Turkey	1
Switzerland	7	Denmark	3	Vietnam	1
Iran	6	Slovenia	2		
Canada	6	Ukraine	2		



ICC-IMR Programs

ICC-IMR was founded in April 2008 as the center for the international collaboration of the Institute for Materials Research (IMR). As one of the centers of excellence in material science, IMR holds 27 research groups and five research centers. ICC-IMR works as a gateway of diverse collaborations between international researchers and IMR members. ICC-IMR has invited 51 visiting professors and conducted 20 international research projects since the start-up. The applications are open for foreign researchers and the projects are evaluated by peer-review process by international reviewers. Currently, ICC-IMR coordinates six different programs:

1) International Integrated Project Research

2) Visiting Professorship

3) Short Single Research Visits

4) International Workshops

5) Fellowship for young researcher and PhD student

6) Material Transfer Program

We welcome applicants from around the globe to participate in these international programs.

Contact Information

Website : <http://www.icc-imr.imr.tohoku.ac.jp/>

E-mail : icc-imr@imr.tohoku.ac.jp

Address : ICC-IMR Office Room#309 Building No.1

Institute for Materials Research, Katahira 2-1-1, Sendai 980-8577, Japan

Tel/Fax : +81-22-215-2019

On the Cover

IMR, which was established by Professor Kotaro Honda, the first director, in 1916, celebrated its 100th anniversary in 2016. The cover photo is the KS steel was invented by Kotaro Honda, and it is exhibited in the IMR lobby.