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Quantum first detection time

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We investigate the quantum first detection problem for a quantum walk
using projective measurement postulates.
A simple relation between the measurement free state function |psi> and |phi>_n is obtained,
the latter
is the first detection amplitude at the n-th attempt. This relation is the quantum renewal equation, its classical counter part is widely used to find statistics of first passage time for random walks and Brownian motion. We investigate statistics of first detection for open and closed systems (first arrival or passage is not well defined in quantum theory). For closed systems, like a ring, with a
translation invariant Hamiltonian, we find Zeno physics, optimum sampling times, critical sampling effect related to revivals, dark states, and quantisation of the mean detection time. For a quantum walk on the line, with particle starting on |x_i> and detected on the origing |0>, with a tight-binding Hamiltonian with hops to nearest neighbours, we find the detection probability decays like (time)^(-3) with super imposed quantum oscillation, thus the quantum exponent is double its classical counter part. The Polya problem is discussed, and it is found that in one dimension the total detection probability, does not depend on the initial distance of the particle from detector, though survival of the particle is not unity. There is an optimal sampling time which maximises the
total detection probability.

Joint work with Harel Fridman, David Kessler, and Felix Thiel.

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