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Condensed matter physics in 100 – 1000 T ultrahigh magnetic fields

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Ultrahigh magnetic field in the range of 100-1000 T opens new research fields in condensed matter physics. The spin Zeeman energy of a free electron reaches 1350 K (0.116 eV) at 1000 T that is large enough to change electronic as well as structural properties of matter. Various kinds of phase transitions can be induced by such ultrahigh magnetic fields and the novel high-field phase is regarded as a kind of new material. Destructive ways are only available for generation of the 100-1000 T fields and thus the time duration of the pulsed-fields is in the microsecond range, which requires us to develop special measurement techniques to overcome this severe condition. For magnetic field generation, the single-turn coil and the electromagnetic flux compression techniques have long been developed in our institute (the Institute for Solid State Physics (ISSP)) and can generate up to 300 and 1000 T, respectively. Various kinds of intriguing phenomena such as the structural phase transition of solid oxygen, magnetic phase transitions in low dimensional magnets, novel spin-state transitions in cobalt-oxides, and the insulator-metal transition in a Kondo material are recently discovered in ultrahigh magnetic fields. Such recent physical achievements as well as developments of magnet technology are presented.



Recent Publications

1. K Nomura, Y H Matsuda, Y Narumi, K Kindo, S Takeyama, Y Hosokoshi, T Ono, N Hasegawa, H Suwa and S Todo (2017) Magnetization process of the $S = 1/2$ two-leg organic spin-ladder compound BIP-BNO. *Journal of the Physical Society of Japan* DOI: 10.7566/JPSJ.86.104713.
2. T Nomura, Y H Matsuda and T C Kobayashi (2017) H-T phase diagram of solid oxygen. *Physical Review B* 96:054439.
3. A Ikeda, T Nomura, Y H Matsuda, S Tani, Y Kobayashi, H Watanabe and K Sato (2017) High-speed 100 MHz strain monitor using fiber Bragg grating and optical filter for magnetostriction measurements under ultrahigh magnetic fields. *Review of Scientific Instruments* 88(8):083906.

Biography

Yasuhiro H Matsuda completed his PhD in the year 1996 from Tohoku University. He is the Associate Professor of The Institute for Solid State Physics, The University of Tokyo. He has published more than 100 papers in reputed journals. He is expertise in high-magnetic-field science and condensed matter. His discoveries of novel field-induced phases shed new light on condensed matter physics.

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