

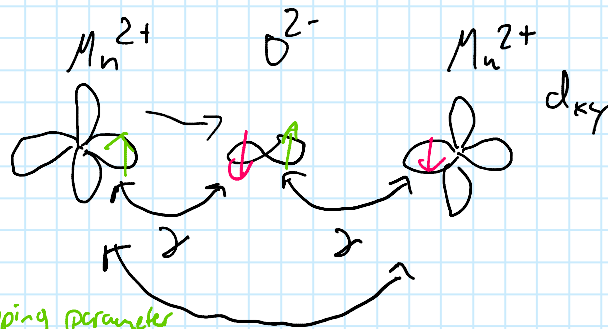
Lecture 21 - WiSe2022/2023

Monday, January 2, 2023 5:28 PM

3.4. Different types of exchange interaction

- **Direct exchange:** localized magnetic moments + overlap of their WF
- **Super exchange:** Coupling between non-nearest neighbors through a non-magnetic (diamagnetic) atom/ion

Example: MnO

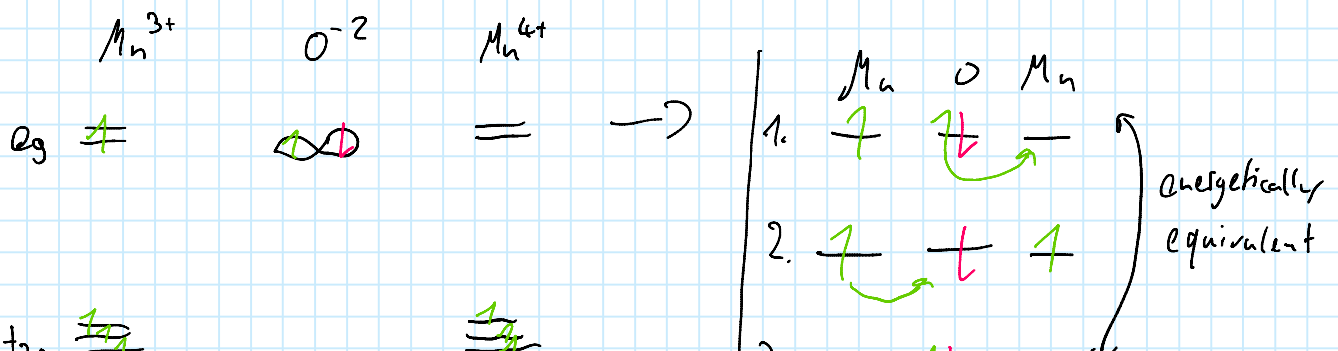


$\rightarrow J \propto \frac{t^2}{U}$
 $\rightarrow$ virtual hopping process
↑ Coulomb interaction

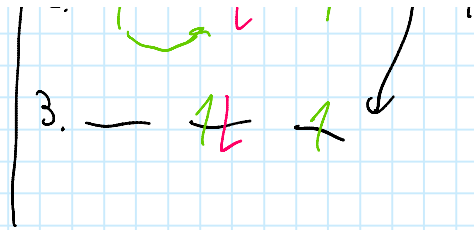
$\hookrightarrow$ Antiferromagnetic coupling

Double exchange:

In a "mixed-valence compounds" for $La^{3+}Ca^{2+}MnO_3$



t_{2g}



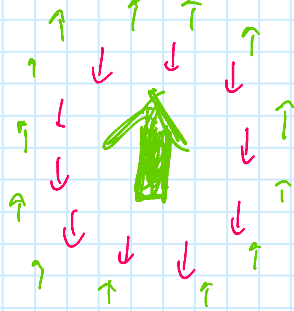
$\Rightarrow$ (real) hopping process $J \propto t$

$\hookrightarrow$ parallel alignment of M_n

$\hookrightarrow$ Ferromagnetic interaction

RKKY - interaction

$\rightarrow$ localized magnetic moment that couples to a "cloud" of conduction electrons



$$J_{\text{RKKY}} \propto \frac{\cos(2 \cdot k_F \cdot r)}{(2 k_F \cdot r)^3}$$

$\hookrightarrow$ long-range oscillating magnetic order

$\hookrightarrow$ Basis for GMR (giant magnetoresistance)

