Nuclear forces and their impact on structure, reactions and astrophysics

Dick Furnstahl
Ohio State University

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Lectures for Week 1

M. QCD 1 (as); Scattering theory 1 (rjf)

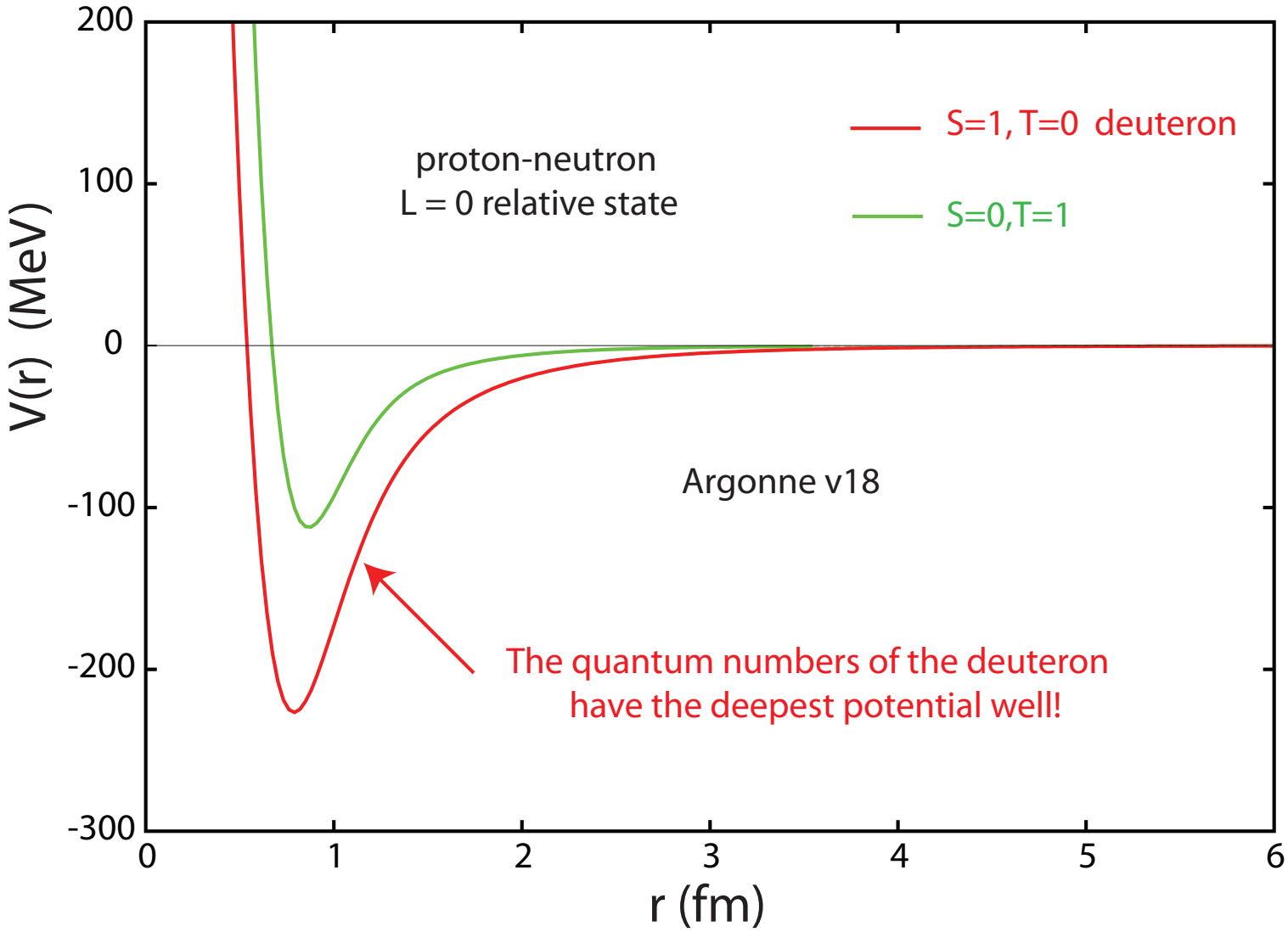
T. Nuclear forces 1 (rjf); Scattering theory 2 (as)

