Towards the inclusion of dissipative effects in Quantum Time Dependent Mean-field Theories

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Dissipative mechanisms
in finite quantum systems

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An old story...

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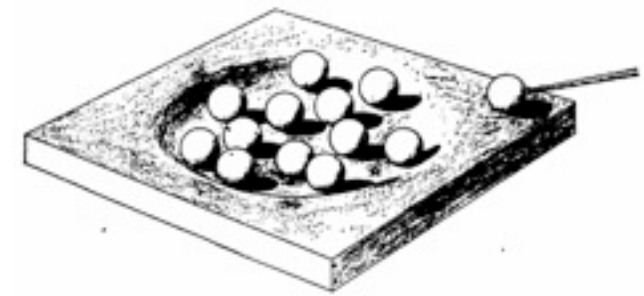
neutron on nucleus



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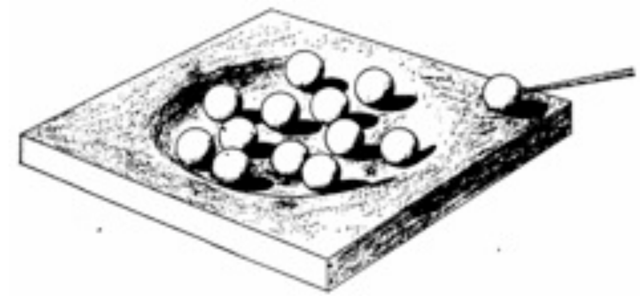

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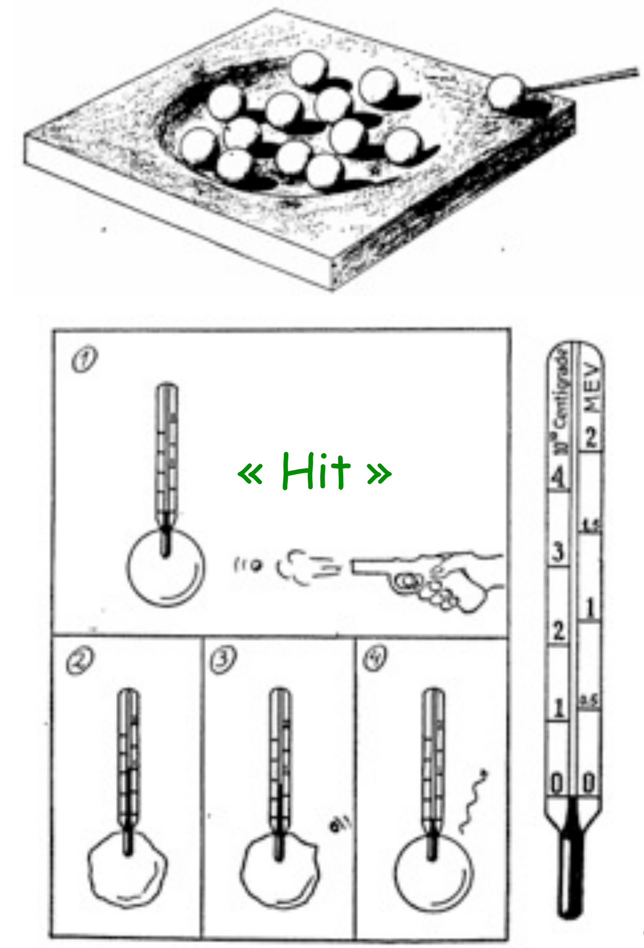

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Dissipative mechanisms

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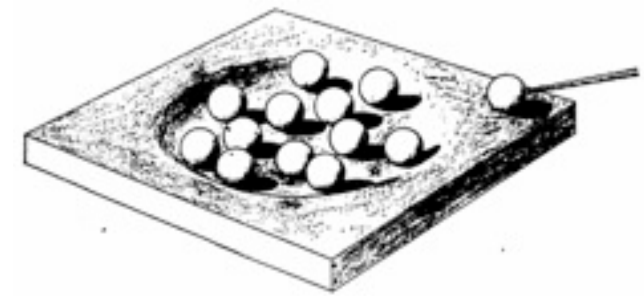
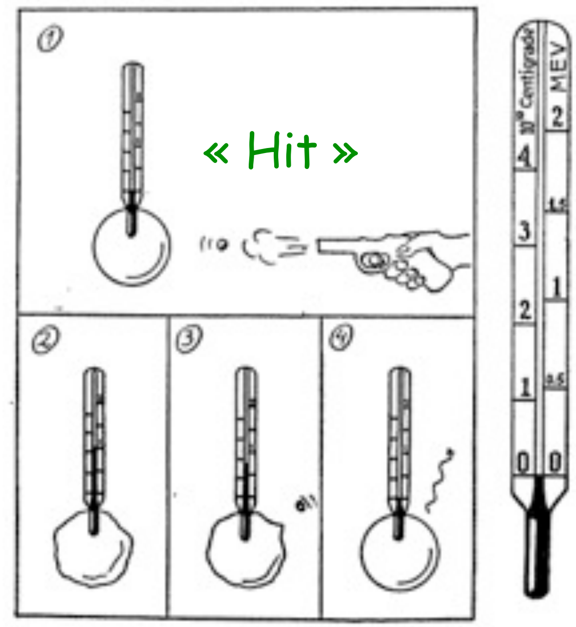
An old story…

- Dissipation
- Dynamical picture
- Microscopic description
- Finite systems

neutron on nucleus





« compound nucleus »

« neutron cooling »

« radiative cooling »

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Angular distributions and temperature

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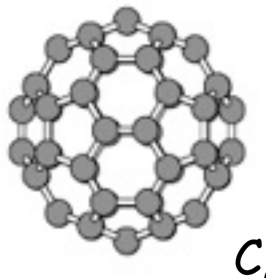

C_{60}

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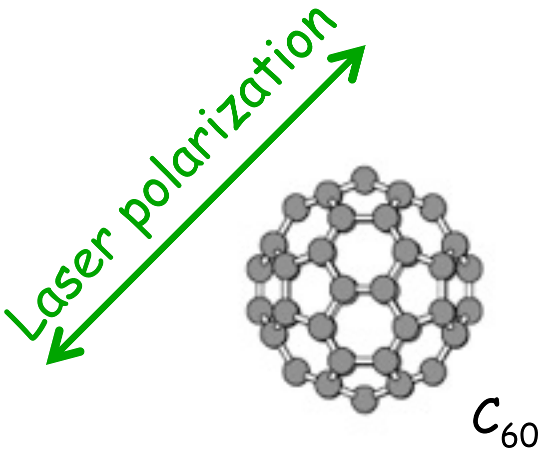

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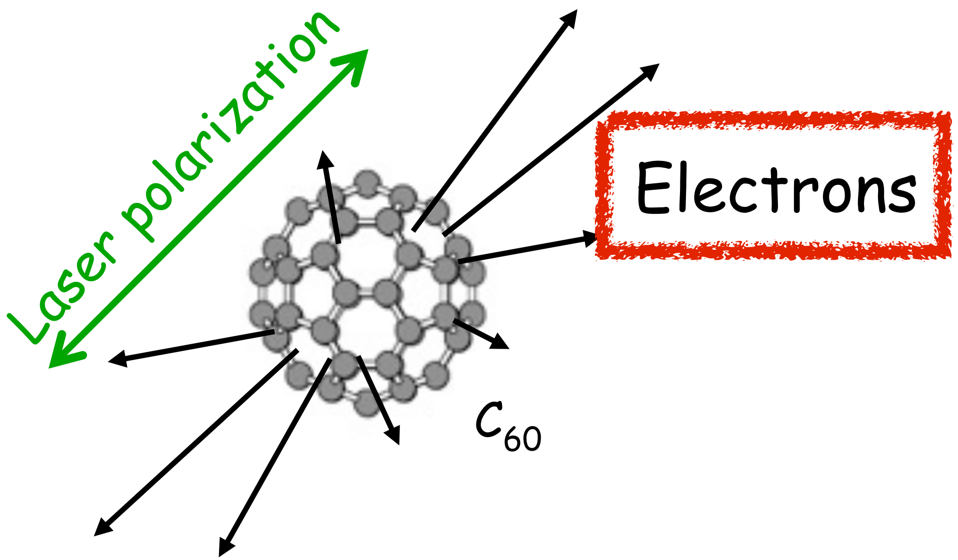

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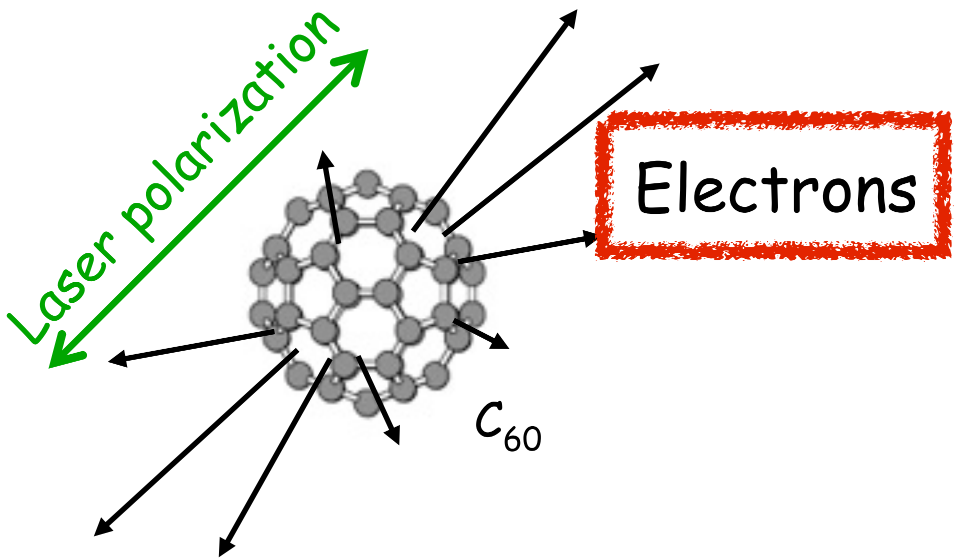

