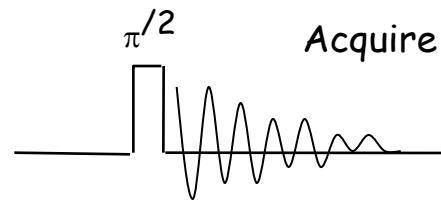


# General One Dimensional Experiment



$t$  →

1



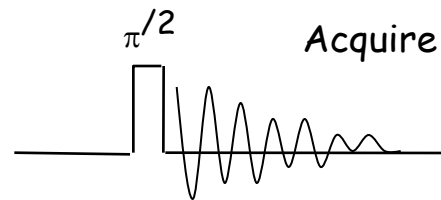
Fourier Transform

$t_1 \rightarrow f_1$



$f_1$  →

# General One Dimensional Experiment



$t$  →

1



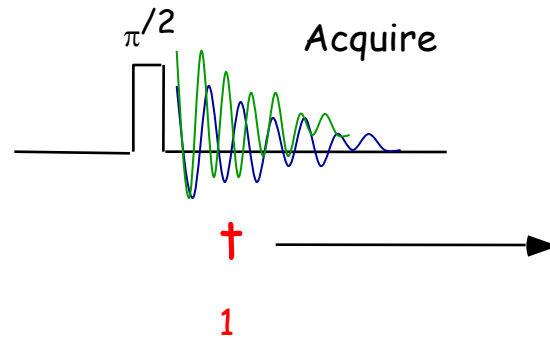
Fourier Transform

$t_1 \rightarrow f_1$



$f_1$  →

# General One Dimensional Experiment

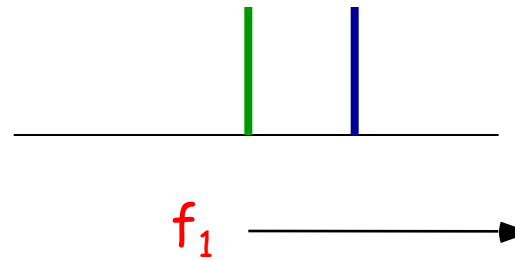


Fourier Transformation  
resolves multiple frequencies  
that overlap in the time domain

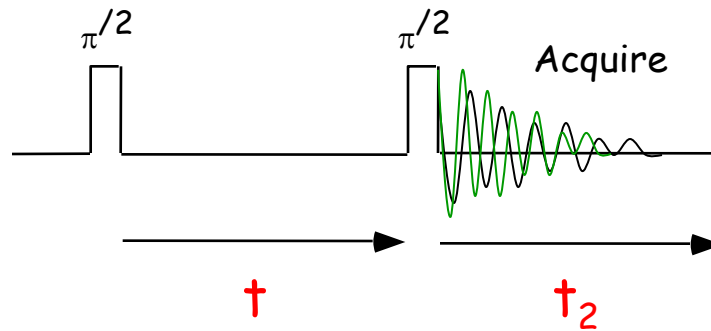


Fourier Transform

$$t_1 \rightarrow f_1$$



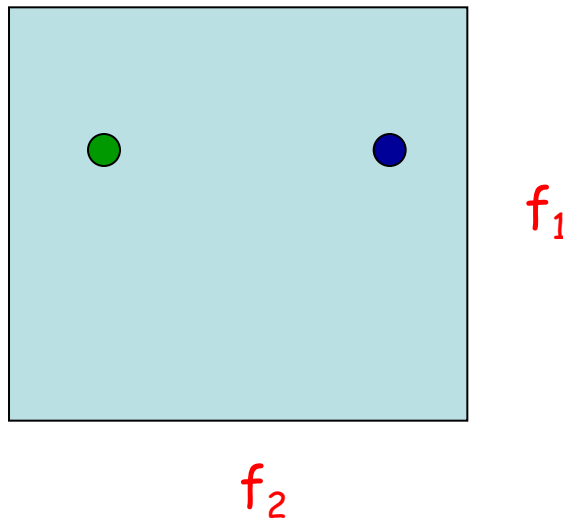
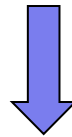
# General Two Dimensional Experiment