W. Nuclear forces 2 (rjf); Renormalization and Universality (as)

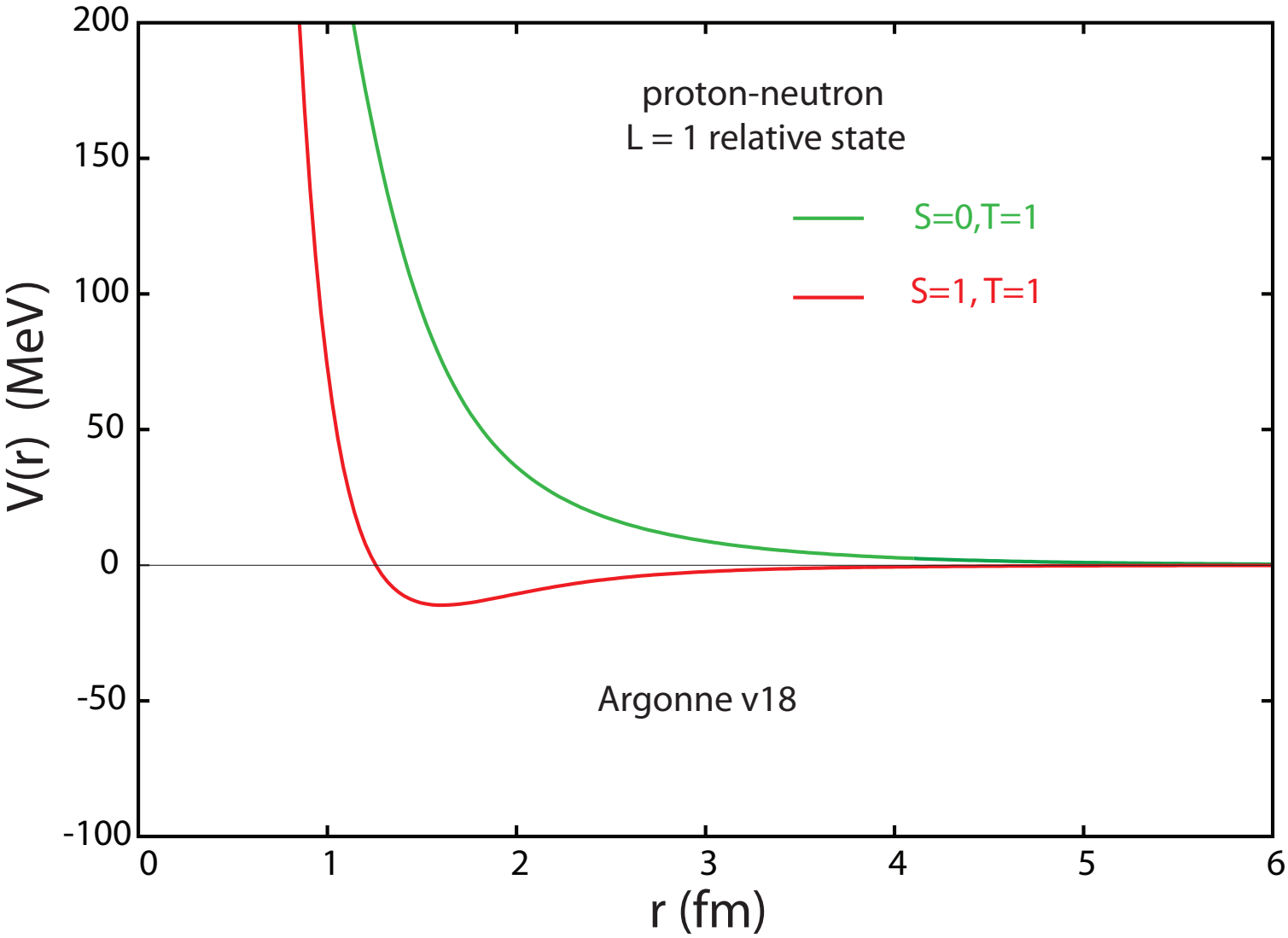
Th. Cold atoms and neutrons, QMC (ag);
Tensor/spin-orbit forces, deuteron properties (rjf)

F. QMC and chiral EFT interactions (ag);
Three-body forces and halo nuclei (as)

AV18 potential (Thanks, George!)