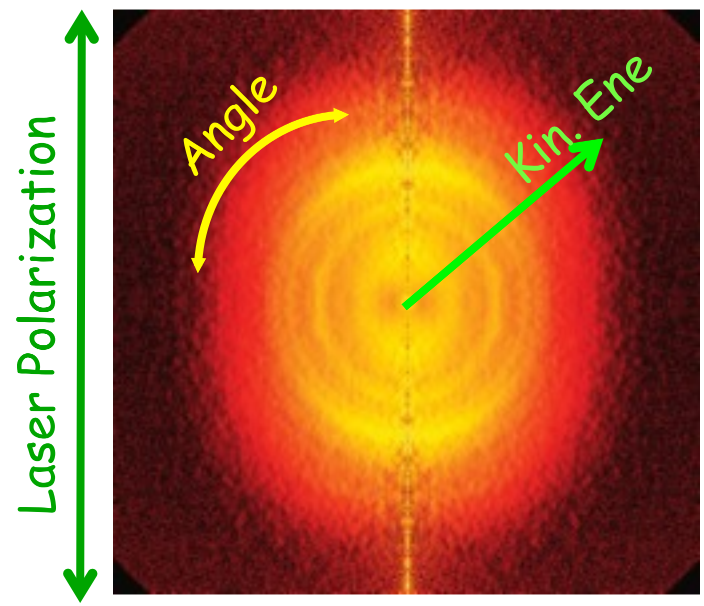

Exp: Campbell 2010

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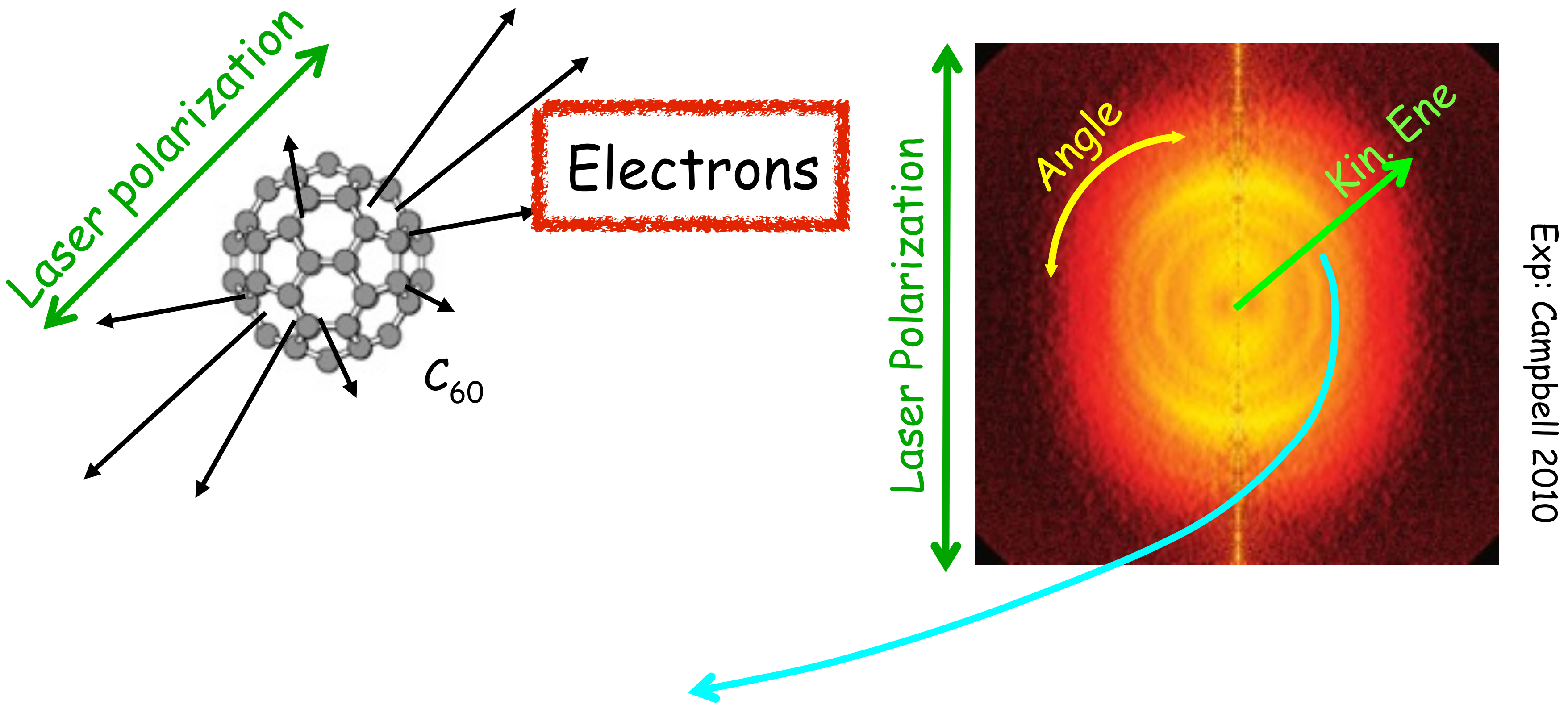

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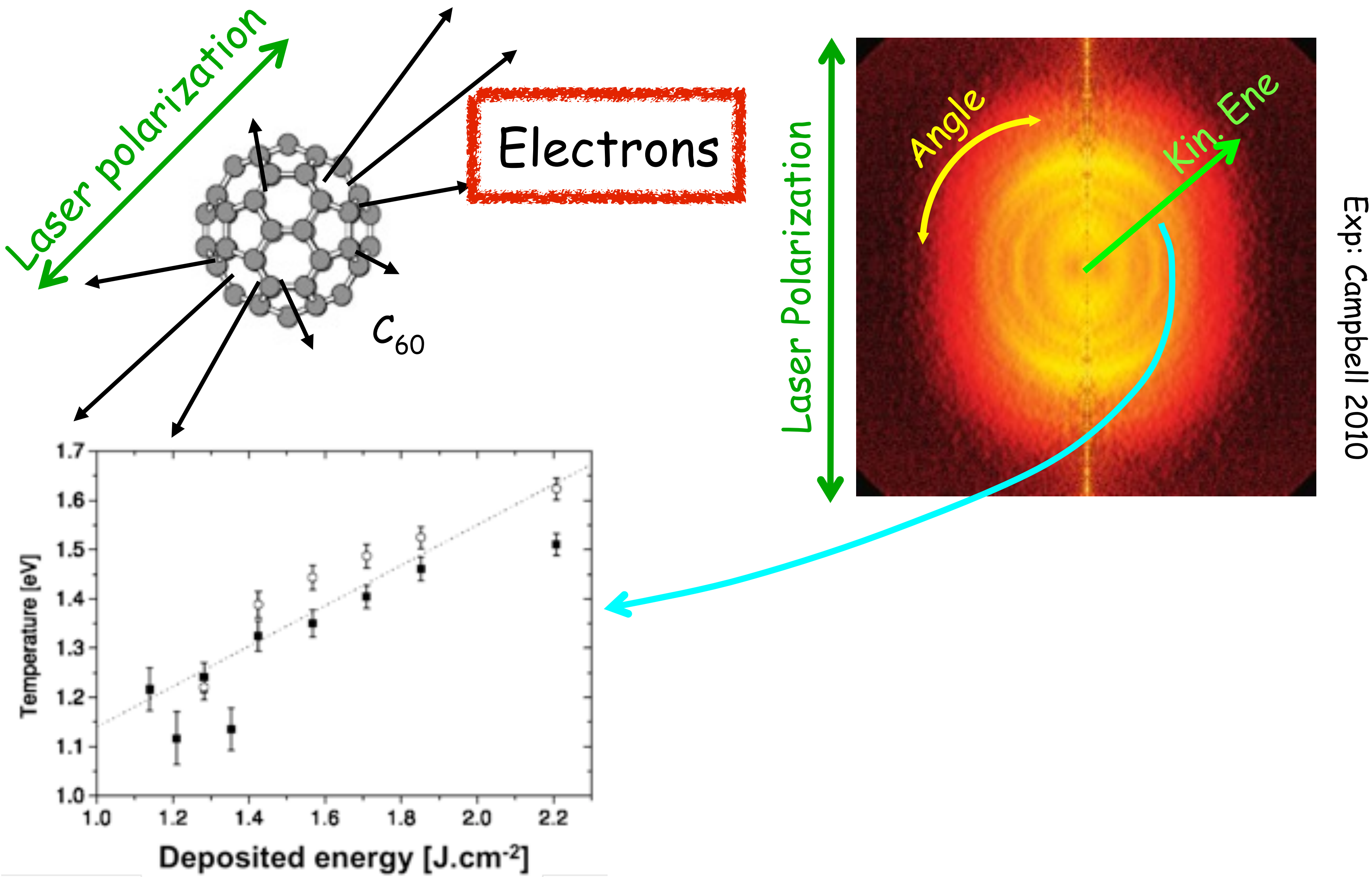

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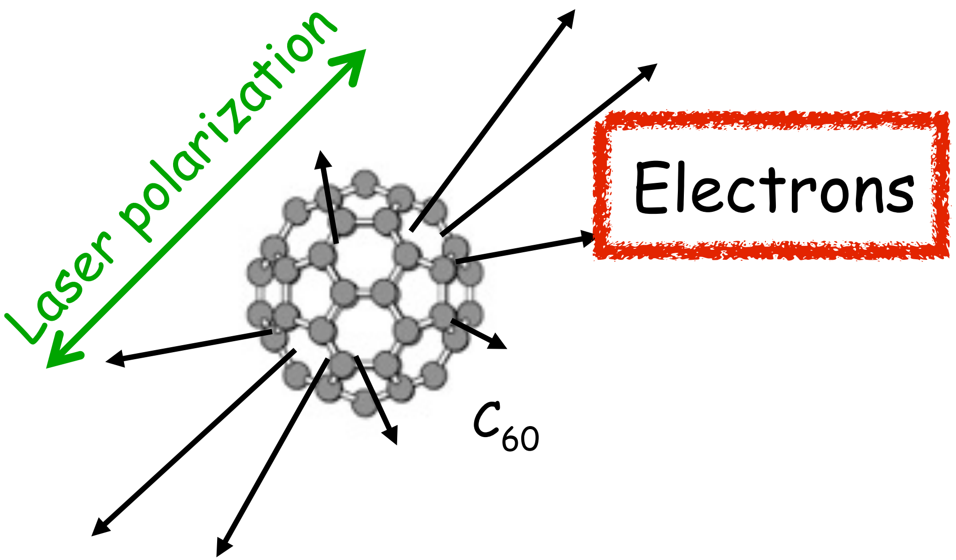

