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Fractional Revival Between Cospectral Vertices On Oriented Graphs

Continuous-time quantum walks have been studied for their potential applications to general-purpose quantum computing. Perfect state transfer (PST) occurs when the quantum walk transfers the state of one Qbit u to another Qbit v at some time. Periodicity occurs when the state of u is returned fully to u at some time.

Fractional revival (FR) interpolates between these two phenomena, occurring when the initial state of Qbit u is split among Qbits u and v according to the FR parameters $\alpha, \beta \in \mathbb{C}$, satisfying $|\alpha|^2 + |\beta|^2 = 1$:

$$U(\tau)\mathbf{e}_u = \alpha\mathbf{e}_u + \beta\mathbf{e}_v.$$

We study FR in the case of oriented graphs, using a skew-symmetric Hamiltonian matrix $H = iS$. If we further demand that the vertices u and v are cospectral, then particularly nice behaviour emerges: the FR will reoccur periodically, with parameters α and β changing each time according to a simple formula. Depending on the spectrum of the graph, this allows either periodicity at some multiple of the first FR time, or FR with parameters ϵ-close to arbitrary desired parameters at some multiple of the first FR time. Examples of both behaviours will be shown.