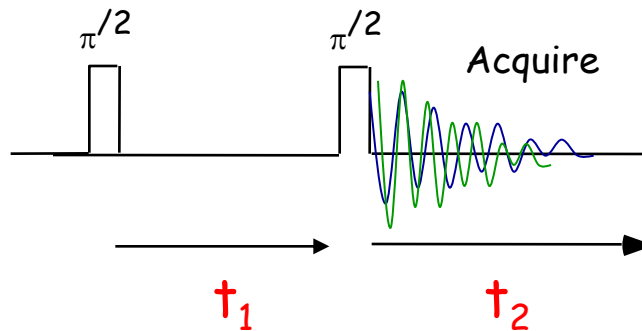
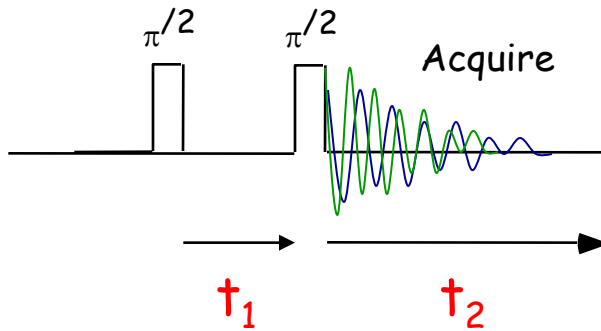
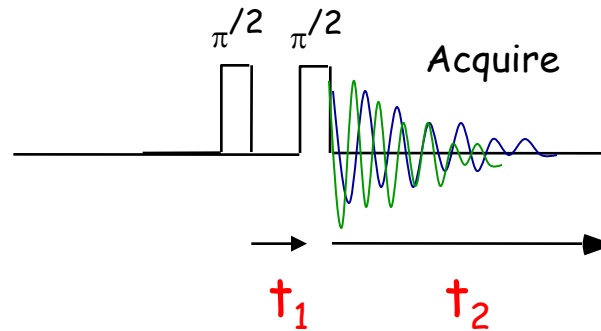
Fourier Transform

