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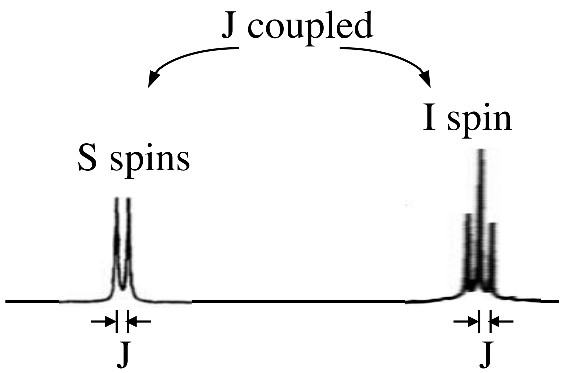
Problem Set #7

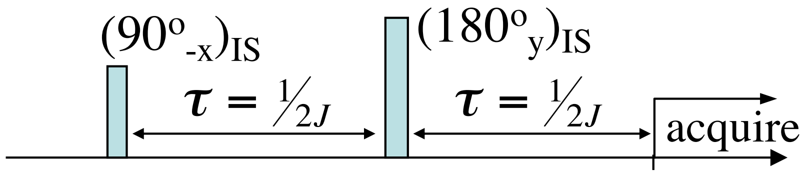
Rad 226a

1. **J-editing.** In class, we discussed J-editing for the doublet resonance of lactate. Other in vivo peaks (*e.g.* GABA) are more complicated (triplets, quartets, etc.). In this problem, we'll consider J-editing for IS_2 spin systems. An example spectrum is shown below.

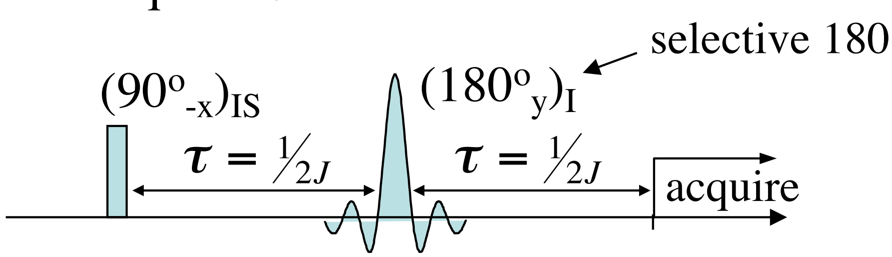


The goal is to edit for the I spin triplet. One proposal is to use the lactate or GABA schemes and subtract the following acquisitions.

Acquisition 1:



Acquisition 2:



<u>Algorithm</u>

edited signal = Acq1-Acq2

What fraction of the I spin signal is observed using this approach. Is there a different value of τ that detects more of the desired signal?

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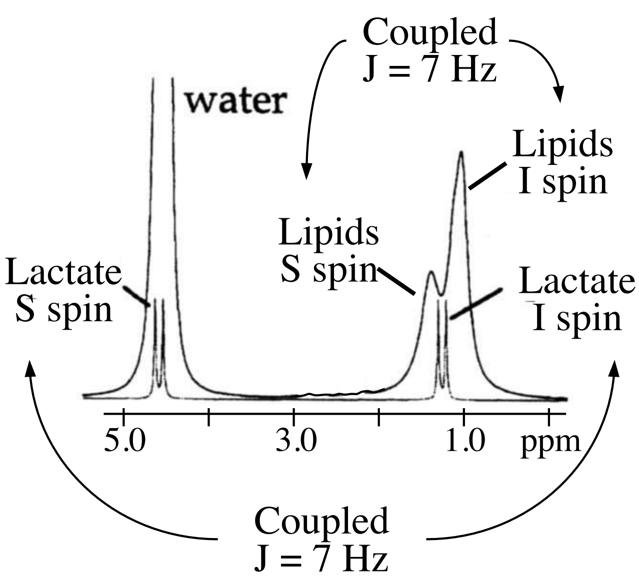
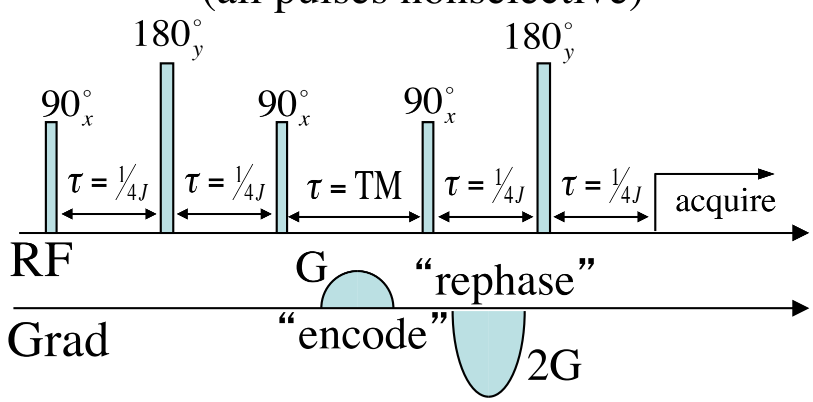
2. **Selective Double Quantum Filtering (selDQF) for Lactate**

