The Role Of Internal Degrees Of Freedom In Reactions With Composite Systems

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Description of the System

The composite object

x_1 x_2

m_1 m_2

Reflection

Incident wave

(Intrinsic energy ħω/2, total energy E)

Transmission

Intrinsic Potential:

Energy levels:

CM Momentum:

The External Potential:

Why is this project interesting?

- We took a non-perturbative approach. We solved the problem **EXACTLY**.
- This can be useful in understanding processes like fission, fusion, particle emission.
- The problem is well-formulated but numerically difficult.
- It is a very general solution of a simple model which can be applied to fields beyond nuclear physics.

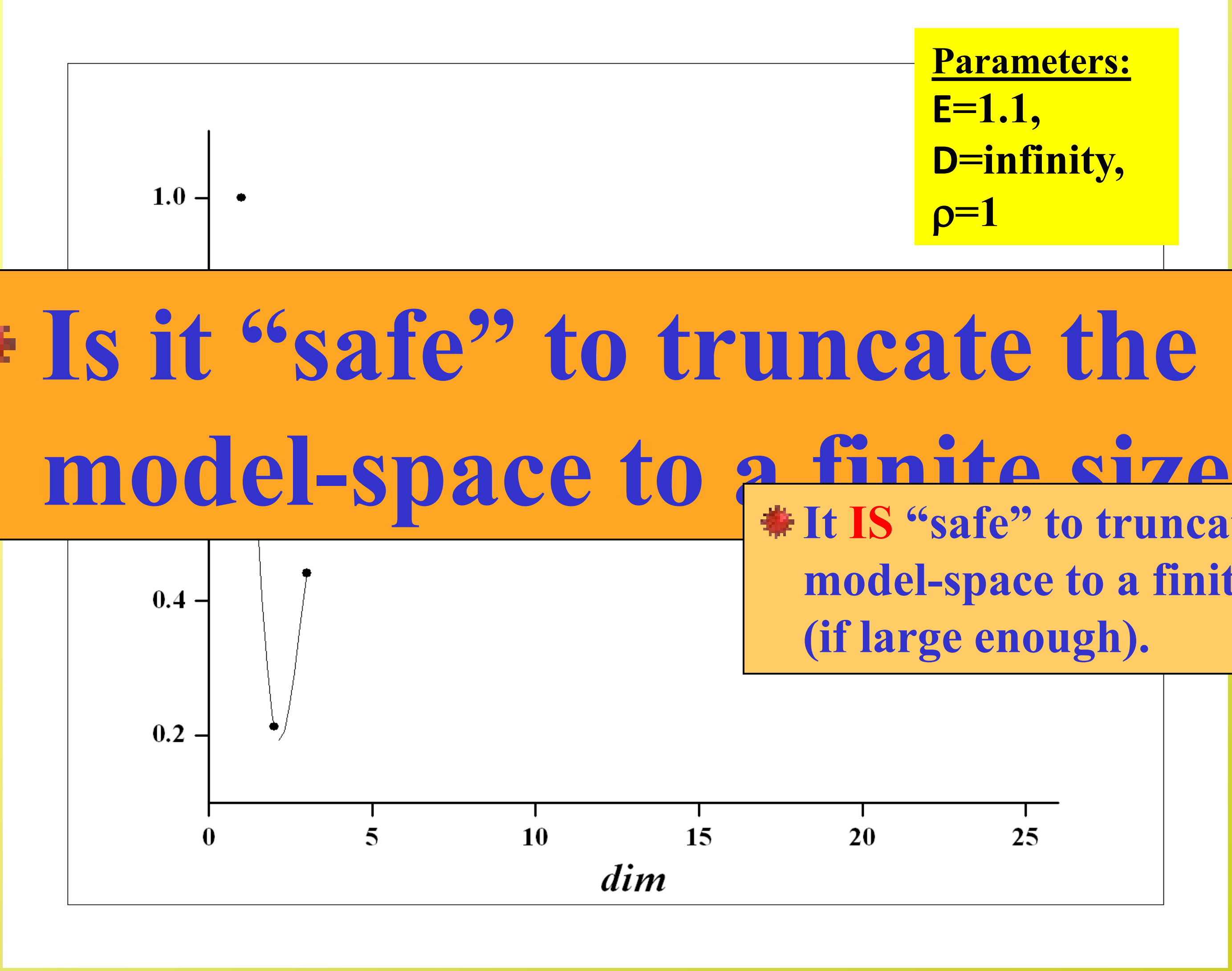
Energy scales used in this project:

- $E_!$ ħ!
- E_P E ¡ — ħ!
- $E_\pm$ $\frac{M\ ®}{ħ}$

Parameters:

- E E_P = $E_!$
- O $E_\pm$ = $E_!$
- ½ $\frac{m}{m}$

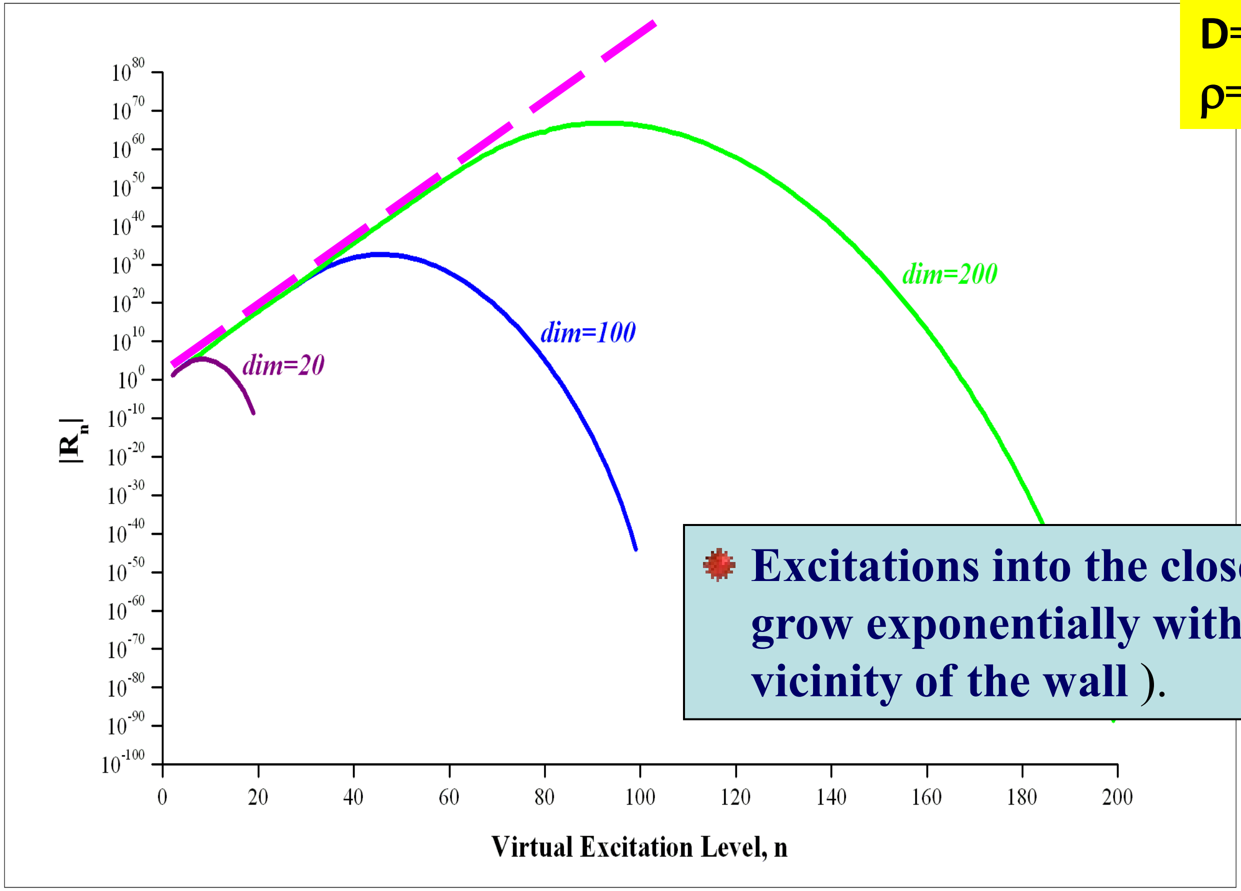
Example: R_0



- **Is it "safe" to truncate the model-space to a finite size?**

- **It IS "safe" to truncate the model-space to a finite size (if large enough).**