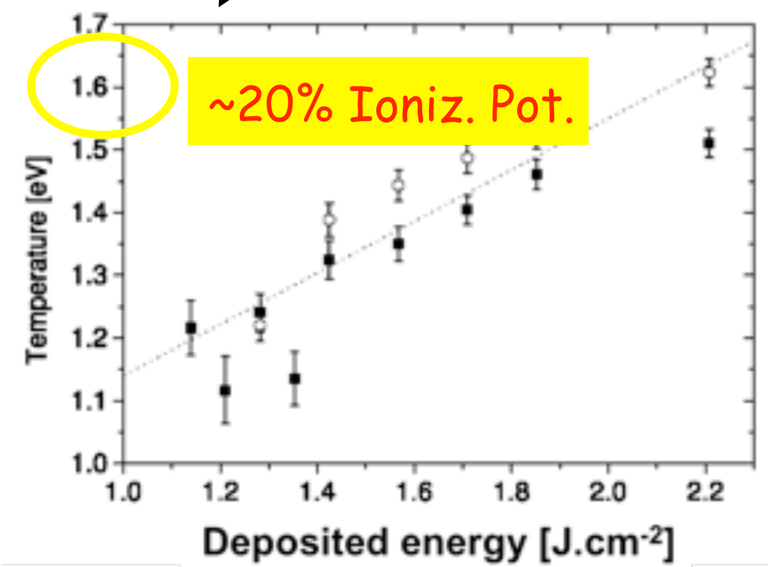

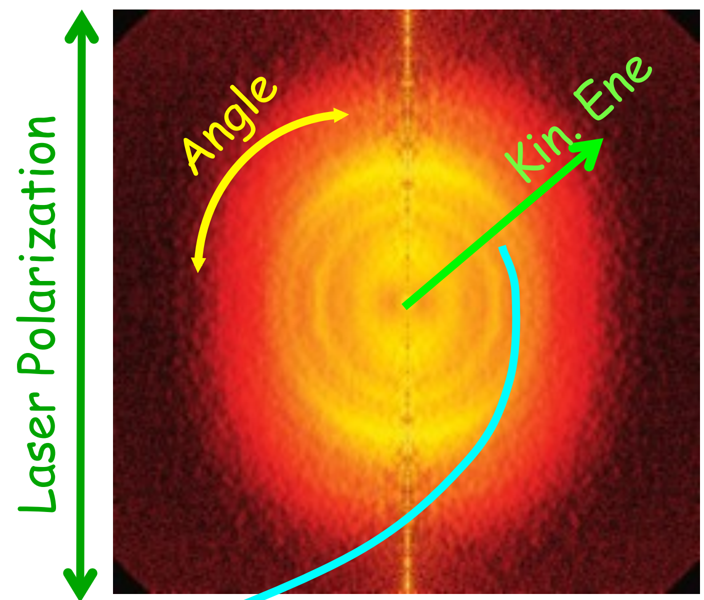

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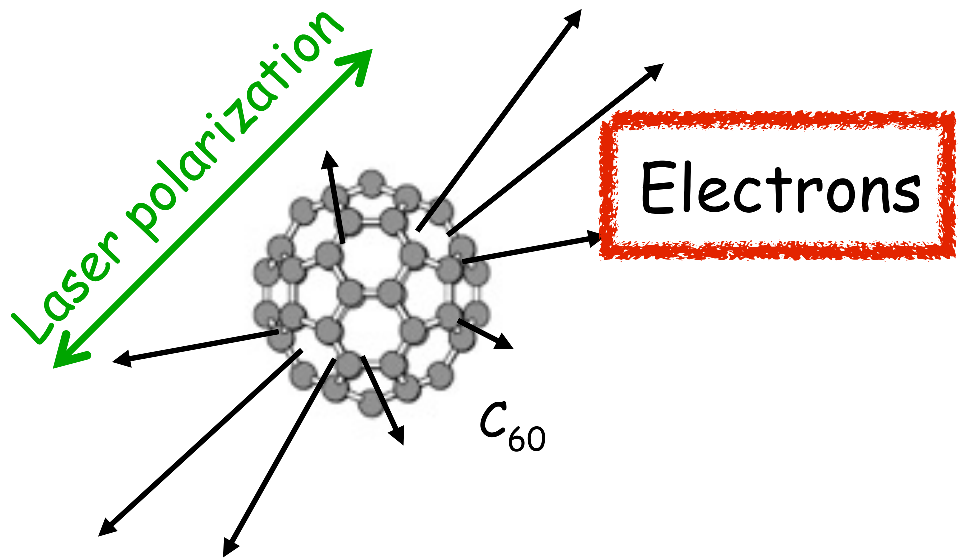

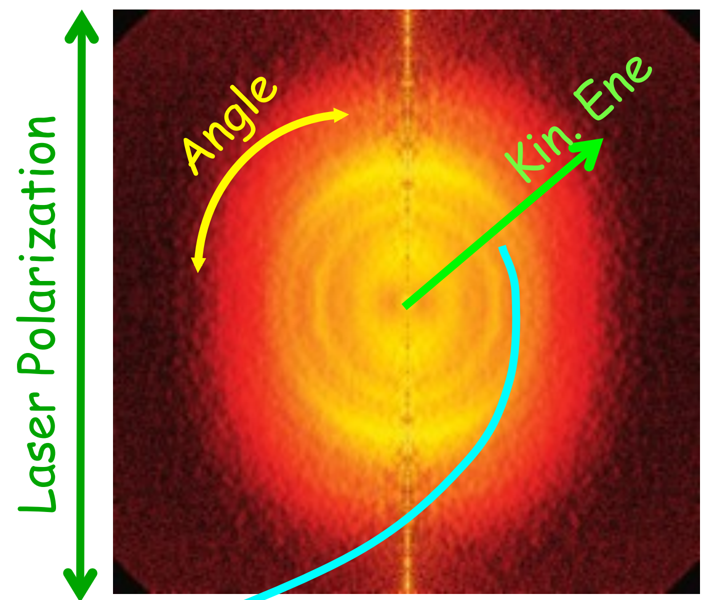

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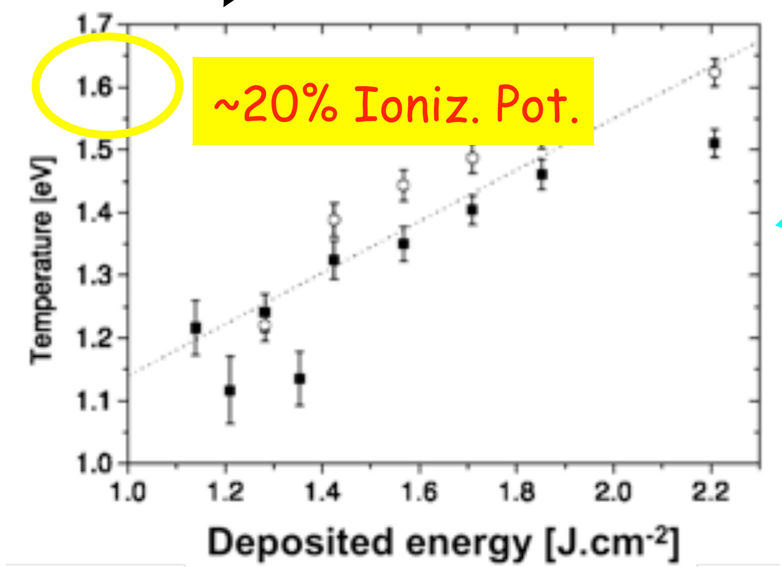

Thermalization

Dissipation:

collective (laser) → thermal

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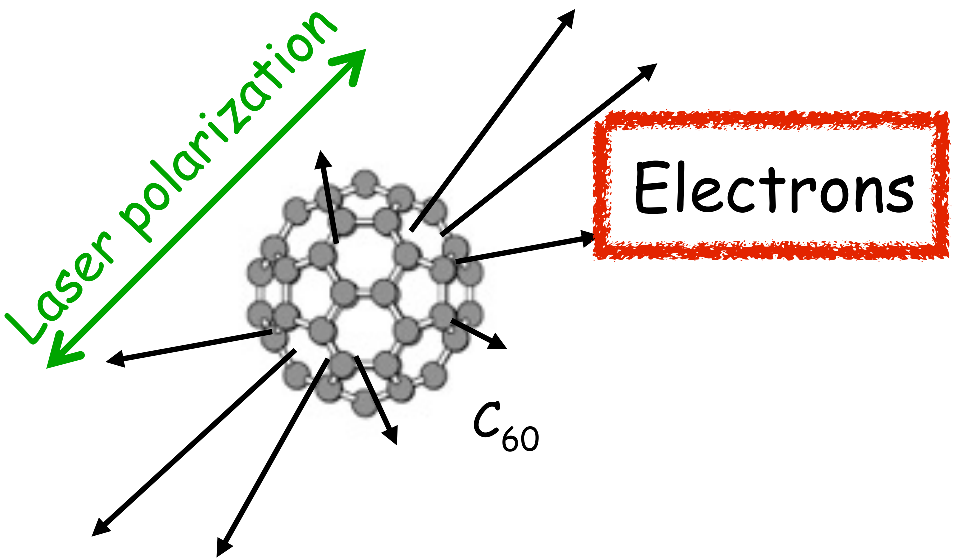

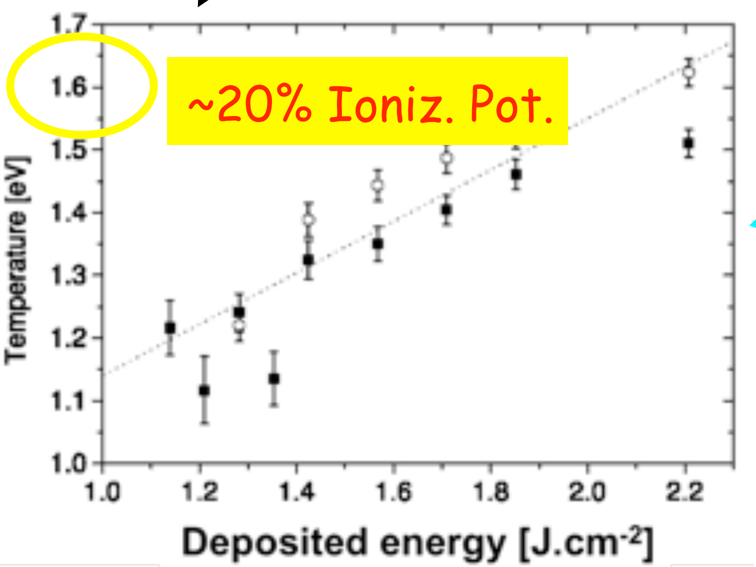

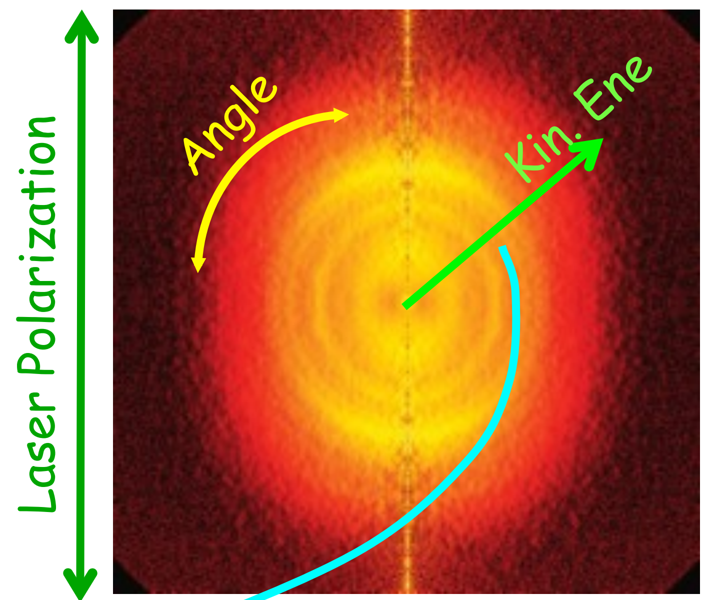

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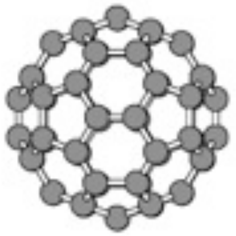

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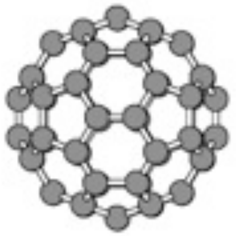

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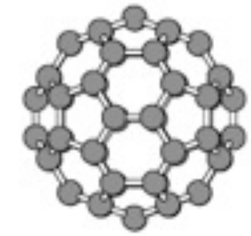

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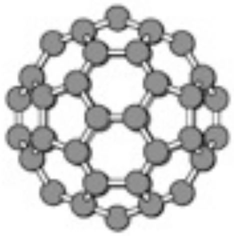

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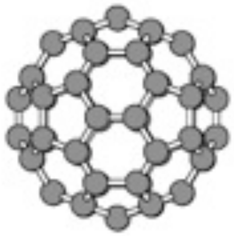

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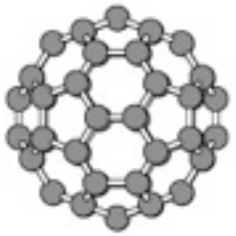

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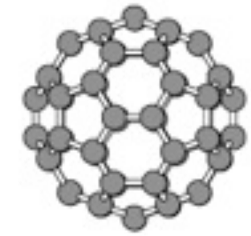

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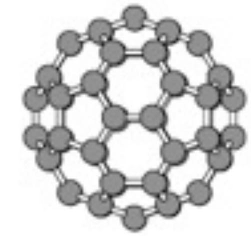

