PIMS Distinguished Lecture Series

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3:30 - 4:30 p.m.

RIC 209

Sensitivity Analysis for Perfect State Transfer in Quantum Spin Networks

In 2003, Bose proposed the idea of using a network of interacting spins as a quantum wire to transfer information within a quantum computer. Associated with the network is a matrix M whose rows and columns are indexed by the spins, and whose entries represent the strengths of the couplings between the various spins in the network. Once all of the dust settles on the physics side, a key quantity to consider is the so-called *fidelity of transfer*: setting $U(t)=e^{M}$, and selecting distinct indices s and r, the fidelity of transfer from s to r at time t is given by $p(t)=|u_{s,r}(t)|^2$. It is straightforward to show that $0 \leq p(t) \leq 1$, and if it happens that $p(t_0)=1$ for some time t_0, then we say that there is *perfect state transfer* (PST) from s to r at time t_0. In Bose's setting, perfect state transfer corresponds to a flawless transfer of information; consequently there has been a great deal of interest in identifying spin networks that exhibit PST.

As one might expect, a number of things - for instance the readout time t_0, the pairs of spins that interact, and the coupling strengths - have to line up just right in order for PST to hold. In view of that observation, it is natural to wonder how sensitive the fidelity of transfer is to small changes in either the readout time or the coupling strengths, and in this talk, we address both of those questions. Using techniques from matrix analysis, we derive formulas for the derivatives of the fidelity of transfer with respect to the readout time and with respect to the coupling strengths.

The results may help to inform the design of spin networks that not only exhibit perfect state transfer but also offer some forgiveness to errors in readout time and/or spin interactions. This talk may also answer another question: can a humble matrix theorist with an infinitesimal knowledge of physics still contribute something to the analysis of PST?

Mathematics and Statistics

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