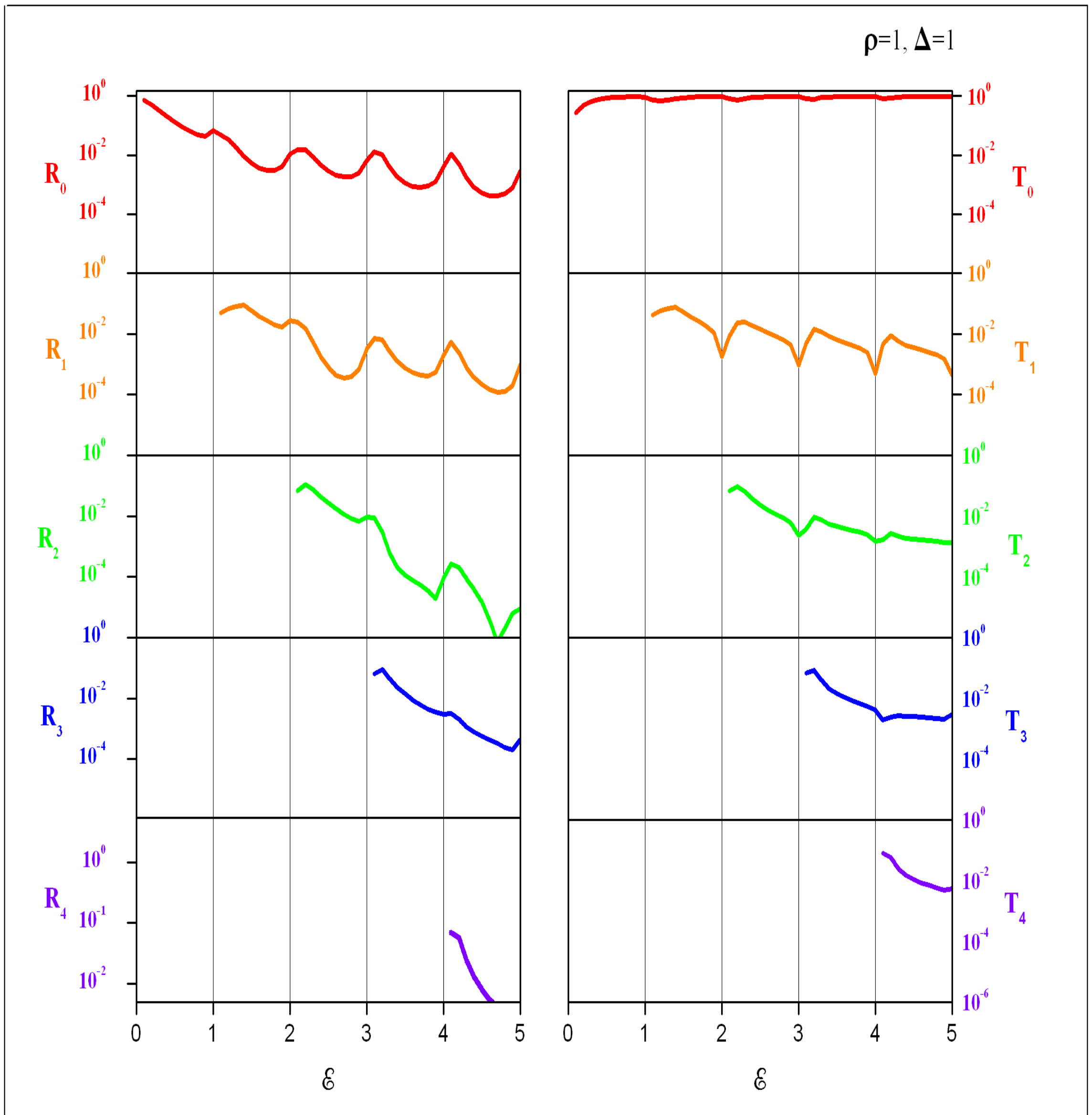
Growth of Virtual Excitations with n



Parameters:
E=1.1,
D=infinity,
ρ=1

- Excitations into the closed channels grow exponentially with "n" (in the vicinity of the wall).

