

from toy model to quantum physics

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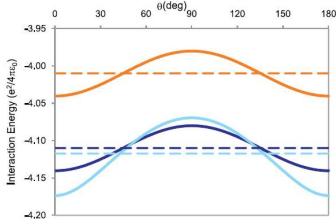
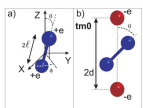
Overview for the charge-charge case

order	multipole moment / field	first order quasi moment / quasi field	second order quasi moment / quasi field	...
$\mathcal{O}(0)$	$M \propto r^0 Y_{00}$ $V \propto r(0)$ } MI [a]	$M^{(1)} \propto \{r^2 Y_{00}\}$ $V^{(1)} \propto \Delta r(0)$ } MS ⁽¹⁾ [d]	$M^{(2)} \propto \{r^4 Y_{00}\}$ $V^{(2)} \propto \Delta^2 r(0)$ } MS ⁽²⁾	...
$\mathcal{O}(2)$	$Q \propto r^2 Y_{20}$ $V_{ij} \propto \partial_{ij} r^2(0)$ } QI [b]	$Q^{(1)} \propto \{r^4 Y_{20}\}$ $V_{ij}^{(1)} \propto \partial_{ij} \Delta r(0)$ } QS ⁽¹⁾ [e]	$Q^{(2)} \propto \{r^6 Y_{20}\}$ $V_{ij}^{(2)} \propto \partial_{ij} \Delta^2 r(0)$ } QS ⁽²⁾	...
$\mathcal{O}(4)$	$H \propto r^4 Y_{40}$ $V_{ijkl} \propto \partial_{ijkl} r^4(0)$ } HDI [c]	$H^{(1)} \propto \{r^6 Y_{40}\}$ $V_{ijkl}^{(1)} \propto \partial_{ijkl} \Delta r(0)$ } HDS ⁽¹⁾	$H^{(2)} \propto \{r^8 Y_{40}\}$ $V_{ijkl}^{(2)} \propto \partial_{ijkl} \Delta^2 r(0)$ } HDS ⁽²⁾	...
...

Corrections due to the shape of the nucleus (quadrupole moment) in the case without overlap

2

Exactly solvable classical toy model : no electrons in nucleus



$$E_0(\theta) = -2C \left(\frac{1}{\sqrt{\ell^2 \sin^2 \theta + (d - \ell \cos \theta)^2}} + \frac{1}{\sqrt{\ell^2 \sin^2 \theta + (d + \ell \cos \theta)^2}} \right) \quad C = e^2 / (4\pi\epsilon_0)$$

3