$t_1 \rightarrow f_1$  and  $t_2 \rightarrow f_2$

1



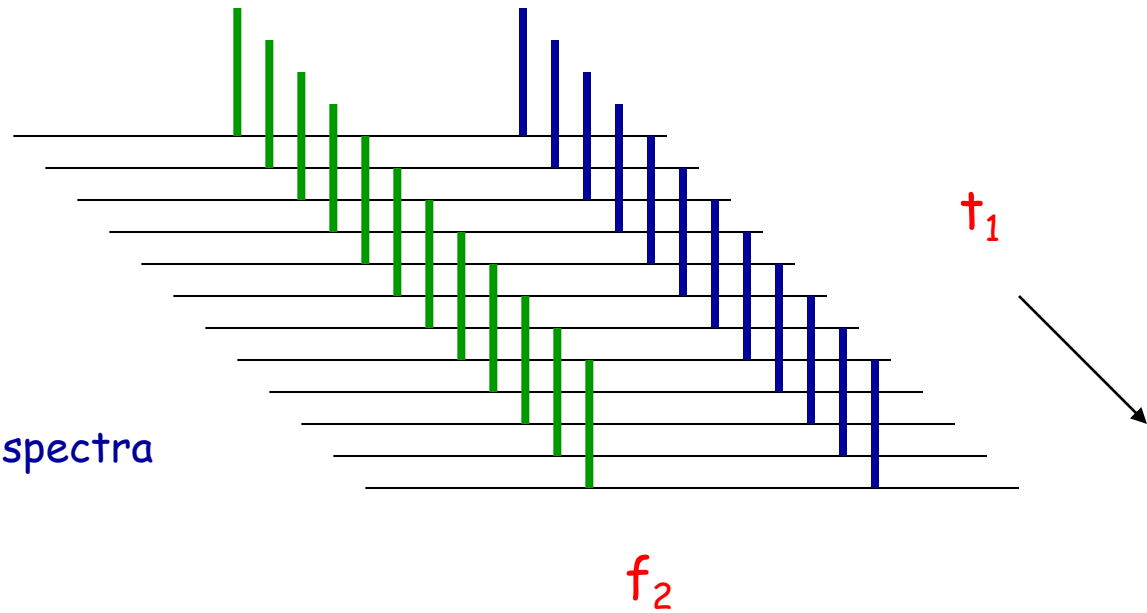
# General Two Dimensional Experiment



Vary  $t_1$   
Collect a series of 1D spectra

# General Two Dimensional Experiment

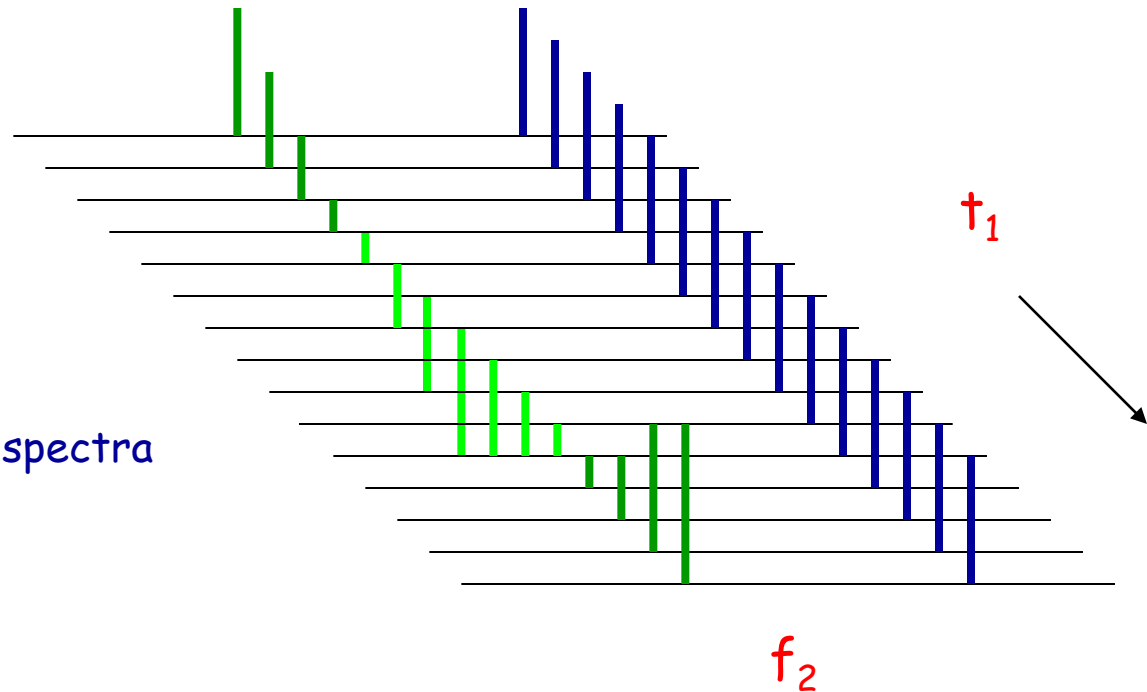
Vary  $t_1$   
Collect a series of 1D spectra



Here, the intensities of  $\color{green}|$  and  $\color{blue}|$  do not change as a function of the  $t_1$  evolution time

