

## Interplays between numerous degrees of freedom in CMR manganites

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In dilute magnetic semiconductors (DMS), the interactions between carrier and spin are known to play important roles. The physical properties of these intriguing materials have similarities as well as differences with those of the CMR manganites, such as (La,Ca)MnO<sub>3</sub>. In this talk, we will focus on how the optical spectroscopy technique can be used to probe interplays between these degrees of freedom in the CMR manganites. Especially, we will address how the carrier and the spin can be strongly coupled, and how the lattice degree of freedom can form lattice polaron, which modifies the strong carrier-spin coupling [1]. We will also show how the spin/orbital ordering pattern can affect the optical properties of the manganites, such as (Nd,Sr)MnO<sub>3</sub> [2]. Then, we will also discuss on possible implications of our results in understanding the physics of DMS.

[1] K. H. Kim, *et. al*, Phys. Rev. Lett. **77**, 1877 (1996); *ibid.* **81**, 1517 (1998).

[2] M. W. Kim, *et. al*, Phys. Rev. Lett. **89**, 016403 (2002).