The first few R's and T's as functions of E



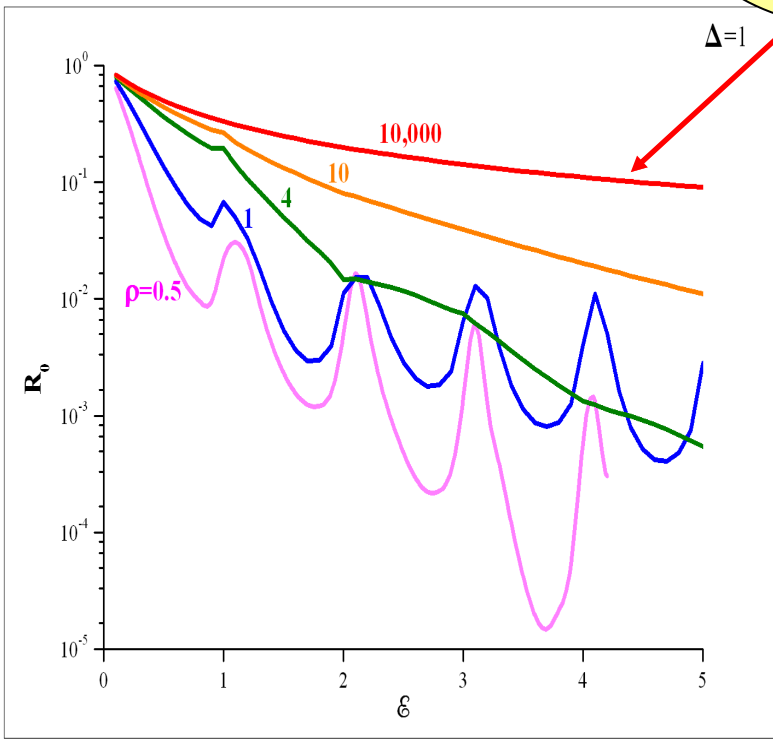
$$\mathcal{E} \equiv \frac{E - \hbar\omega}{\hbar\omega}$$

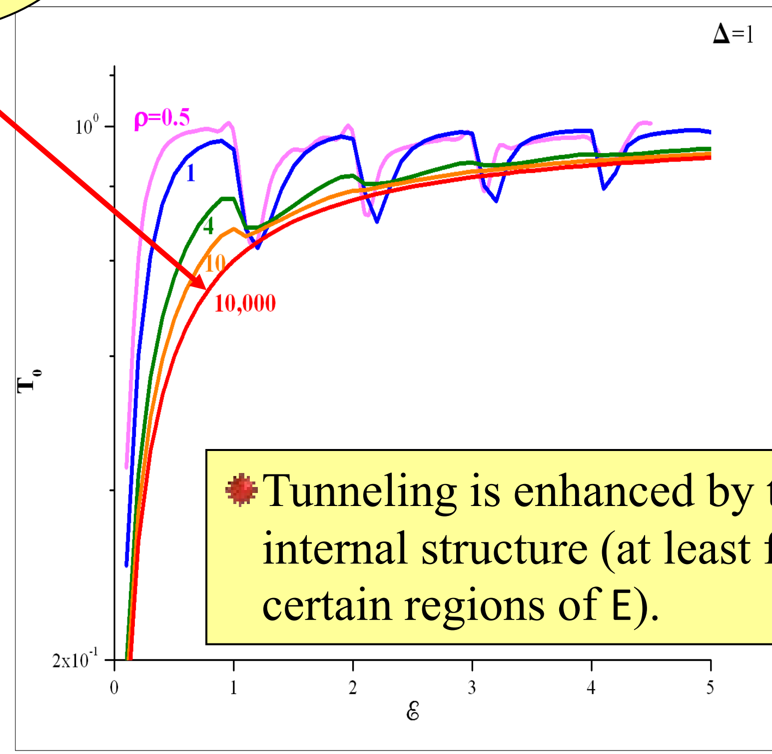
- A new channel opens at each integral value of E.
- Away from the thresholds there are **bumps.** →

UNEXPECTED

R_0 and T_0 for different r's

Limit of a Structure-less Particle.





