Effects of ^{1}H-^{1}H homonuclear couplings in ^{1}H-^{13}C HMBC spectra

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Heteronuclear long-range correlation experiments are crucial experiments to connect structural fragments via nonprotonated carbons or across heteroatoms, and, currently, there are a plethora of proton-detected methods available for long-range heteronuclear shift correlation [1].
The oldest and still, quite likely, most widely used long-range heteronuclear shift correlation experiment is the HMBC experiment described in 1986 by Bax and Summers [2]. Among the important issues associated with the HMBC experiment [3-4], it is commonly admitted that the $\Sigma\cos(\pi^{n}J_{HH}\Delta)$ term, originating from the homonuclear proton proton couplings can cause accidental cancellation of cross-peaks. However, as will be shown in this contribution, this assumption appears incorrect, and cross peaks in HMBC *only* vanish when the long-range coupling evolution delay, Δ, matches the long-range heteronuclear coupling constant, $\Delta = 0.5/^{n}J_{CH}$. As such, it appears that HMBC-based experiments are more robust than HSQC-based experiments optimized for long-range couplings (LR-HSQC or HSQMBC), because the possibility that long-range cross peaks are missing due to a particular combination long-range coupling evolution delay-long-range heteronuclear coupling constant-homonuclear coupling constant is much lower in HMBC-based experiments.

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