# Quantum walk vs. classical random walks

The classical random walk is a well-known model in statistical physics, for example for diffusion phenomena. In a one-dimensional, discrete-time, random walk, the walker steps left or right depending on the outcome of flipping a coin. After many steps the probability distribution approaches a Gaussian distribution with a width that grows as ∝ t1/2.

In a quantum walk (https://en.wikipedia.org/wiki/Quantum\_walk) the walker is a spin-1/2 particle. Instead of a classical coin, the ‘quantum coin’ consists of a spin rotation (a.k.a. single-qubit gate) which is applied to the spin. After that the spin-up component of the particle steps left, the spin-down component steps right. After many rounds one typically finds two peaks in the probability distribution that move left or right with constant speed (so ∝ t rather than ∝ t1/2). The main difference with the classical case is the interference of different wave function components.

In this project you set up a model for the quantum walk and investigate the linear vs. diffusive behaviour. Other interesting things to explore may include:

* Realize the quantum version of a biased random walk, by changing the quantum coin.
* Investigate what happens at the edges of the walking space, by applying different boundary conditions.
* Start with two walkers, and see what happens when they ‘collide’
* Generalize to 2D

Contact person: Robert Spreeuw, r.j.c.spreeuw@uva.nl