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Quantum kinetic equation

Involved object... Need of simplifications for realistic cases

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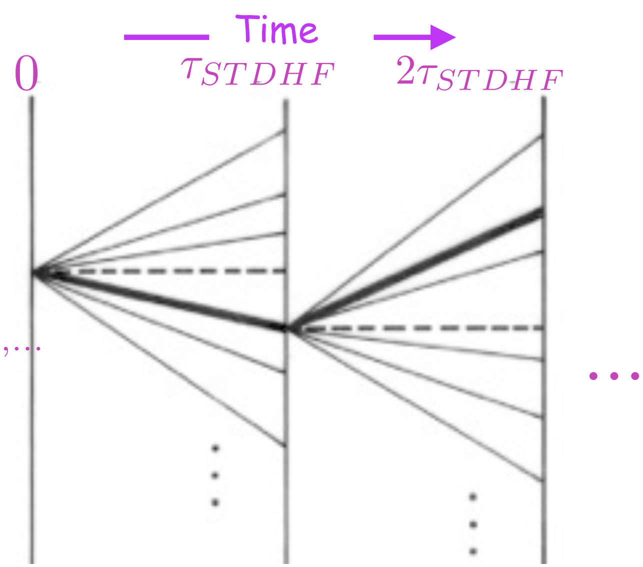

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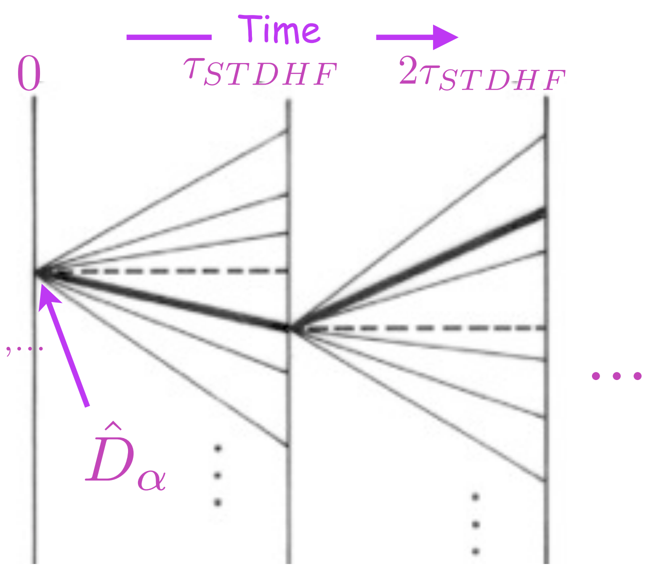

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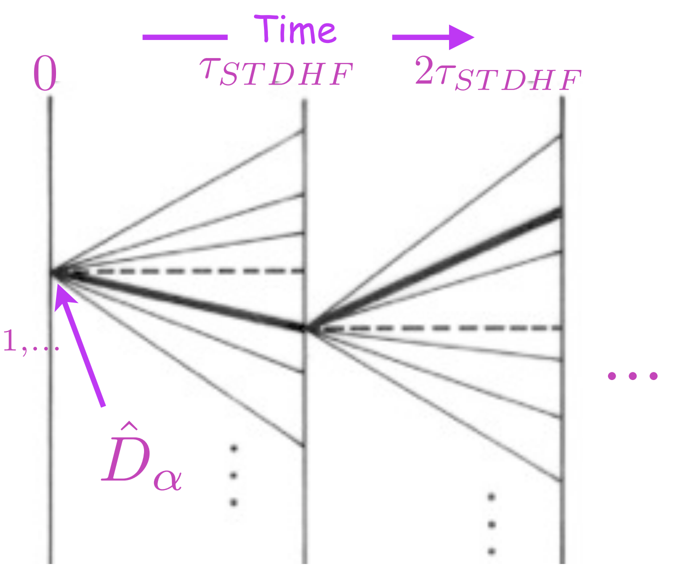
TDHF Propagatation



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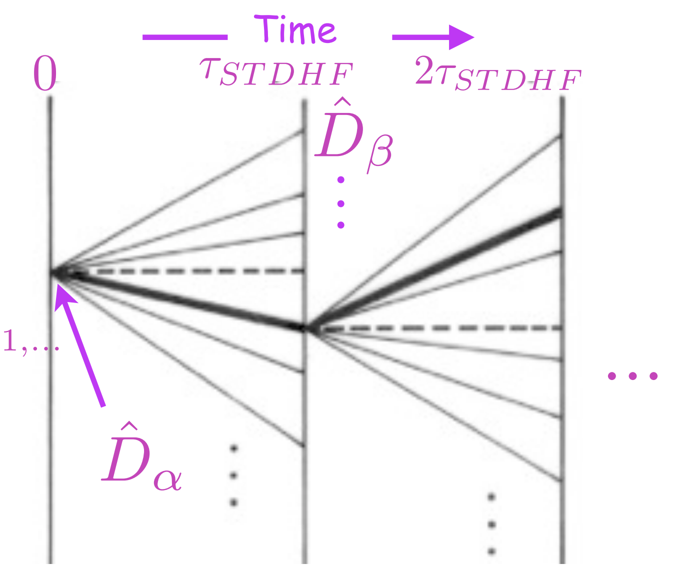

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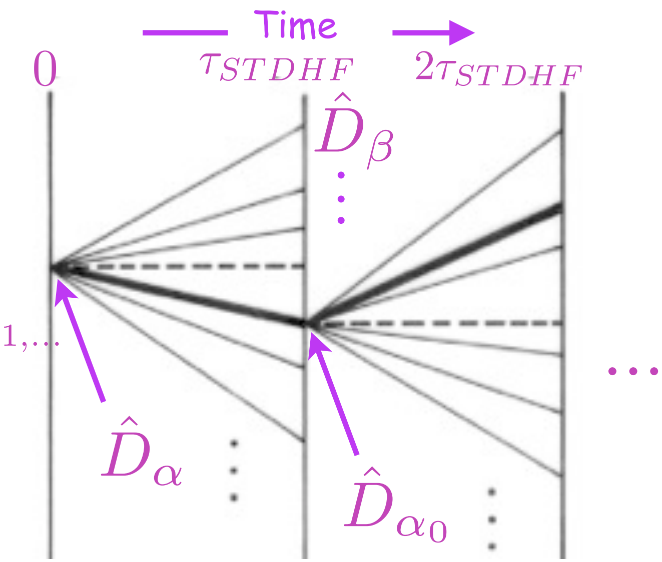

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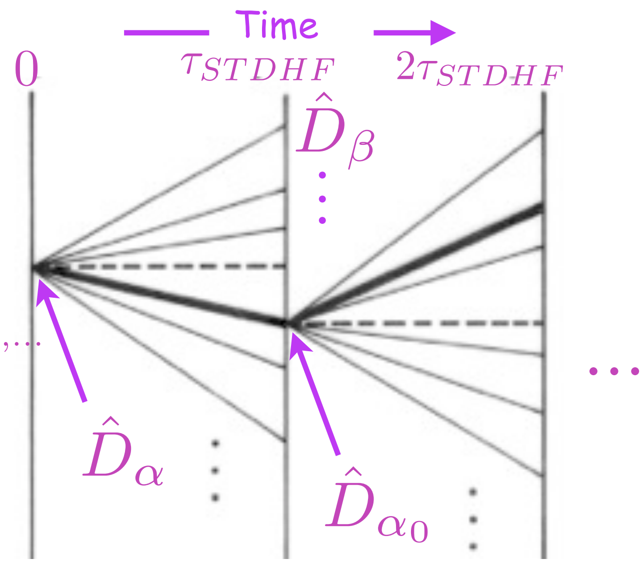

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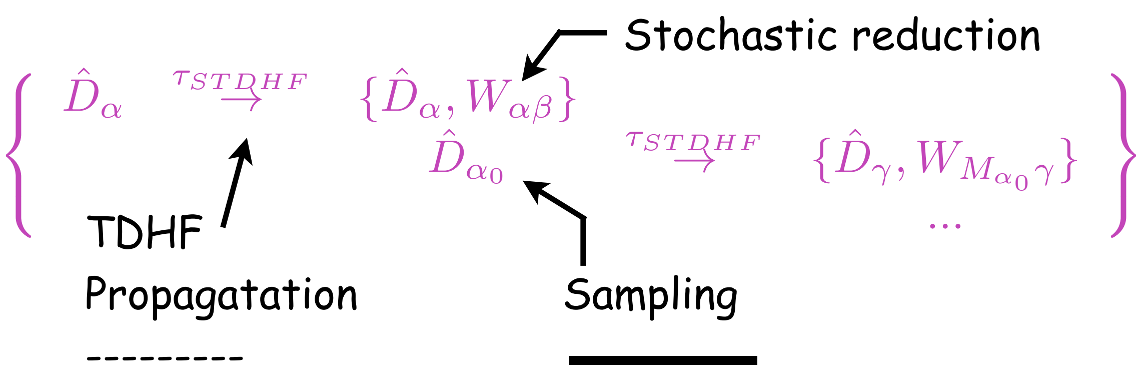

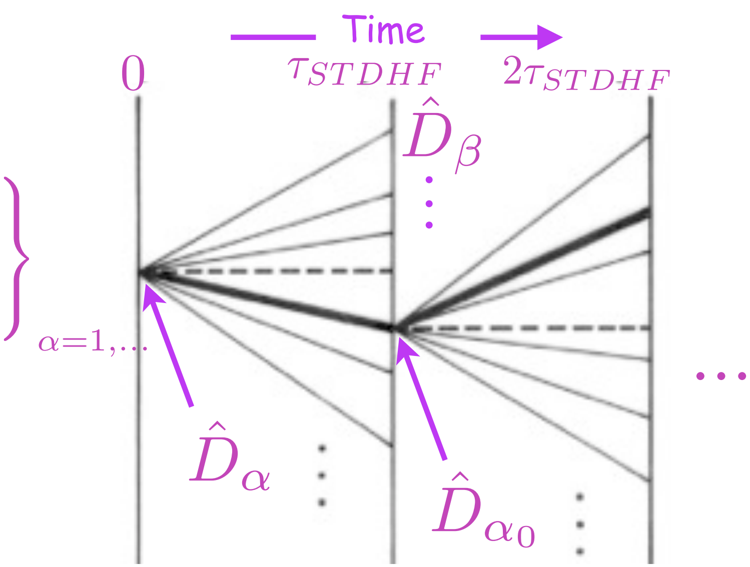

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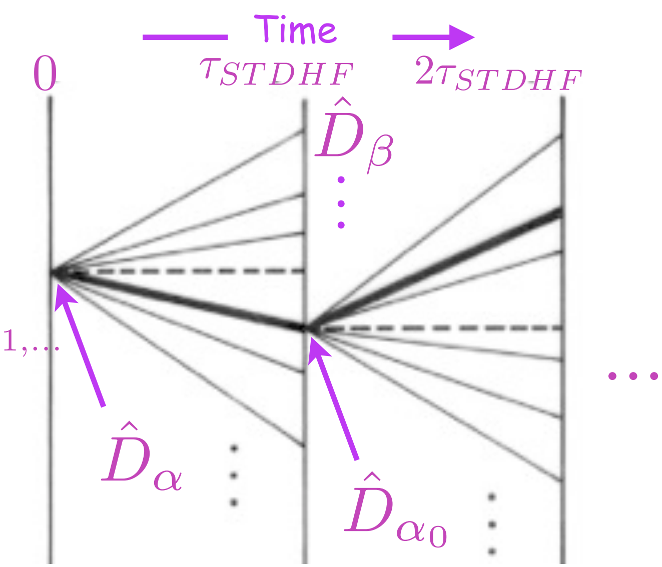

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  - Simple practical scheme, in principle...

