

Kwantumfysica I

2008-2009

Hoorcollege dinsdag 6 januari 2009

Deze week delen van Hoofdstuk 7 en 8

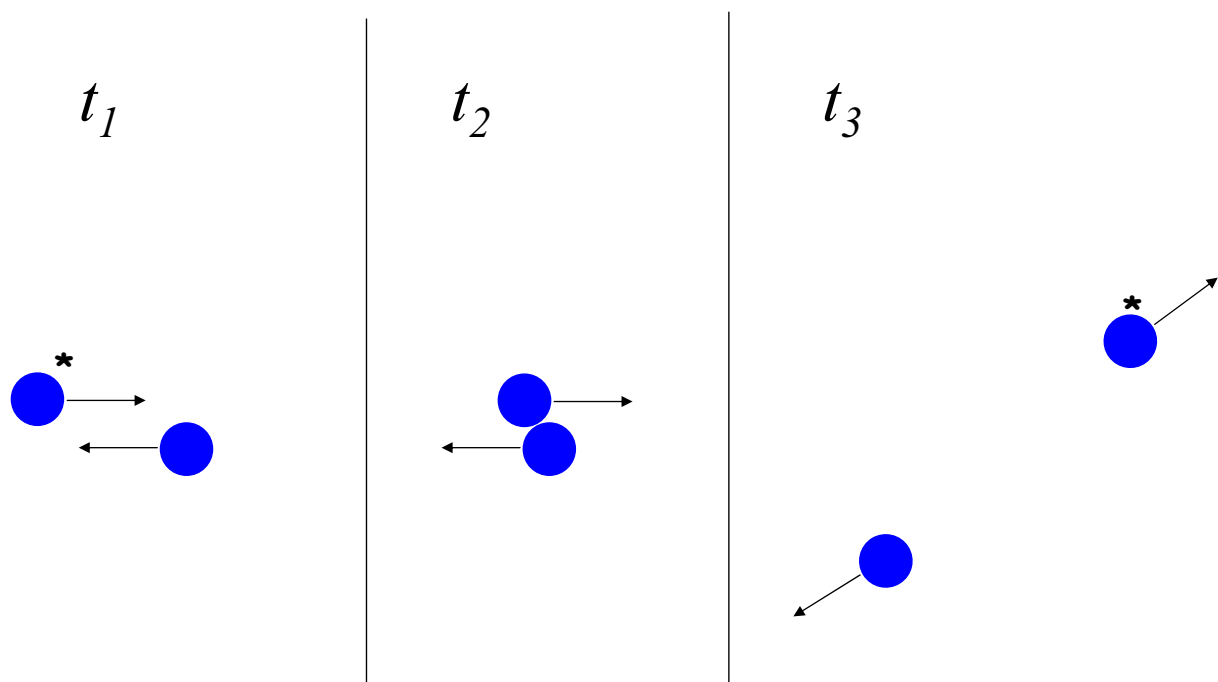
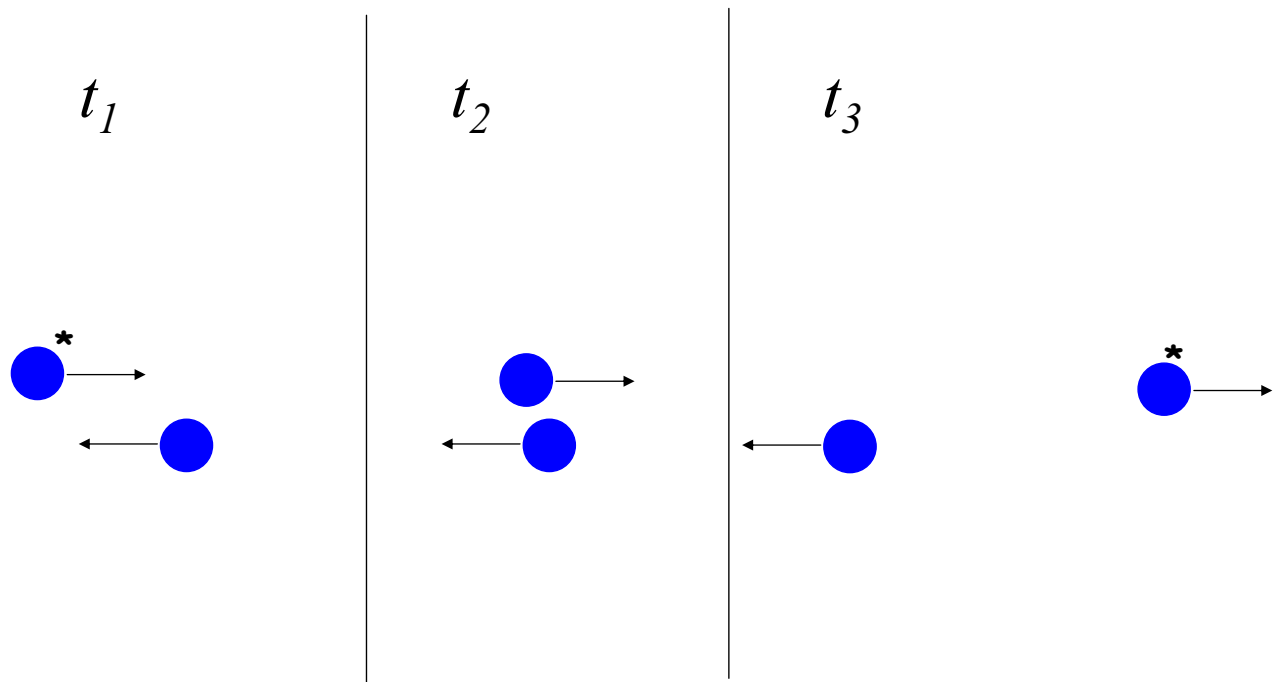
Vragen n.a.v. stof tot nu toe?

