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Decoherence in a fermion environment: Non-Markovianity and Fermi edge singularity

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We analyze the non-Markovian character of the dynamics of an open two-level atom interacting with a gas of ultra-cold fermions. In particular, we discuss the connection between the phenomena of orthogonality catastrophe and Fermi-edge singularity occurring in such a kind of environment and the memory-keeping effects which are displayed in the time evolution of the open system and which can be quantified in terms of the information exchange between system and environment. Furthermore, we show that the decoherence of the atom is a way of probing the response of the gas to the effective local quench that the atom produces.