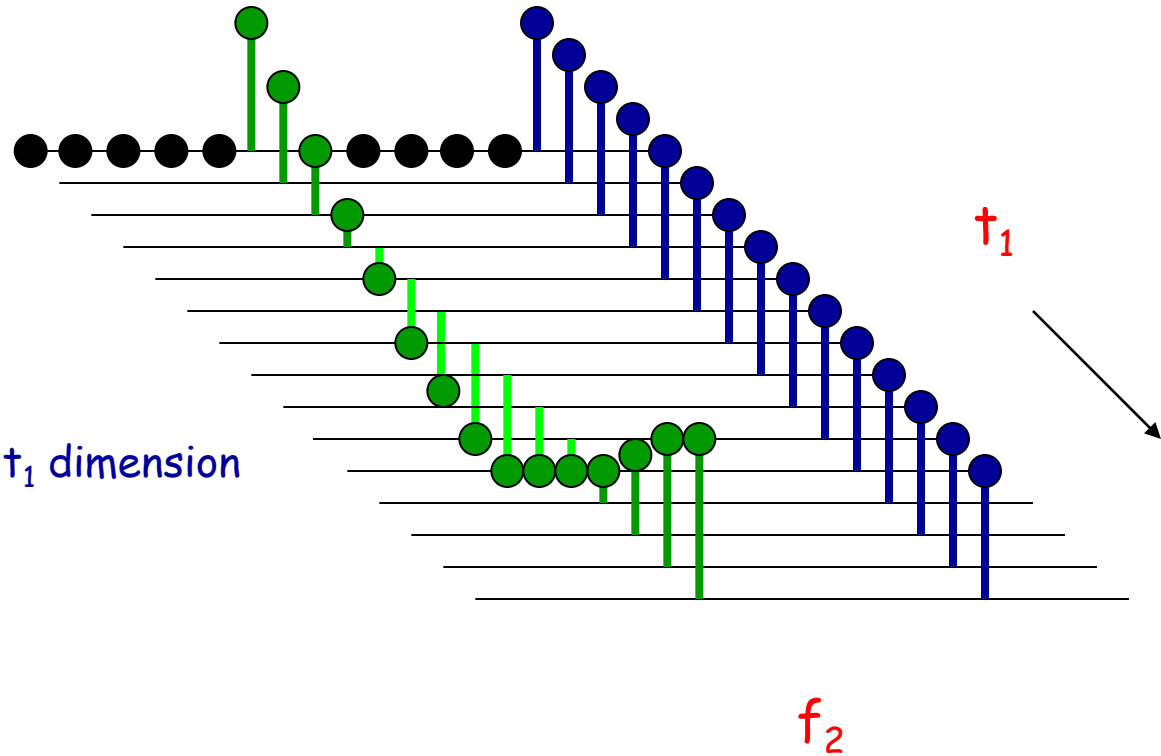
# General Two Dimensional Experiment

Vary  $t_1$   
Collect a series of 1D spectra



Whereas here, the intensity of  is modulated as a function of the  $t_1$  evolution time

