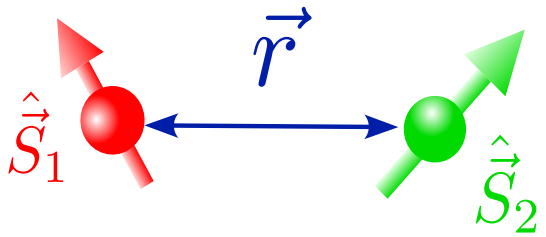
Magnetic dipole-dipole Hamiltonian:

$$\mathcal{H}_{\mathrm{dd}} = \frac{J_0}{r^3}\left[3(\hat{\vec{S}}_1 \cdot \vec{u})(\hat{\vec{S}}_2 \cdot \vec{u}) - \hat{\vec{S}}_1 \cdot \hat{\vec{S}}_2\right]$$



$J_0/\hbar \approx 51.8\ \mathrm{MHz} \cdot \mathrm{nm}^3$

$$\begin{array}{c} \\ \langle -1;-1| \\ \langle -1;0| \\ \langle -1;+1| \\ \langle 0;-1| \\ \vdots \end{array}
\begin{array}{c}
\begin{array}{cccccc} |-1;-1\rangle & |-1;0\rangle & |-1;+1\rangle & |0;-1\rangle & \cdots \end{array} \\
\begin{pmatrix}
J_{zz} & 0 & 0 & 0 & \\
0 & 0 & 0 & J_{xx}^* & \cdots \\
0 & 0 & -J_{zz} & 0 & \\
0 & J_{xx} & 0 & 0 & \\
\vdots & & \vdots & & \ddots
\end{pmatrix}
\end{array}$$

: Energy shift
→ Spectral broadening

: Spin exchange
→ Flip-flop, relaxation