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Non-Markovianity as a probe of structural phase transitions in ion crystals

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We investigate the back-flow of information in a system with a second-order structural phase transition, namely a quasi one-dimensional Coulomb crystal. Using standard Ramsey interferometry which couples a target ion (the system) to the rest of the chain (a phononic environment), we study the non-Markovian character of the resulting open system dynamics. We study two different time-scales and show that the back-flow of information pinpoints both the phase transition and different dynamical features of the chain as it approaches criticality. We also establish an exact link between the back-flow of information and the Ramsey fringe visibility.