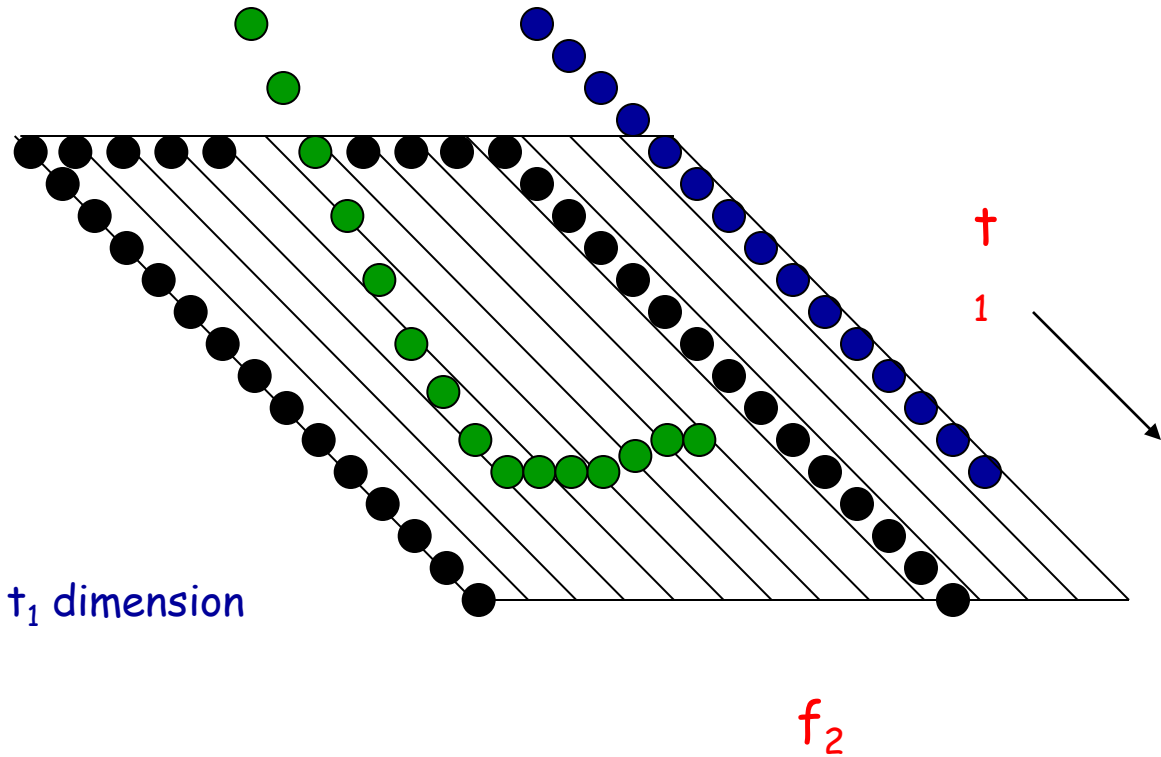
# General Two Dimensional Experiment



Transpose and then  
Fourier transform in  $t_1$  dimension



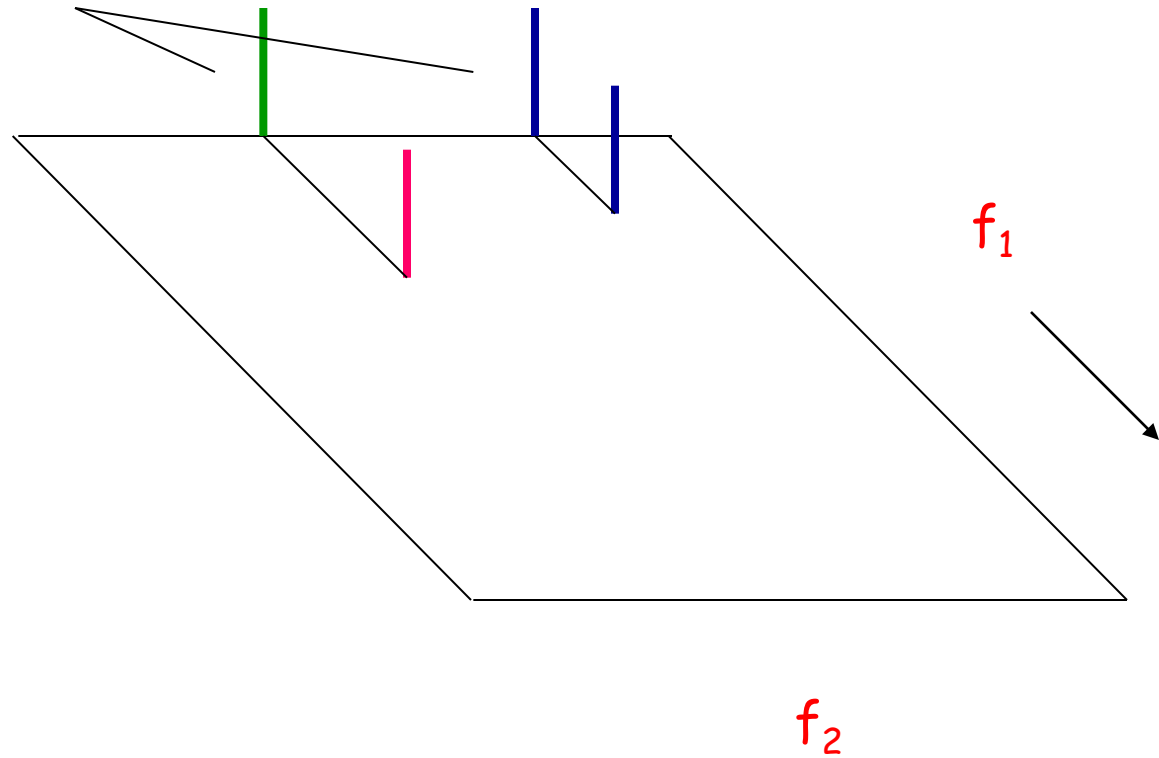
# General Two Dimensional Experiment



Transpose and then  
Fourier transform in  $t_1$  dimension

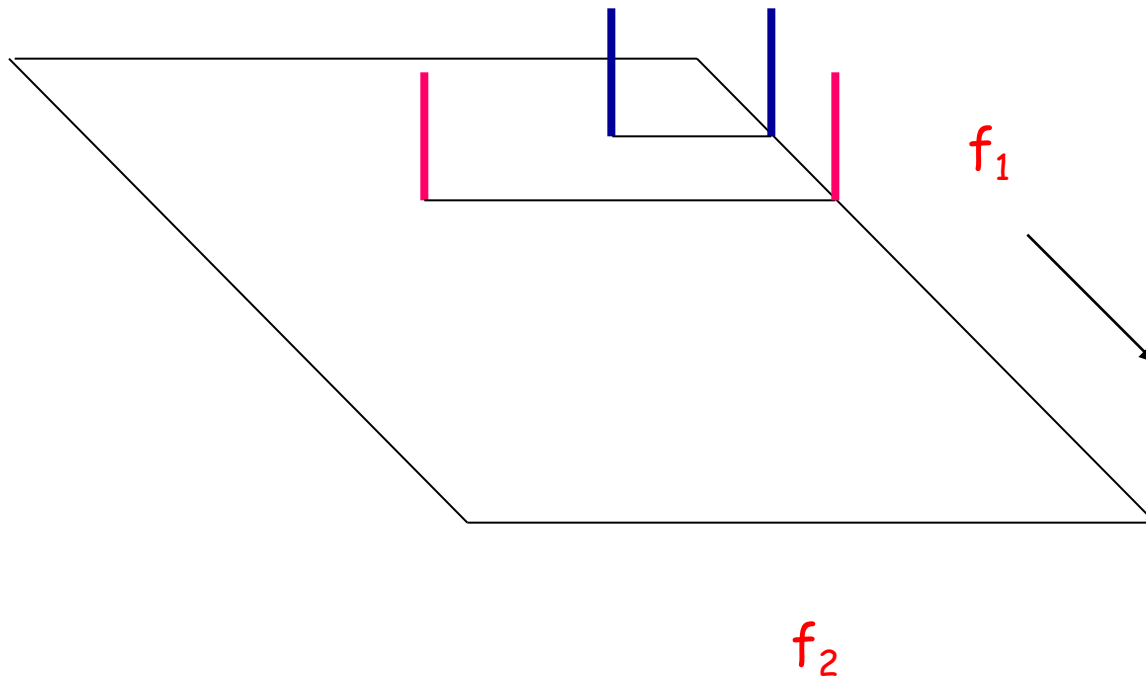
