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## The quantum first detection problem


Abstract: We are considering a quantum system initially prepared in a pure state, that is repeatedly projectively measured in some detection state with a fixed inter-detection period. We investigate the distribution and the statistics of the time of the first successful detection event. The such obtained first detection time gives an operational definition to the time-of-arrival in the detection state. The probability of first detection can be obtained by means of a renewal equation. For systems with an absolutely continuous energy spectrum, we demonstrate how the asymptotics of this first detection probability are dominated by singularities in the spectral measures. For generic initial and detection states, these singularities can be identified with the system's van-Hove singularities. We give a detailed discussion of the transition problem in the tight-binding model on the infinite line, where the initial and detection position of a single quantum walker are separated. After that, we show how the normalization of the first detection distribution is obtained from the overlap with an invariant subspace. We present lower and upper bounds for this normalization and how it is related to the system's symmetries.