AV18 potential (Thanks, George!)

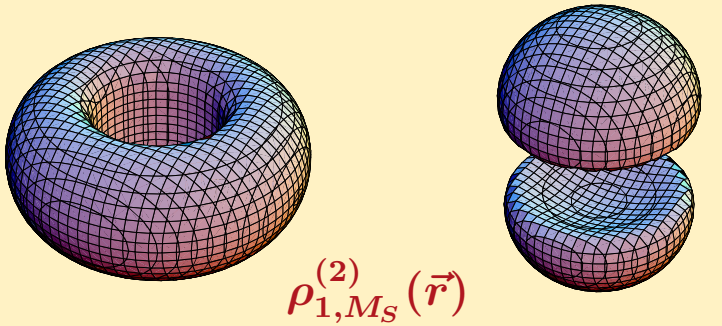


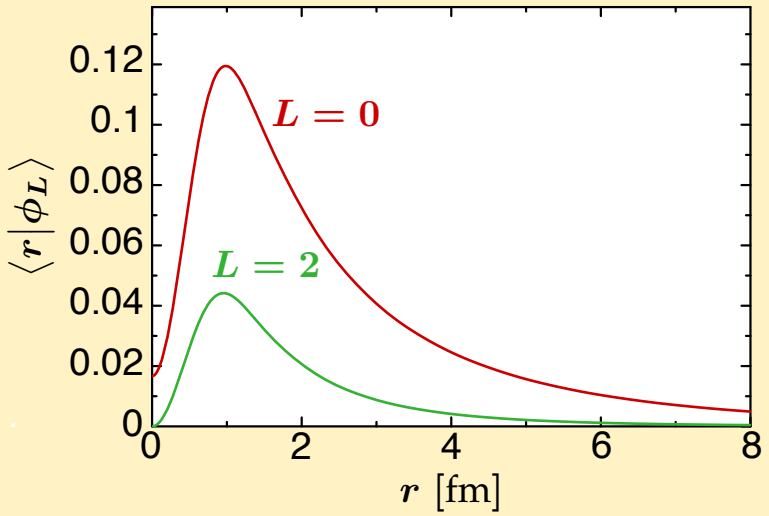
Deuteron with the AV18 potential

Deuteron Solution for a Realistic NN Interaction

$M_S = 0$
$\frac{1}{\sqrt{2}}(|\uparrow\downarrow\rangle + |\downarrow\uparrow\rangle)$

