IBS CINAP Seminar

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ZnO as a New Platform for Quantum Electronic Devices

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Abstract: Clean two-dimensional electron system (2DES) in semiconductor heterostructures has been a platform to study quantum phenomena of electrons which can be applied for quantum electronic devices. Here, we show ZnO heterostructure is a new material system hosting clean 2DES, parallel to conventional semiconductors, but possessing characteristic material parameters distinct from conventional semiconductors [1]. Owing to a longstanding effort to improve the thin film growth technique, electron scattering time of 2DES in the ZnO heterostructure reaches the best-quality of 2DES of GaAs [2], exhibiting the clear integer and fractional quantum Hall effects (QHE) [3].

We reveal many characteristic aspects of the 2DES of ZnO heterostructures. For instance, the electron correlation of the 2DES is substantially strong owing to the large effective mass, leading to a large spin susceptibility (at most 80 times larger than that of GaAs) [4]. The strong correlation and large spin susceptibility lead to the observation of exotic even-denominator fractional QHE at $\nu = 3/2$, 5/2, and 7/2 [5].

We also investigate many other aspects such as an interface proximity effect of 2DES/superconductor junction for a possible topological superconductor [6] and long spin coherence of 2DES [7] together with a gating technique to create 1D transport [8], essential for quantum devices. Our studies demonstrate that ZnO will be a new and unique platform for quantum devices.

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Brief Bio:

Dr. Yusuke Kozuka obtained B.E. (2005), M.S. (2007), and Ph. D in Advanced Material Science of the University of Tokyo. He carried out his Assistant Professor activity in Institute for Material research, Tohoku university from 2010. He Joined to Quantum-phase Electronics Center in the University of Tokyo as a Research associate (2011~2013). And he contributed as a lecturer in Quantum-phase Electronics Center in the University of Tokyo (2013 ~ 2018). Now, he is independent/senior scientist in Research Center for Magnetic and Spintronic Materials, National Institute for Materials Science, Japan (NIMS). During his professional research career, He abstained 24th Advanced Technology Award from Nippon broadcasting system Inc. at 2010, 27th Inoue Research Award for Young Scientist at 2011, and he was winner of Commendation for Science and Technology by MEXT, The Young Scientists Prize at 2018.

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