# General Two Dimensional Experiment

Projection on  $f_2$  gives  
original chemical shifts

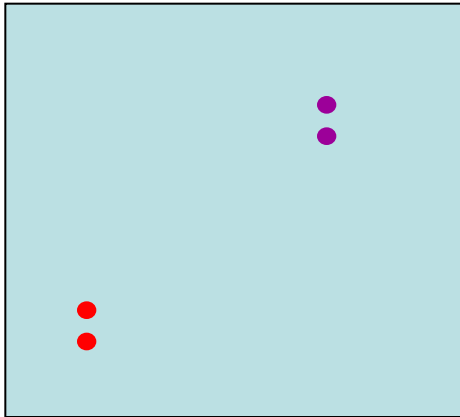


# General Two Dimensional Experiment

Projection on  $f_1$  yields  
new information

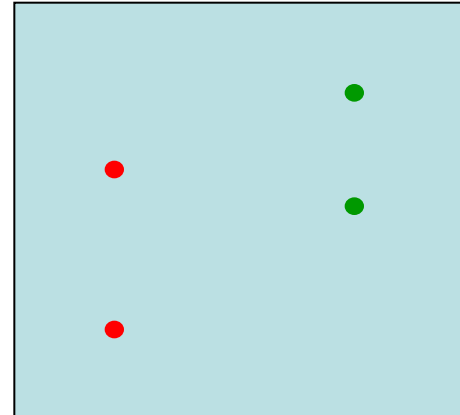


# General Two Dimensional Experiment



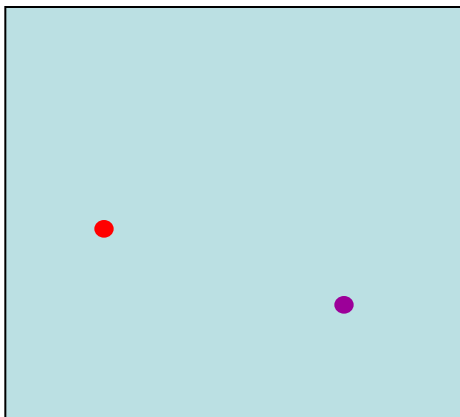
J coupling

$^1\text{H}$  chemical shift