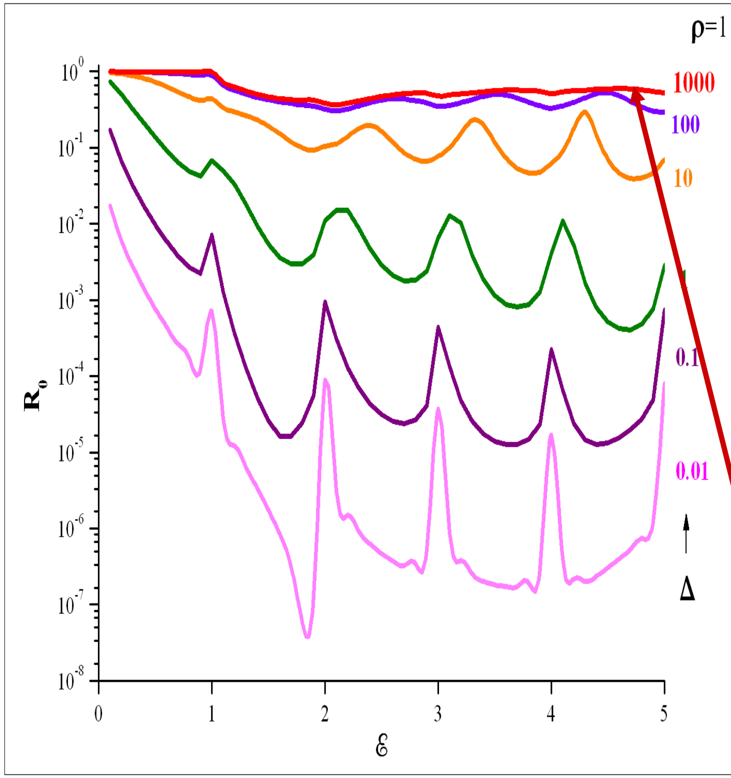
- Tunneling is enhanced by the internal structure (at least for certain regions of E).

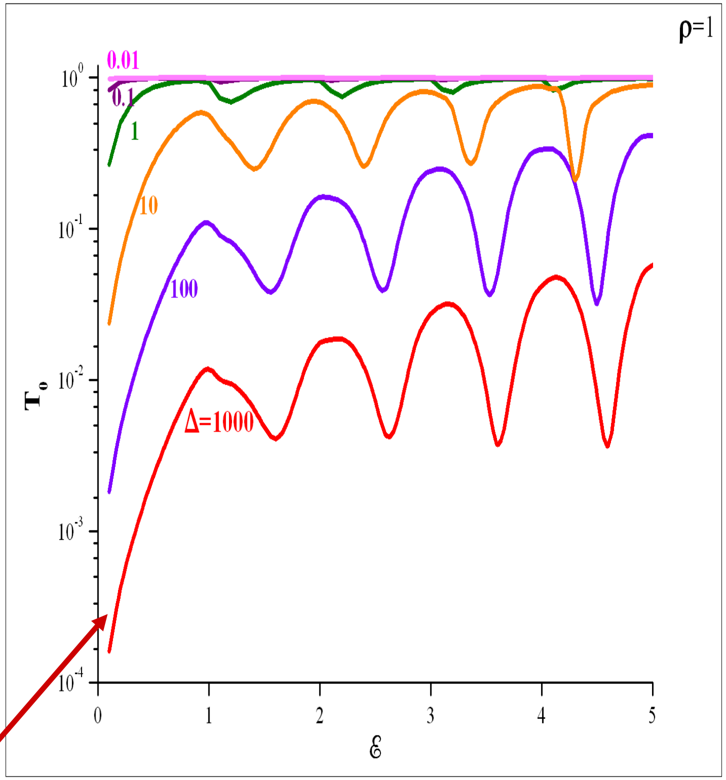
½ m mass of interacting particle

m mass of non¡ interacting particle

- **The wiggles start to smooth out with growing r.**

R_0 and T_0 for different D's





Approaches the limit of an infinite wall.

- As D increases there is, naturally, more reflection and less transmission.

Immediate Future Plans

1. Explore resonances that occur away from the channel-thresholds.
2. Study the phase-shifts and time-delays associated with these processes.
3. Now that a mathematical layout of the method is handy, we would like to extend this to a problem which is more general and more realistic.