Vandaag

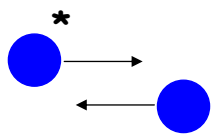
1. Symmetry and identical particles
System with 2 particles - exchange

Symmetry, identical particles, and exchange...

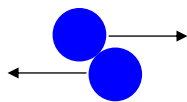
Assume a collision experiment with classical particles:



t_1



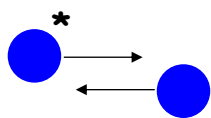
t_2



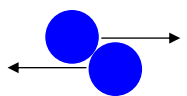
t_3



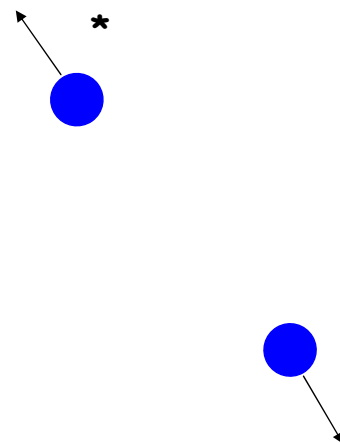
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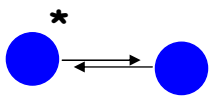
t_2



t_3



t_1



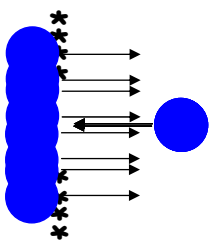
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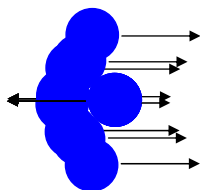
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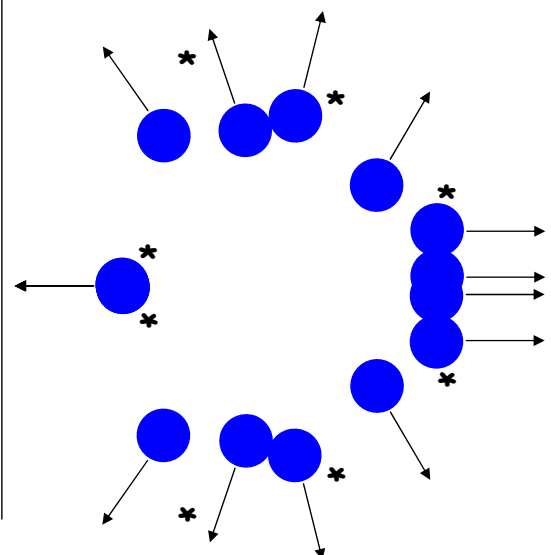
t_1



