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Mechanism of decoherene-free coupling between giant atoms

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Giant atoms are a new paradigm of quantum optics going beyond the usual local coupling. Building on this, a new type of decoherence-free (DF) many-body Hamiltonians was shown in a broadband waveguide. Here, these are incorporated in a general framework (not relying on master equations) and contrasted to dispersive DF Hamiltonians with normal atoms: the two schemes are shown to correspond to qualitatively different ways to match the same general condition for suppressing decoherence. Next, we map the giant atoms dynamics into a cascaded collision model (CM), providing an intuitive interpretation of the connection between non-trivial DF Hamiltonians and coupling points topology. The braided configuration is shown to implement a scheme where a shuttling system subject to periodic phase kicks mediates a DF coupling between the atoms. From the viewpoint of CMs theory, this shows a collision model where ancillas effectively implement a dissipationless, maximally-entangling two-qubit gate on the system.

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