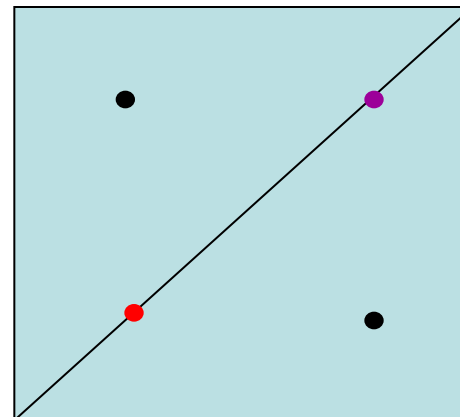
Dipolar coupling

$^1\text{H}$  chemical shift



$^{13}\text{C}$  chemical shift

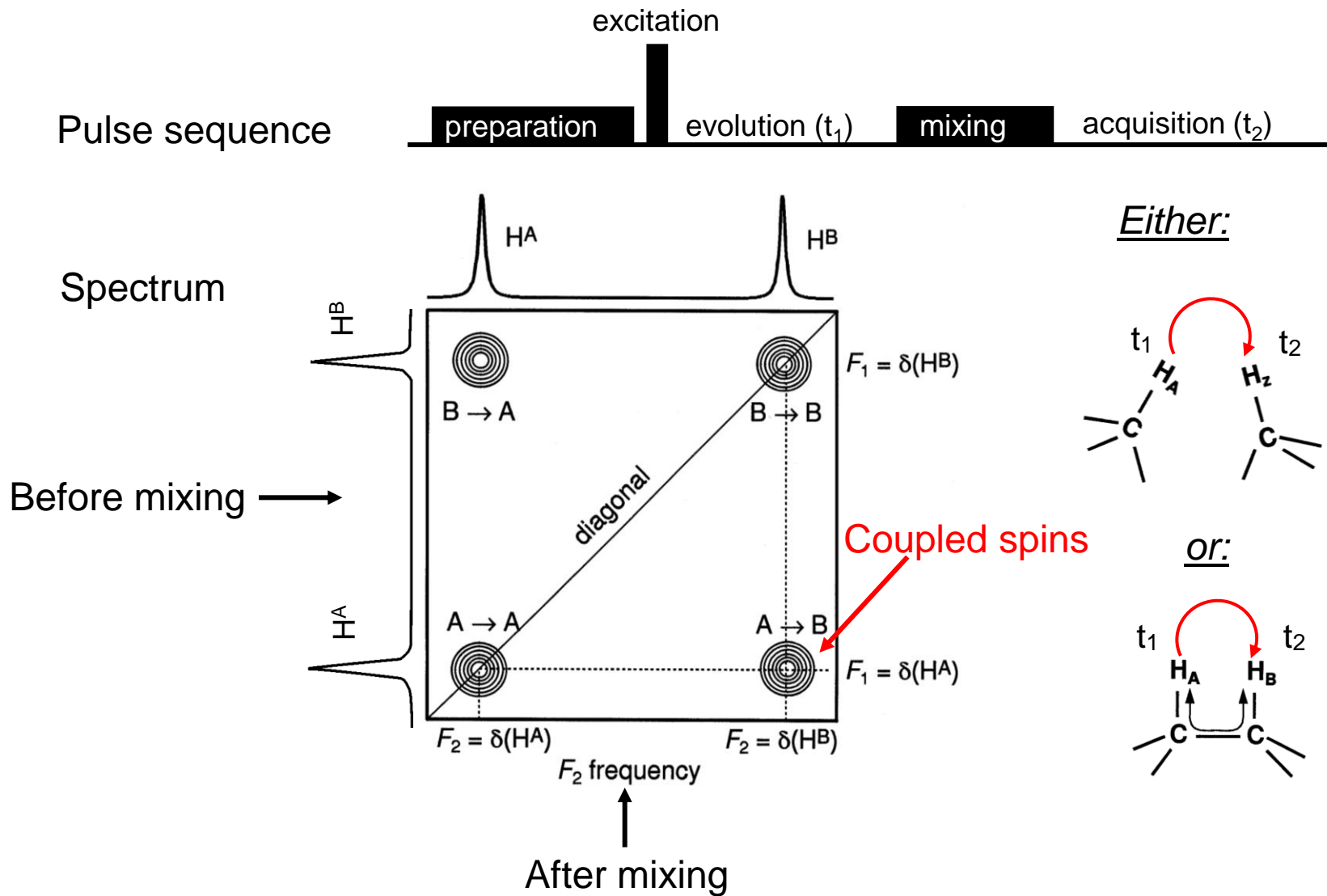
$^1\text{H}$  chemical shift



$^1\text{H}$  chemical shift

$^1\text{H}$  chemical shift

# 2D NMR Spectrum



# The Power of 2D NMR

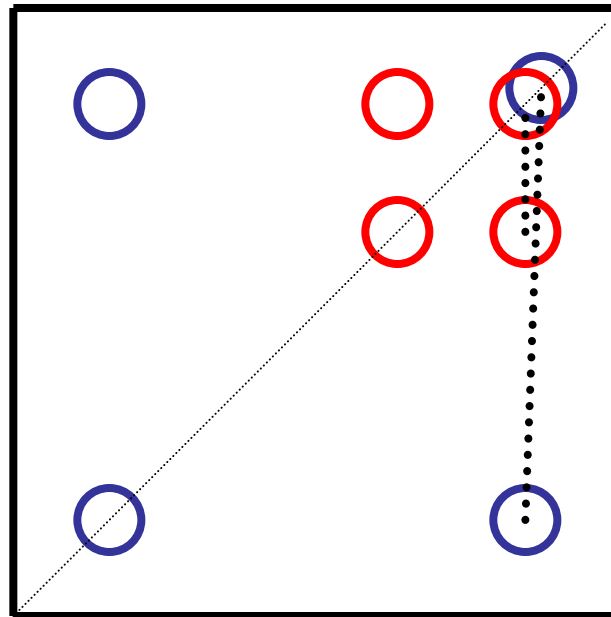