t_2

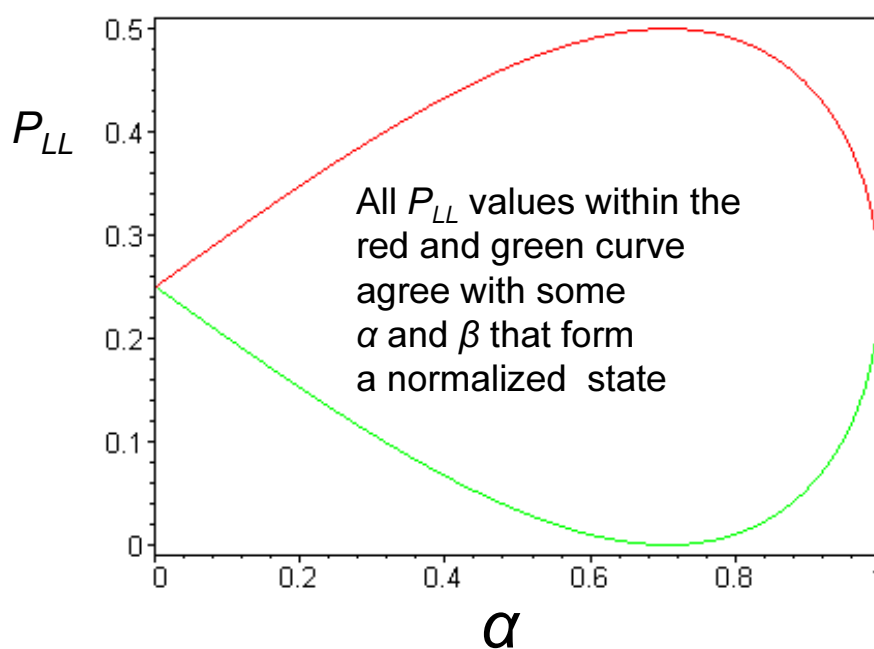
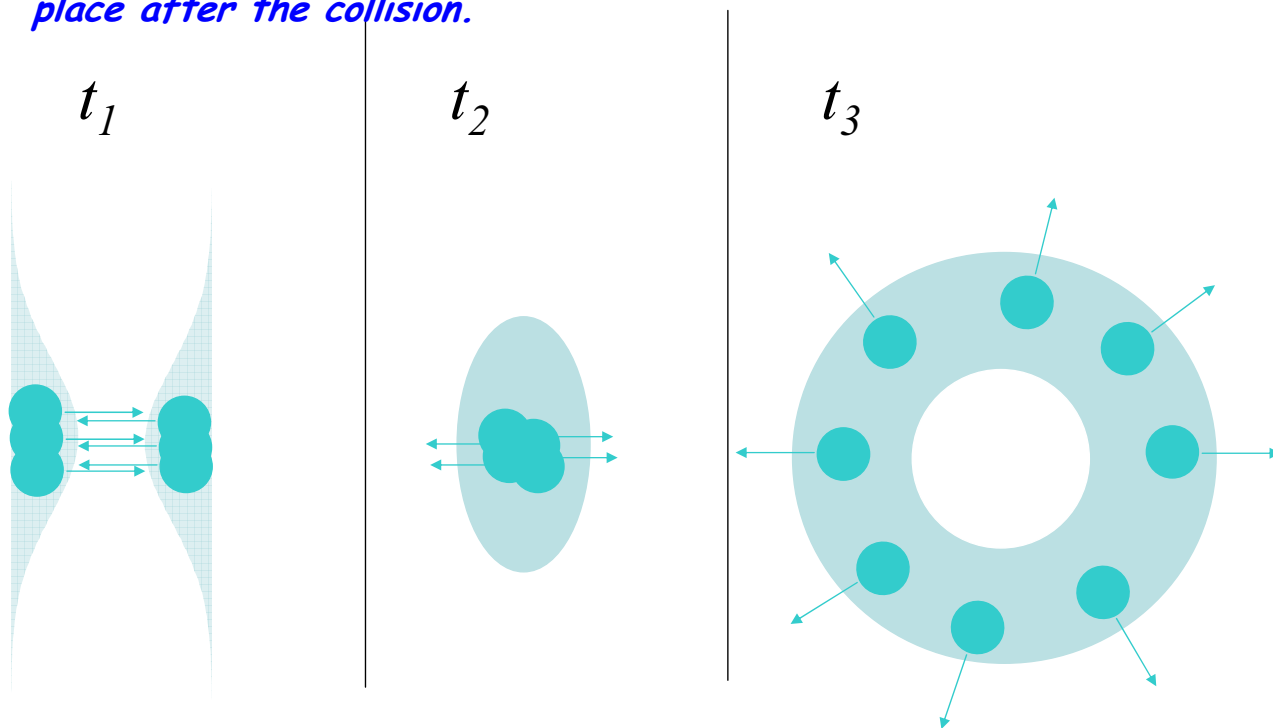


t_3



Assume a collision experiment with two IDENTICAL quantum particles:

It is fundamentally impossible to tell which of the two particles is detected, if one detects a particle at some place after the collision.



Related to P_{LL} in extra handout on exchange

State of total (two-particle) system is a product state of the individual particle states (see book p. 318)

$$\Psi_T = \Psi_{n_1}(x_1)\Psi_{n_2}(x_2)$$

State of total (two-particle) system is a product state of the individual particle states

$$\Psi_T = \Psi_{n_1}(x_1)\Psi_{n_2}(x_2)$$

But we might as well do different labeling 1 and 2 (as it is also an eigen state of the Hamiltonian with the same eigen energy, and we cannot distinguish the particles).

$$\Psi_T = \Psi_{n_1}(x_2)\Psi_{n_2}(x_1)$$

Only a symmetric or anti-symmetric states with respect to our arbitrary particle labeling does give results where the physics does not depend on our labeling.

$$\Psi_S = \frac{1}{\sqrt{2}} [\Psi_{n_1}(x_1)\Psi_{n_2}(x_2) + \Psi_{n_1}(x_2)\Psi_{n_2}(x_1)]$$

$$\Psi_A = \frac{1}{\sqrt{2}} [\Psi_{n_1}(x_1)\Psi_{n_2}(x_2) - \Psi_{n_1}(x_2)\Psi_{n_2}(x_1)]$$

For a system with two identical quantum particles, the state must always be symmetric or anti-symmetric with respect to our arbitrary particle labeling (otherwise the state cannot represent real physics)

Symmetry and identical particles

Exchange leads to degeneracy

Symmetry leads to degeneracy

There can be accidental degeneracy

Samenvatting:

1. Symmetry, systems with two identical particles, degeneracy, exchange