TECHNISCHE UNIVERSITÄT DRESDEN

IFMP Institut für Festkörper- & Materialphysik

IFMP Seminar

Date: Tuesday, November 02, 2021, at 14:50

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Speaker: **Markus Kriener**

RIKEN Center for Emergent Matter Science, Wako, Japan

Title: **Valence-Skipping Indium and Its Role in the New Superconductor (Ge,In)Te**

Abstract: A major target in the field of superconductivity is to identify and understand the mechanisms which control and increase the superconducting transition temperature T_c. About 30 years ago, Varma pointed out the possibility of enhanced superconducting interactions in systems containing valence-skipping elements due to charge fluctuations [1]. One example is In: It skips its 2+ state and usually appears as In^{1+} or In^{3+}. In GeTe, it replaces divalent Ge giving rise to such a valence instability. GeTe itself is a well-known multifunctional system (cf., e.g., [2] and References therein). In spite of its semiconducting nature, it exhibits metallic resistivity and superconducts below critical temperature $T_c < 350$ mK due to Ge vacancies [3]. When doping In, the superconductivity is quickly suppressed. Upon further increasing the In content, $Ge_{1-x}In_xTe$ exhibits a critical doping concentration $x_c = 0.12$ where various properties change concurrently, among them the crystal structure, the nature of the charge carriers, and a several orders-of-magnitude enhancement and subsequent suppression of the resistivity [4]. Most importantly, a new superconducting phase with monotonically increasing T_c emerges for $x > x_c$. Simultaneously, a crossover of the In valence state from 3+ to 1+ is observed. This subtle correlation strongly suggests that the superconducting phase in $Ge_{1-x}In_xTe$ is a direct consequence of the valence instability of the In dopant. In this talk, we will present a comprehensive discussion of the characteristic features of this solid solution and discuss a model which accounts satisfactorily for all observations.

[1] C. Varma, Phys. Rev. Lett. 61, 2713 (1988).
[2] M. Kriener, T. Nakajima, Y. Kaneko, A. Kikkawa, X. Z. Yu, N. Endo, K. Kato, M. Takata, T. Arima, Y. Tokura and Y. Taguchi, Sci. Rep. 6, 25748 (2016).
[3] R. Hein et al., Phys. Rev. Lett. 12, 320 (1964).
[4] M. Kriener, M. Sakano, M. Kamitani, M. S. Bahramy, R. Yukawa, K. Horiba, H. Kumigashira, K. Ishizaka, Y. Tokura, and Y. Taguchi, Phys. Rev. Lett. 124, 047002 (2020)

Host: D. Peets