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Extensive quantum entanglement and localization in quantum spin chains

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Quantum entanglement is the most surprising feature of quantum theory. Ground states of quantum many-body systems typically exhibit the area law behavior in the entanglement entropy, which measures the amount of entanglement between a subsystem and the rest of the system. Recently, a class of solvable spin models with local interactions has been constructed by Mavassagh and Shor and by Salberger and Korepin, in which the ground state is expressed as a superposition of random walks, and has much larger entanglement. Its entanglement entropy is shown to be proportional to the square root of the volume.
In this talk, after a brief review of the models, we construct an extension of these models based on symmetric inverse semigroups, and discuss entanglement properties of ground states and its implications in quantum gravity and string theory. As a feature of the extended models that is not found in the original models, there are excited states corresponding to disconnected paths in decorated random walks. Interestingly, Anderson localization phenomena occur in such excited states.

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