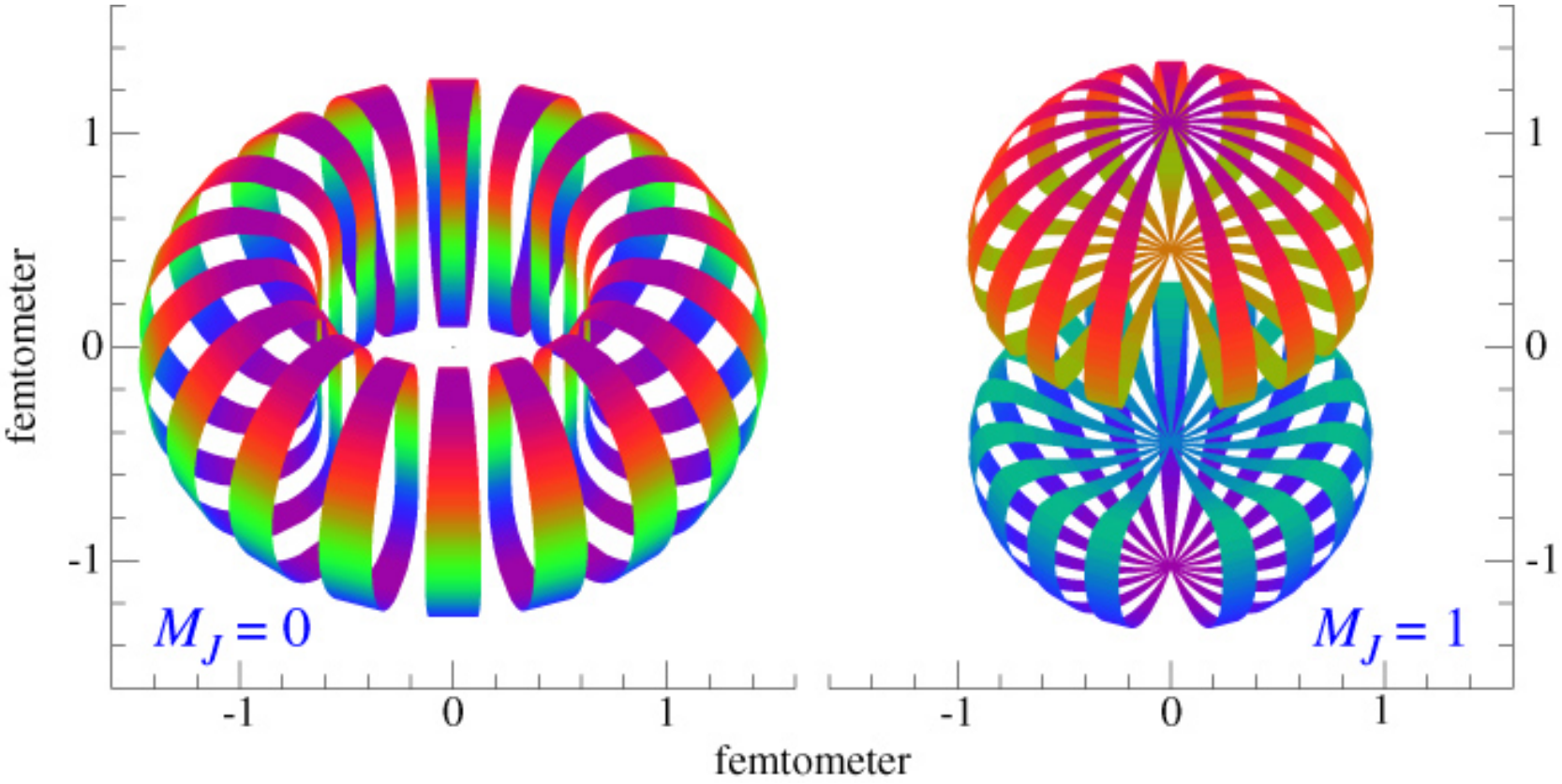
$M_S = \pm 1$
$|\uparrow\uparrow\rangle, |\downarrow\downarrow\rangle$





- Non-central components from the tensor force (pion exchange, for example) yields a hole in the middle.
- What is measurable?

