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Transient Loschmidt Echo and Orthogonality Catastrophe in highly excited Quantum Ising Spin Chains MARCO SCHIRO, Institut de Physique Theorique, Universite Paris Saclay, CNRS, CEA, CARLA LUPO, Politecnico di Torino, Corso Duca degli Abruzzi, 24, 10129 Torino Italy and Universite Paris Sud Paris XI, 15 Rue Georges Clemenceau, 91400 Orsay — We study the response to sudden local perturbations of highly excited Quantum Ising Spin Chains. The key quantity encoding this response is the overlap between time-dependent wave functions, which we write as a transient Loschmidt echo. We compute the Echo perturbatively in the case of a weak local quench and study its asymptotics at long times, which contains crucial information about the structure of the highly excited non-equilibrium environment induced by the quench. Our results reveal that the Echo decays exponentially, rather than power law as in the low-energy Orthogonality Catastrophe, a further example of quench-induced decoherence. The emerging decoherence scale is set by the strength of the local potential and the bulk excitation energy. In addition, the transient evolution features aging behavior at the Ising quantum critical point.

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