Reply to the Comment on "Anyonic Braiding in Optical Lattices"

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This is the reply to the comment arXiv:0801.4620 by Vidal, Dusuel, and Schmidt.

In a Comment [1] on our recent work [2] on anyonic braiding in optical lattices, Vidal *et al.* claim that the vanishing of certain spin correlators apparently invalidates our conclusions in [2]. This claim [1] demonstrates a complete lack of understanding of our work in particular and cold atom optical lattice physics in general. We assert that all our results and conclusions in [2] remain valid in spite of the vanishing of certain spin correlation functions [3]. The main result derived in our work [2] is an explicit experimental scheme involving external laser configurations which is capable of carrying out anyonic braiding in optical lattices, and nothing in the Comment by Vidal et al. [1] pertains to this central result of our work.

The fact that the spin-spin correlation function $\langle \sigma_{D'}^x \sigma_F^x \rangle$ along a z-link is zero, as found in ref. [3], only implies that our proposed technique for detecting anyonic braiding needs to be applied to some other non-zero spin-spin correlation function, as was already appreciated in ref. [3]. For example, the non-zero function $\langle \sigma_{D'}^x \sigma_V^x \rangle$ along a x-link [3] serves our purpose equally well, and can be used for detecting anyonic statistics following the experimental scheme outlined in our paper. We emphasize the fact, completely missed in [1], that our work provides a general experimentally feasible scheme for measuring arbitrary spin correlators on optical lattices, which can be suitably adapted for detecting anyonic statistics.

For the other comment concerning fermionic excitations [1], we merely point out that the fermionic excitations are protected by an energy gap $2|J_z|$, which is much larger than the anyonic excitation gap J_{eff} in the relevant part of the phase diagram [4]. When the spin operations are slower than $\sim \hbar/2|J_z|$, the number of these excitations is exponentially small.

Finally, we mention that the task of an experimental demonstration of anyonic braiding statistics in a real system, the goal of our work in ref. [2], is quite distinct from the understanding and the elucidation of anyonic excitations in a well-defined theoretical model (e.g. the Kitaev model [4]), a distinction completely lost in the Comment by Vidal *et al.* [1].

[1] J. Vidal, S. Dusuel, and K. P. Schmidt, arXiv:0801.4620.
[2] C. Zhang, V. W. Scarola, S. Tewari, and S. Das Sarma, Proc. Natl. Acad. Sci. U.S.A. **104**, 18415 (2007).
[3] G. Baskaran, S. Mandal, and R. Shankar, Phys. Rev. Lett. **98**, 247201 (2007).
[4] A. Kitaev, Ann. Phys. **321**, 2 (2006).