Deuteron with the AV18 potential



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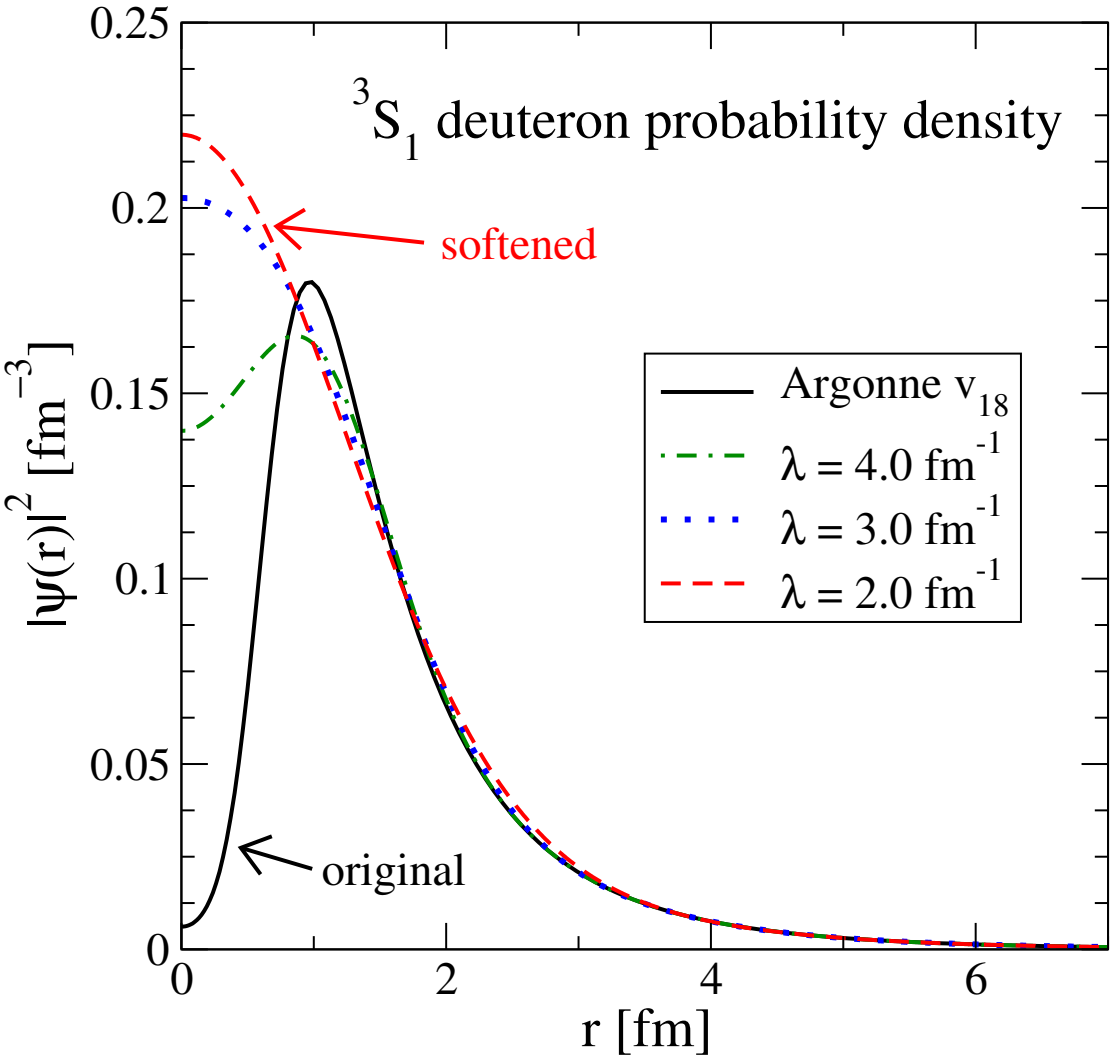
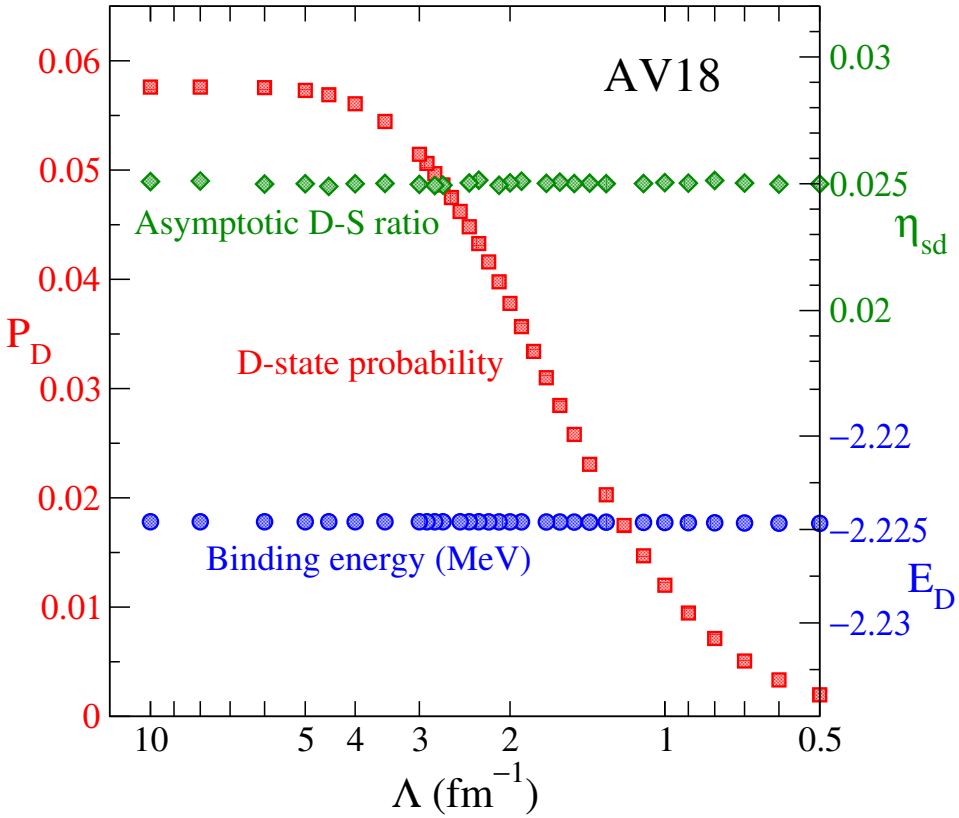
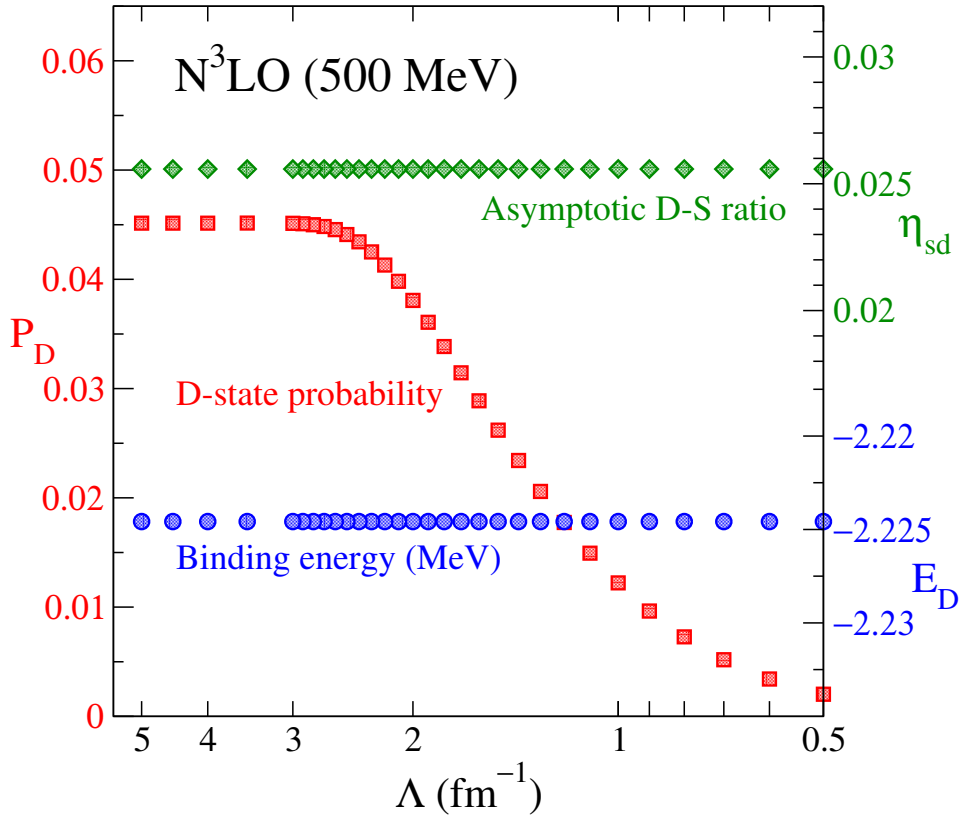
Preview: unitary transformations and deuteron wf



$\Longrightarrow$ Only the interior is changed

Deuteron scale-(in)dependent observables





- $V_{\text{low } k}$ RG transformations labeled by Λ (different V_Λ's)
  - $\Longrightarrow$ soften interactions by lowering resolution (scale)
  - $\Longrightarrow$ reduced short-range and tensor correlations
- Energy and asymptotic D-S ratio are unchanged (cf. ANC's)
- But D-state probability changes $\Longrightarrow$ not observable!