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- Same (ensemble) strategy of stochastic jumps : $|\Phi_\alpha\rangle \longrightarrow |\Phi_\beta\rangle$
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$$|\Psi_\alpha\rangle \simeq \sum_{pp'hh'} c_{pp'hh',\alpha}|\Phi_\alpha\rangle$$

- Estimate $c_{pp'hh',\alpha}$ from Fermi golden rule assuming 2 particle 2 hole excitations on $|\Phi_\alpha\rangle$: $|\Phi_\beta\rangle \simeq \hat{a}^\dagger_p \hat{a}^\dagger_{p'} \hat{a}_{h'} \hat{a}_h |\Phi_\alpha\rangle$
- For residual interaction $\hat{V}_{res}$ we have (Fermi Golden rule)

$$\begin{aligned}
W_{\alpha\beta} &= |c_{pp'hh'}|^2 \\
&\simeq \tau_{STDHF} \quad |\langle\Phi_\beta|\hat{V}_{res}|\Phi_\alpha\rangle|^2 \quad \delta(E_\beta - E_\alpha) \\
&\simeq \tau_{STDHF} \quad |\langle\Phi_\alpha|\hat{a}^\dagger_h \hat{a}^\dagger_{h'} \hat{a}_{p'} \hat{a}_p \hat{V}_{res}|\Phi_\alpha\rangle|^2 \quad \delta(\varepsilon_{\alpha,p} + \varepsilon_{\alpha,p'} - \varepsilon_{\alpha,h} - \varepsilon_{\alpha,h'})
\end{aligned}$$

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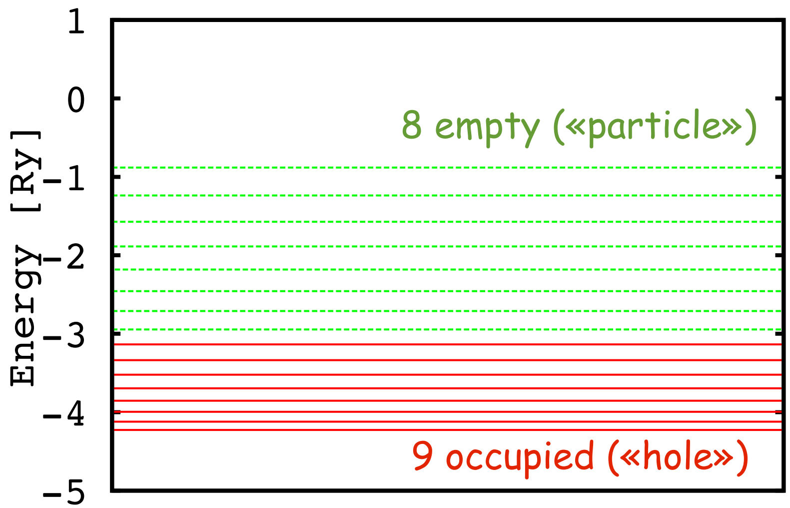

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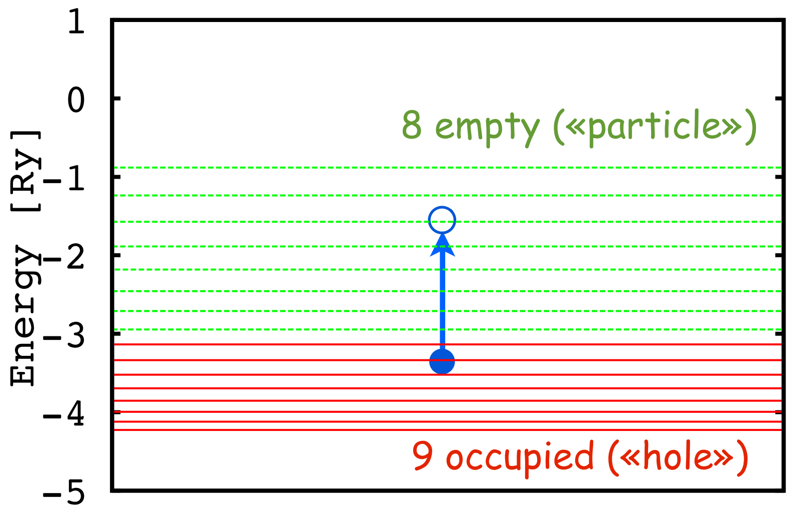

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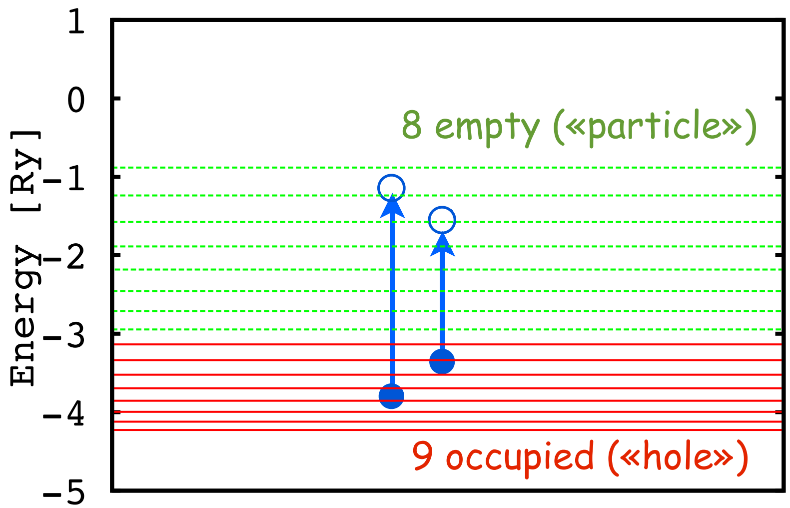

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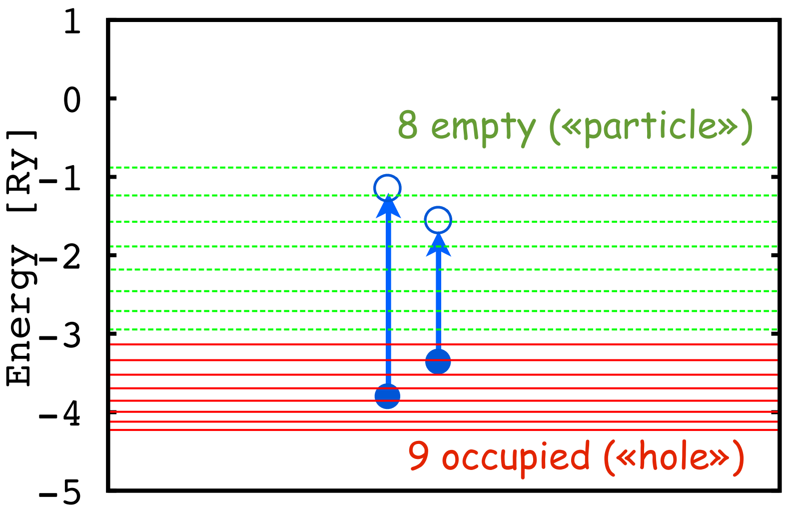

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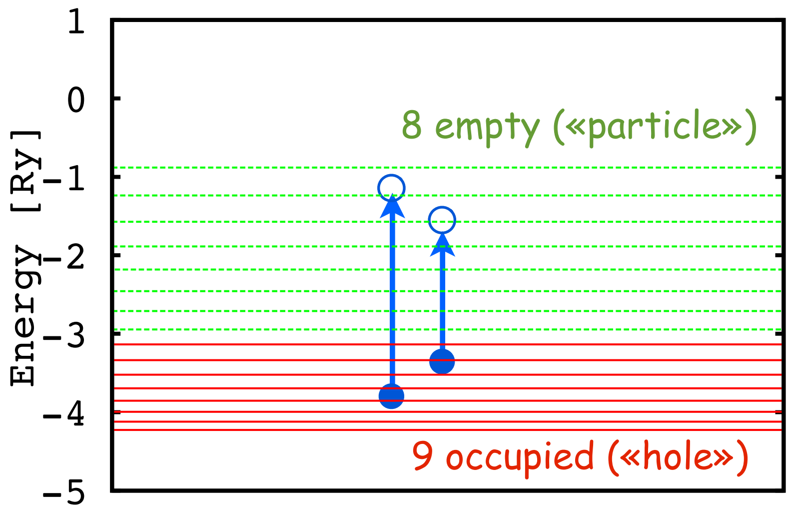

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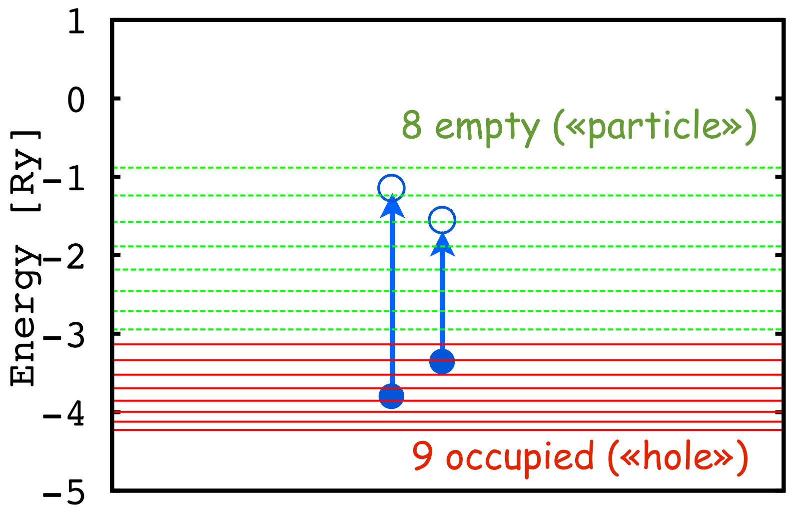

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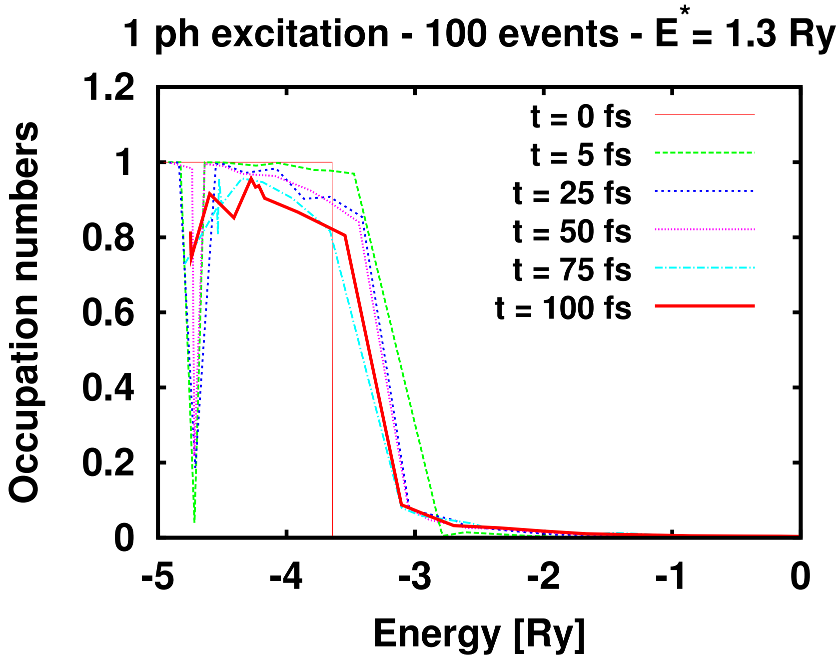