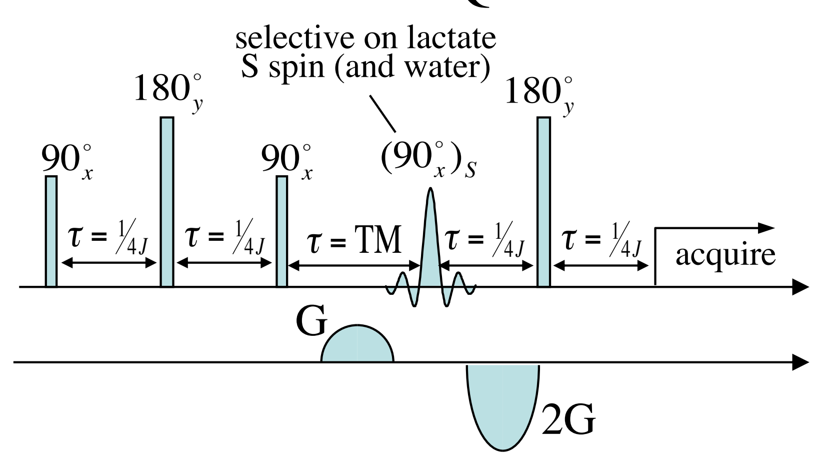
The conventional double quantum filter is of limited utility for measuring lactate *in vivo*. While water is removed by the filter, lipids, like lactate, are coupled with J around 7 Hz, and hence pass through the filter unattenuated. *In vivo*, large lipid peaks can easily overwhelm the lactate methyl signal (at 1.3 ppm). A proposed solution is the use of a frequency selective readout pulse for the last 90^o pulse of the DQ-filter (hence the name "selective double quantum filter"). Representative (and simplified) lactate and lipid spectra along with the proposed pulse sequence are shown below.



Conventional DQ filter
(all pulses nonselective)



Selective DQ filter



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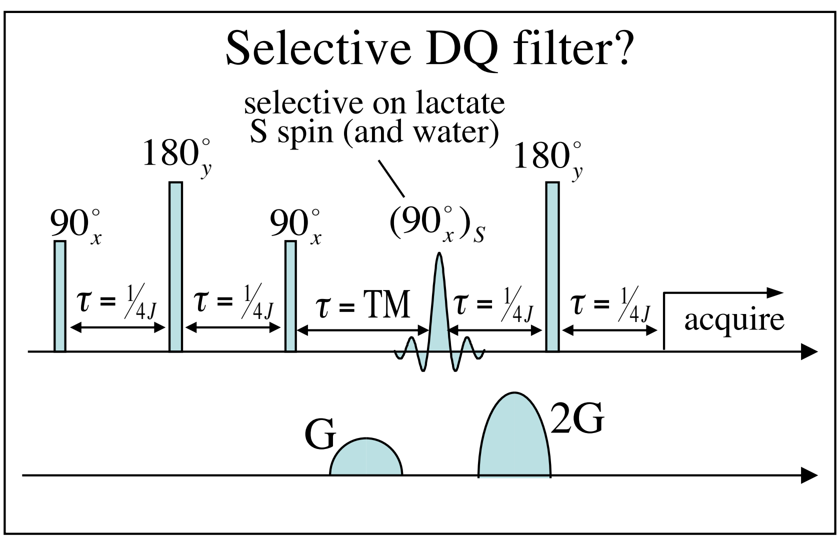
2. **Selective Double Quantum Filtering (SelDQF) for Lactate**

a) Using the Product Operator Formulism show that not only does the selDQF sequence suppress both the unwanted water and lipid resonances but also generates twice the lactate methyl signal as a conventional DQ-filter (As is shown in the diagram, assume both lipids and lactate are weakly coupled IS spin systems).

b) Analyze the performance of the pulse sequence if a positive instead of a negative rephasing gradient is used. How does this compare with the conventional DQ-filter?



