Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Anomalous Fermi level behavior in GaMnAs at the onset of ferromagnetism IRIYA MUNETA, HIROSHI TERADA, SHINOBU OHYA, MASAAKI TANAKA, Department of Electrical Engineering and Information Systems, The University of Tokyo — The origin of the ferromagnetism and the metal-insulator transition (MIT) has been a long-debated issue in the prototype ferromagnetic semiconductor GaMnAs. Previously, the valence band (VB) conduction picture has been widely accepted in this material, where the MIT of GaMnAs was understood by the Fermi level crossing over the VB similarly to p-type GaAs doped with non-magnetic acceptors. Here, we carefully analyze the VB structure and the Fermi level position in a series of $Ga_{1-x}Mn_xAs$ from the unexplored insulating region ($x \simeq 0.01\%$) to the metallic region ($x = 3.2\%$) by using resonant tunneling spectroscopy. We find that the Fermi level never crosses over the VB near the MIT: The Fermi level becomes closest to the VB top at $x = 1.0\%$ at the onset of the ferromagnetism, but it moves away from the VB with increasing or decreasing x from 1.0%. This anomalous behavior of the Fermi level is completely different from that of GaAs doped with other non-magnetic shallow acceptors [1]. This work was partly supported by Grant-in-Aids for Scientific Research including Specially Promoted Research, Project for Developing Innovation Systems of MEXT, and FIRST Program of JSPS.

[1] I. Muneta, H. Terada, S. Ohya, and M. Tanaka, *submitted*; arXiv:1208.0575.

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Date submitted: 07 Nov 2012 Electronic form version 1.4