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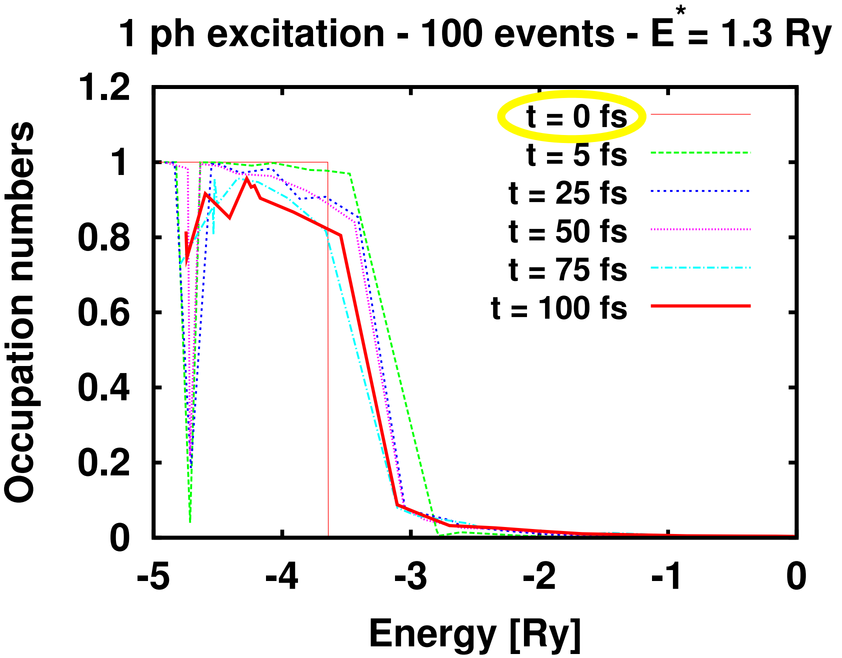

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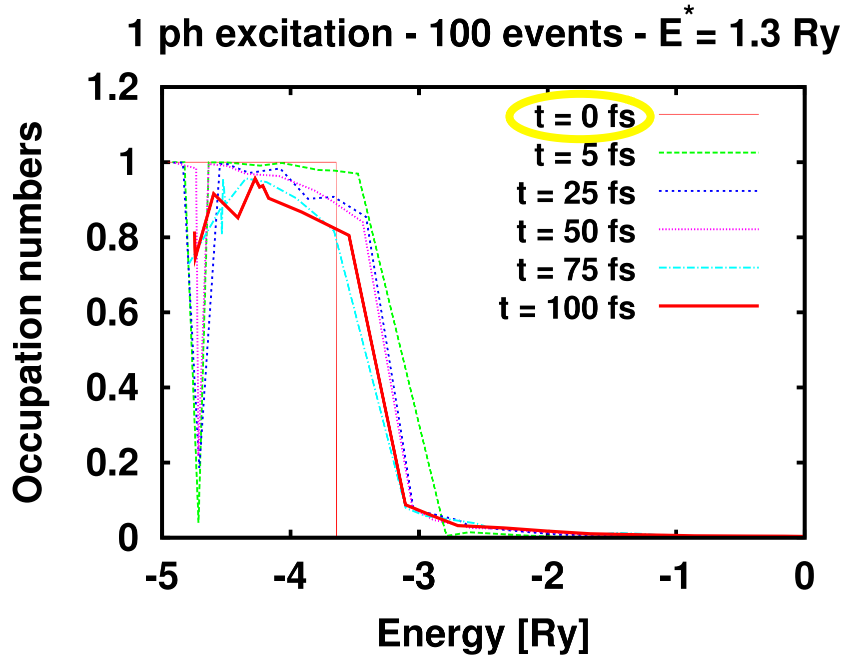

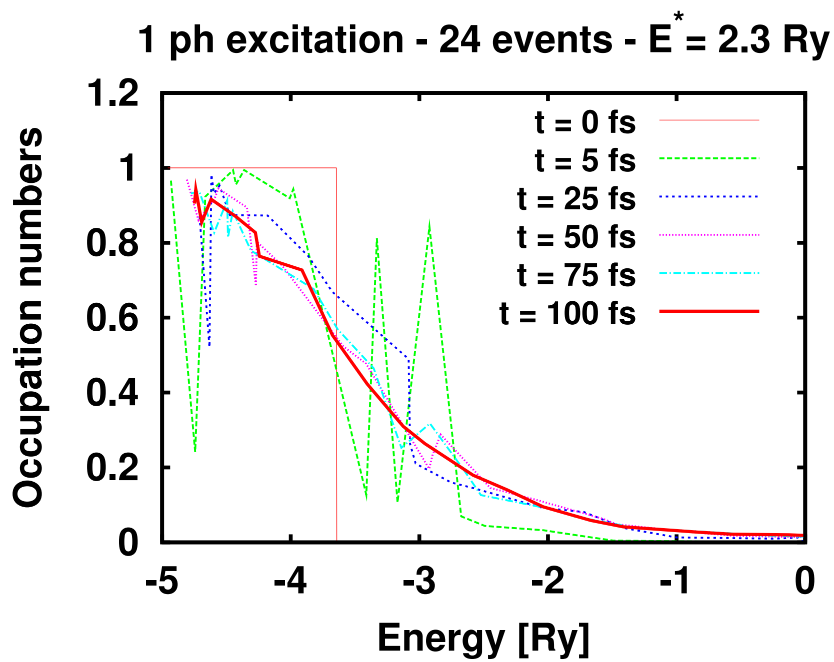

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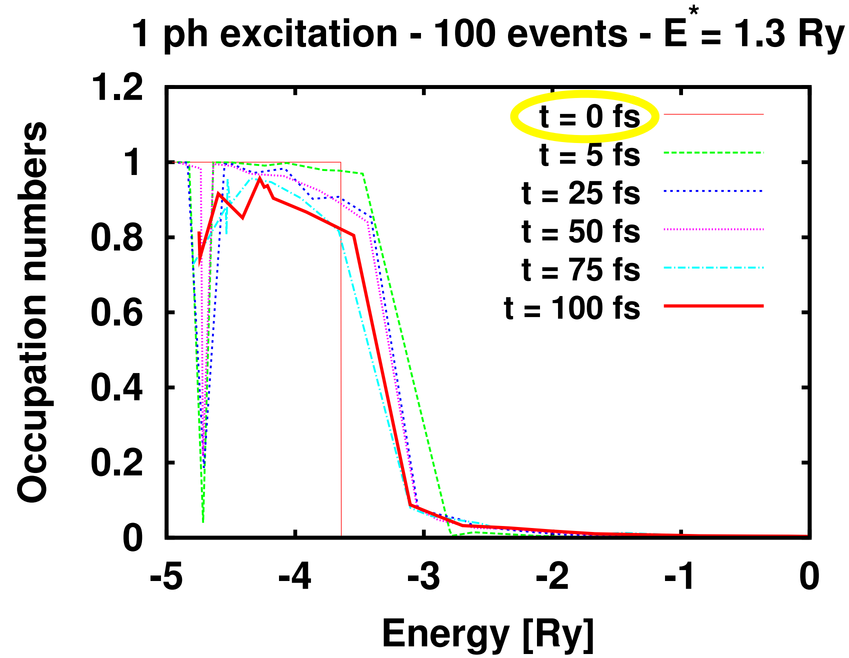

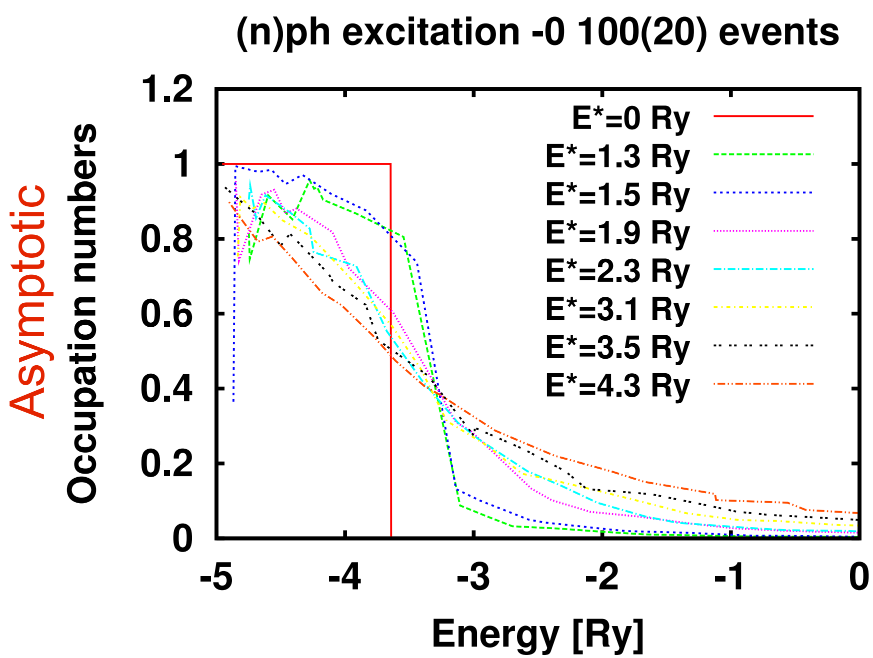

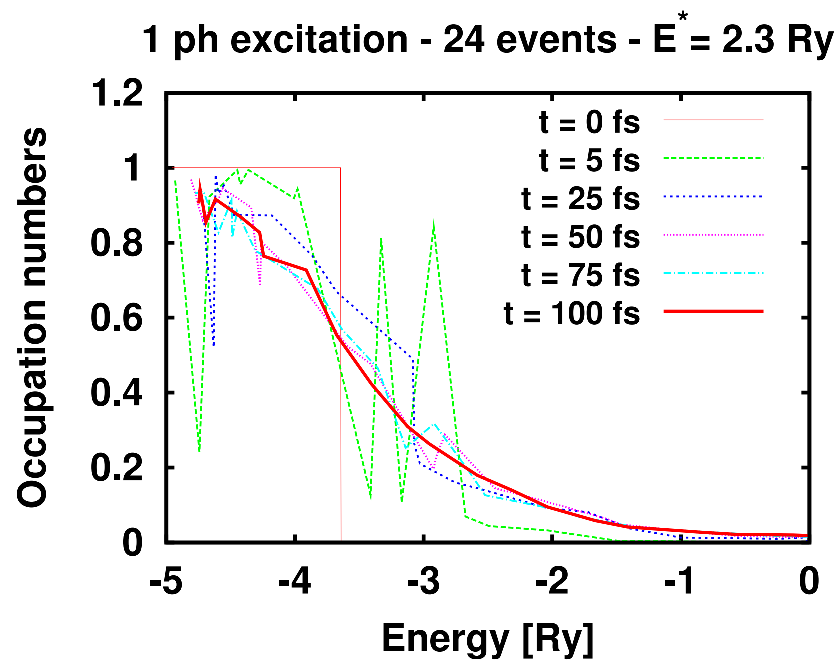

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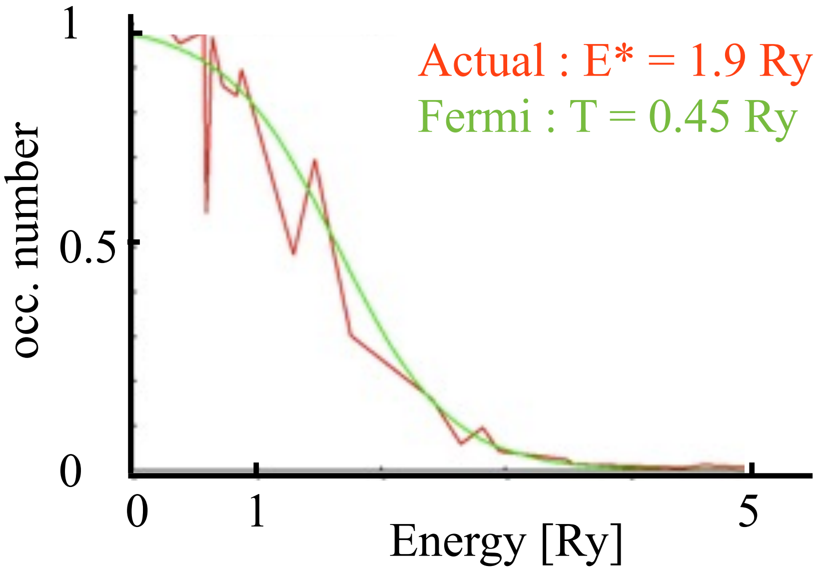