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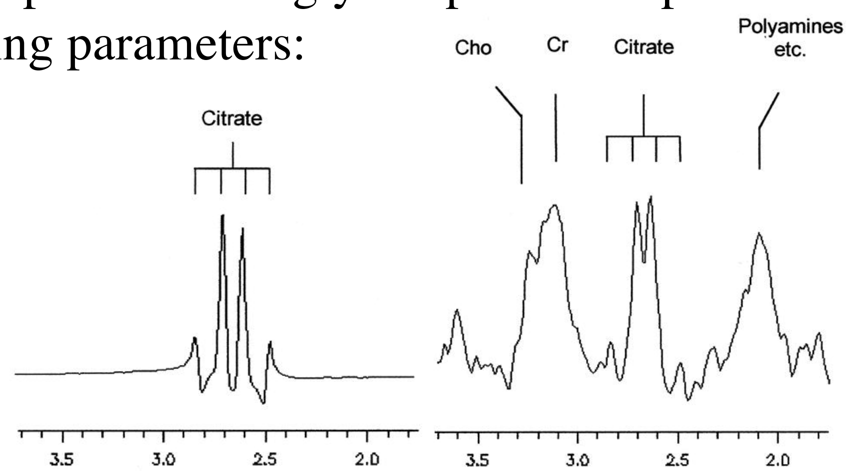
3. **A strongly coupled spin system.**

At 3T, citrate is an example of a strongly coupled two-spin system with the following parameters:

$$\Omega_I - \Omega_S = 0.15 \text{ ppm}$$

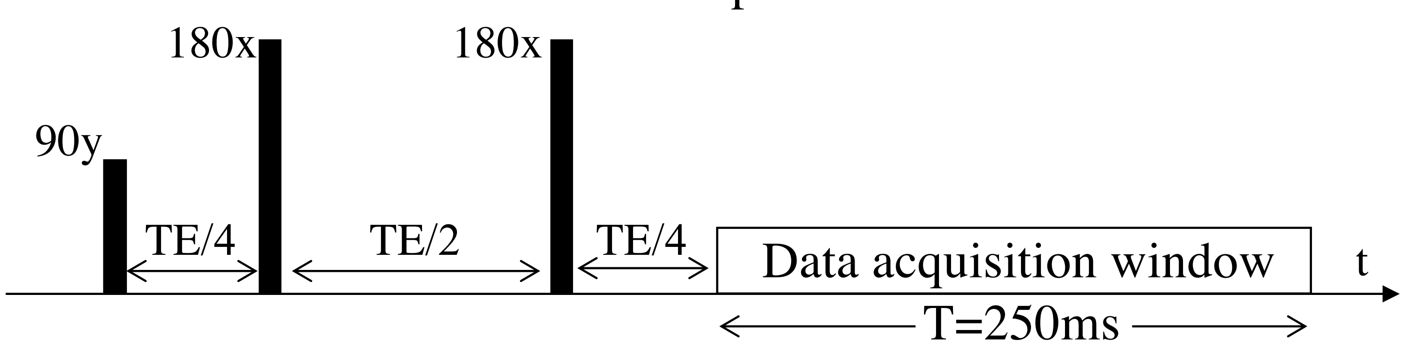
$$J = 15.4 \text{ Hz}$$

$$T_2 = 150 \text{ ms}$$



In Vitro In Vivo (prostate)

A version of the following pulse sequence is most often used to measure citrate in the human prostrate.



a) Using the full density matrix, simulate (e.g. using Matlab) the measured citrate spectrum for a series of TEs ranging from 50-300 ms. Use a first order approximation for the effect of T_2 by simply assuming the received signal is weighted by a factor of $e^{-t/T2}$ (i.e consider relaxation only during the data acquisition window).

b) What echo time, TE, would you choose to maximize the detection of citrate?