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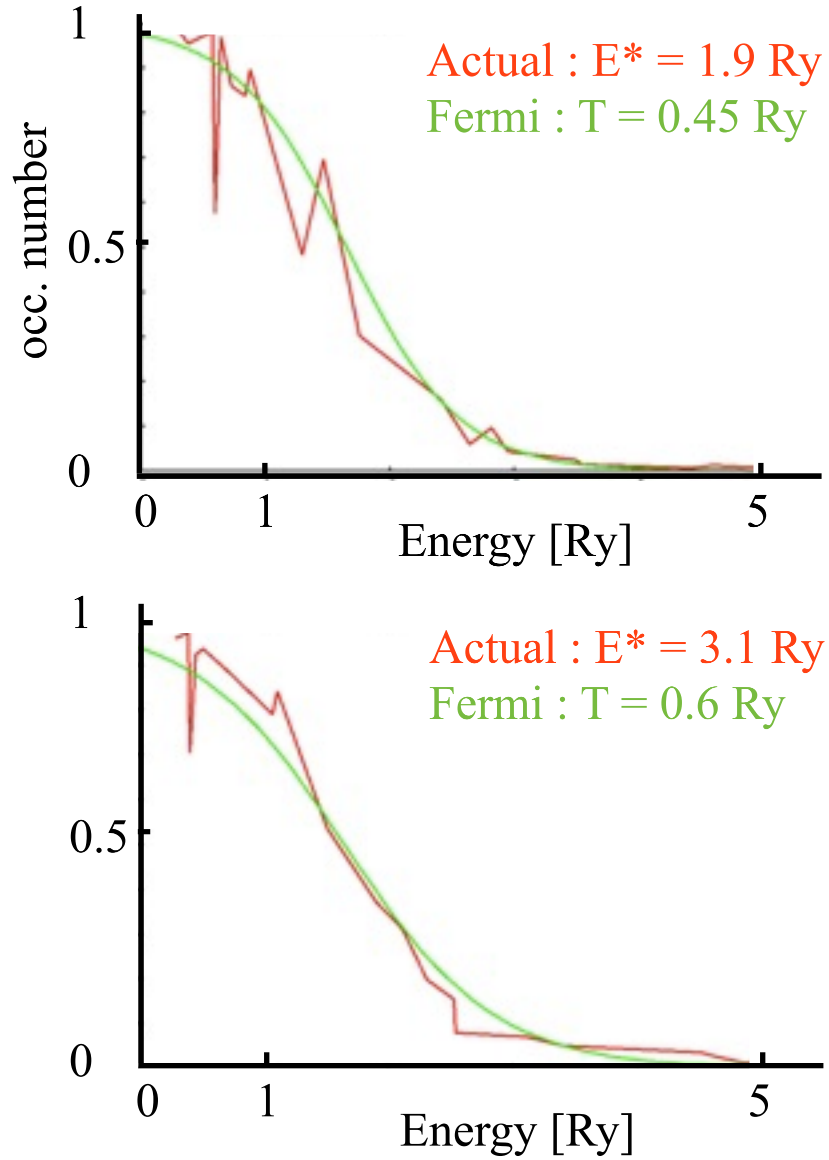

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- Fit of $n_i(\varepsilon)$ on Fermi factors
- Low temperature expressions

  $E^* \simeq aT^2 \qquad S \simeq 2aT$

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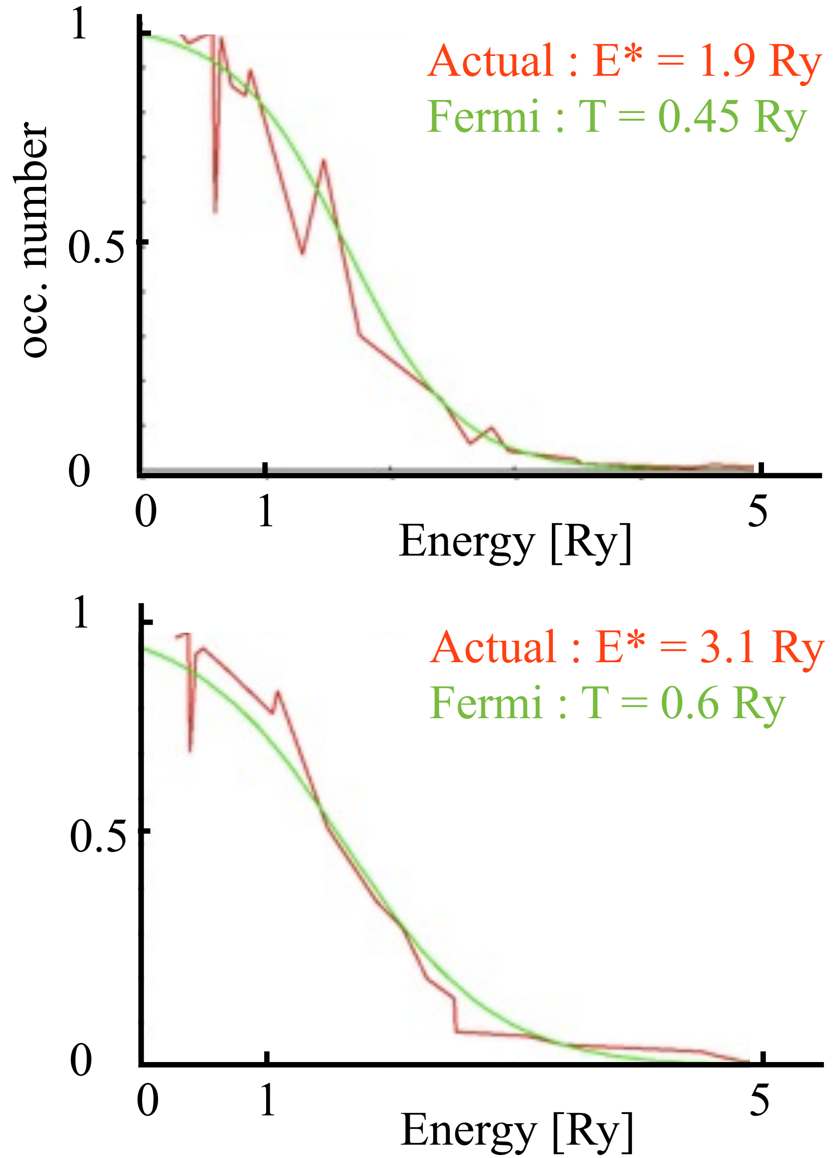

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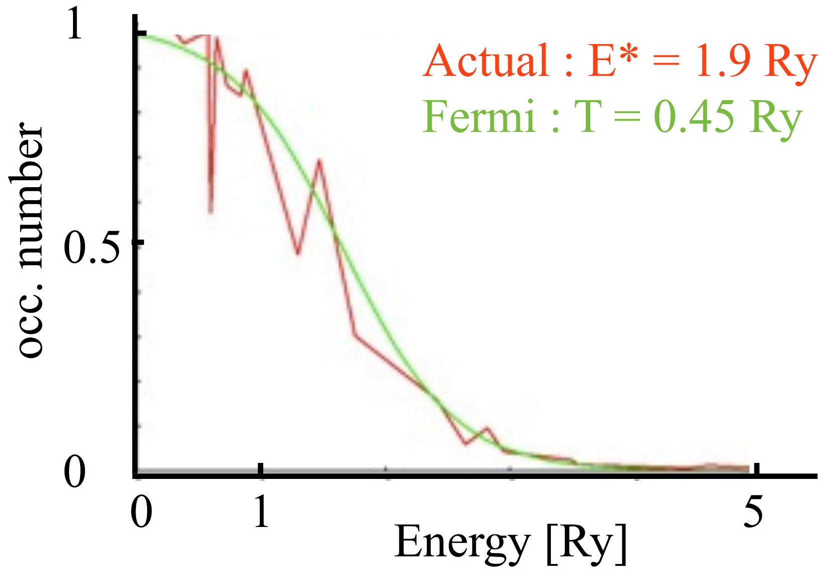

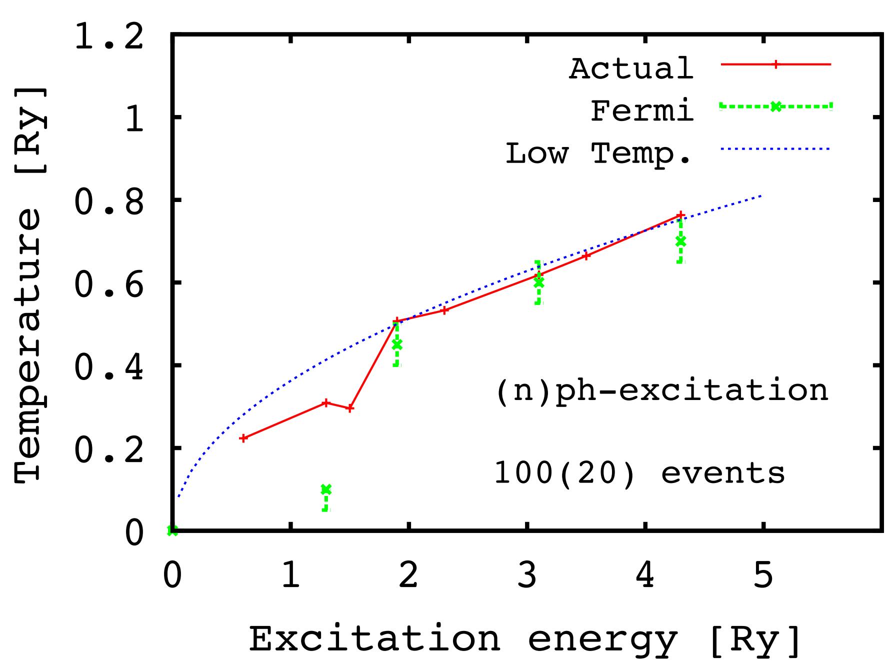

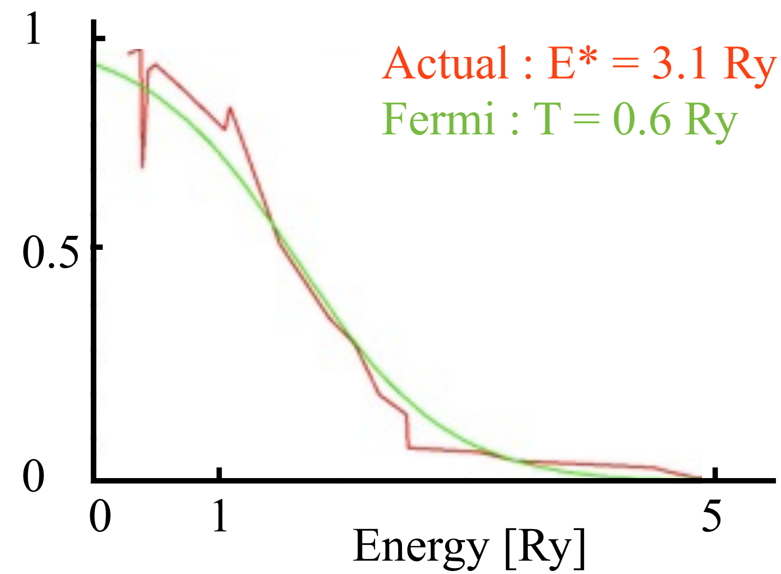

Analysis of entropy ...

- Single particle entropy provides a compact mesure of thermalization

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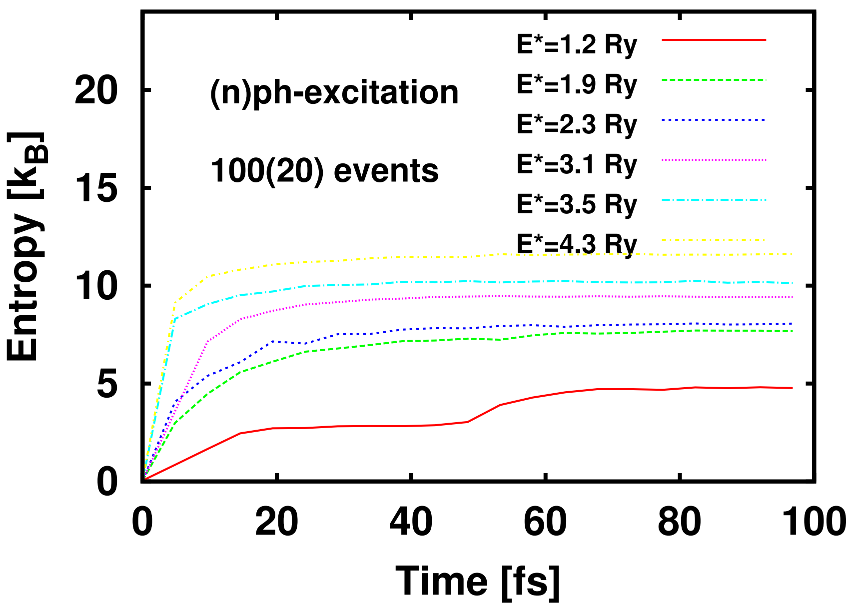

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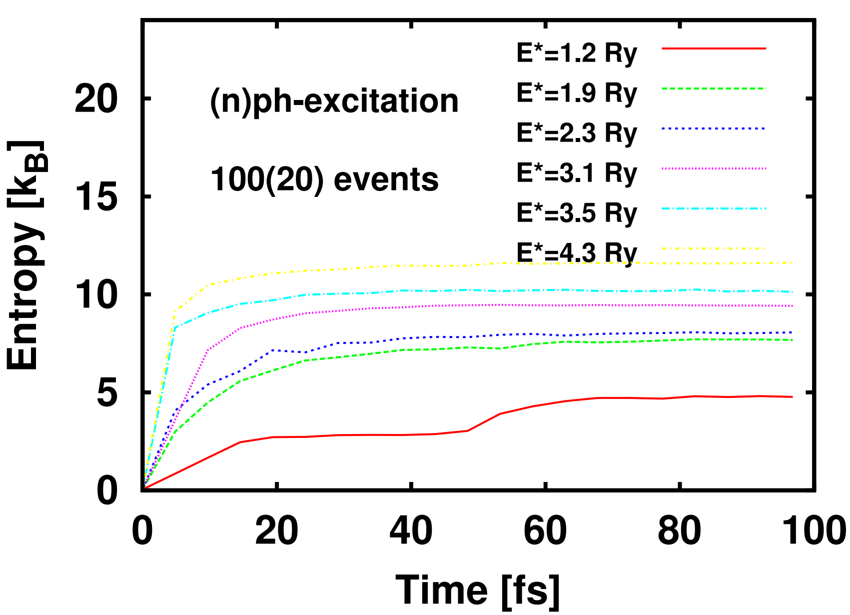

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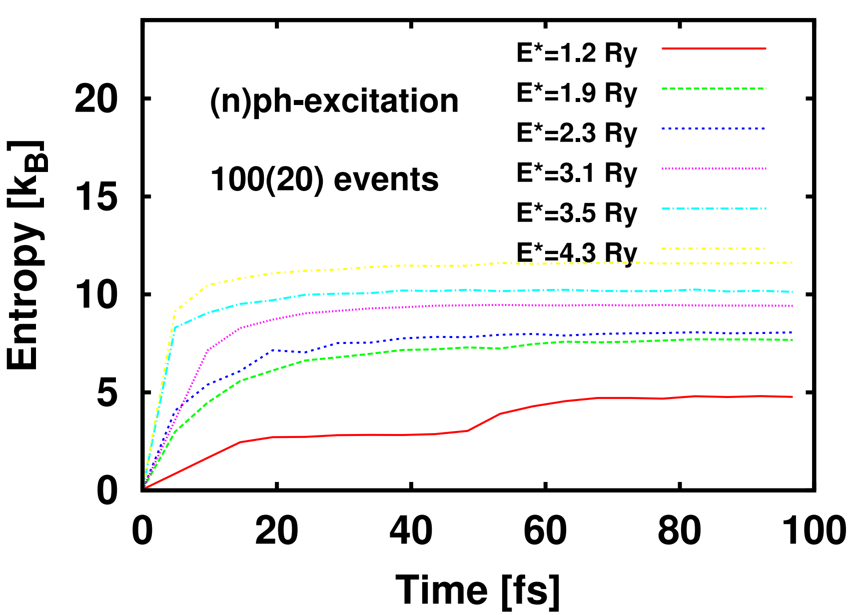
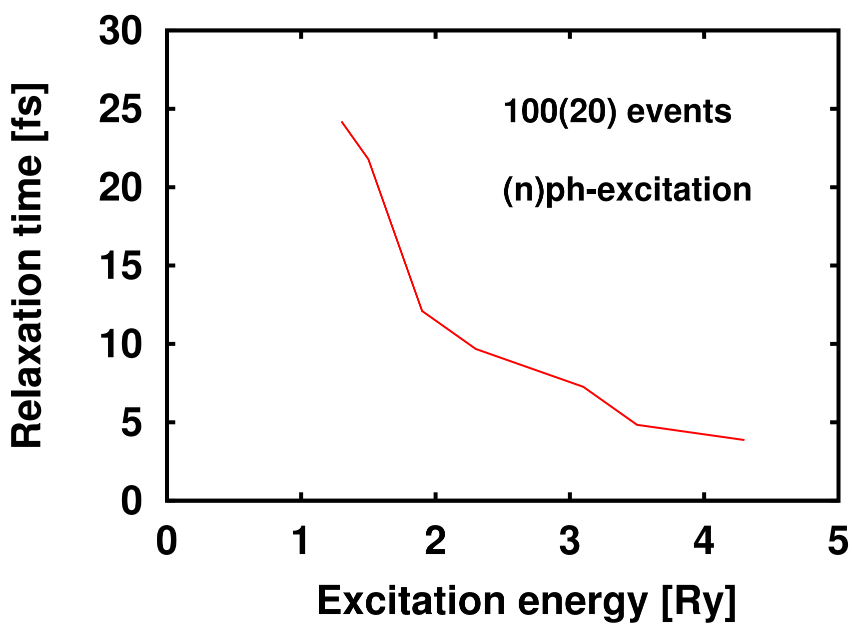
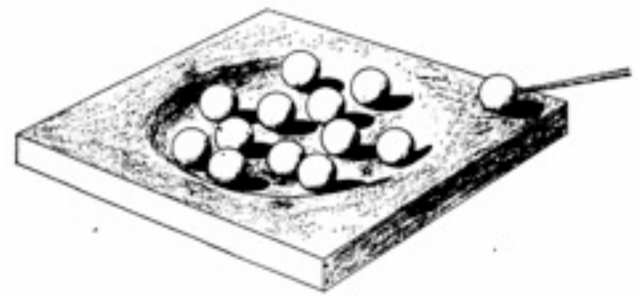




Towards the inclusion of dissipative effects in Quantum Time Dependent Mean-field Theories

neutron on nucleus



Dissipative mechanisms

in finite quantum systems

An old story...

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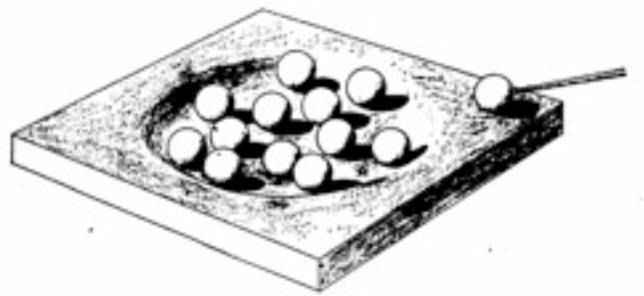

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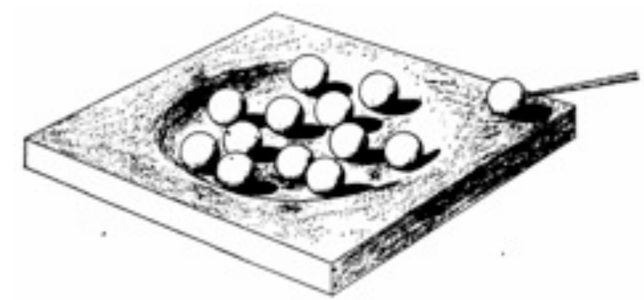

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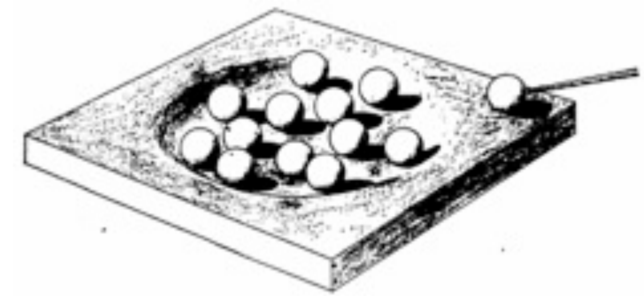

Many directions to be investigated
- Systematics of the 1D model (parameters, scenarios…)
- Direct extension to 3D in simple cases
- (Re)derivation of a kinetic-like theory
- Tests of kinetic-like approaches
- …

STHF provides a sound and simple basis for inclusion of dissipation in quantum time dependent mean field theories


Thank you for your attention

Thank you too…

People

P. G Reinhard
P. M. Dinh
P. Romaniello
N. Slama

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