## Resolving Overlapping Signals

1D



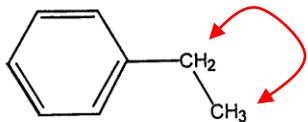
2 signals  
overlapped

2D



2 cross peaks  
resolved

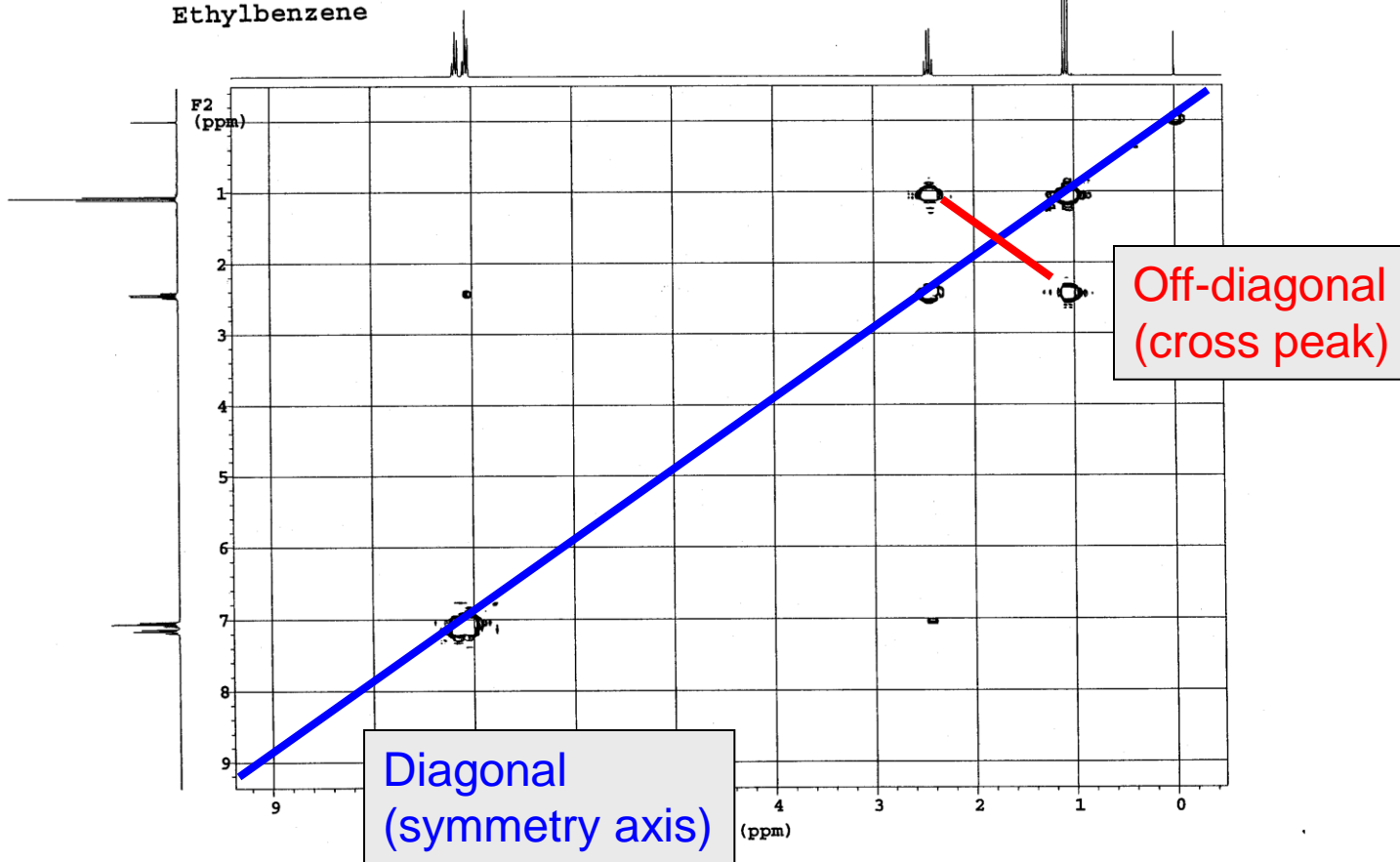
Ethylbenzene  
c6d6, TMS  
Shoulders  
y67d



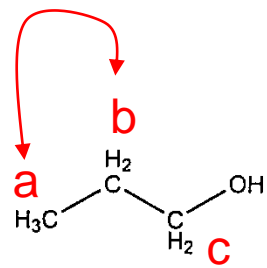
Ethylbenzene

COSY

$^1\text{H}$ - $^1\text{H}$  2D correlation NMR spectrum (COSY)

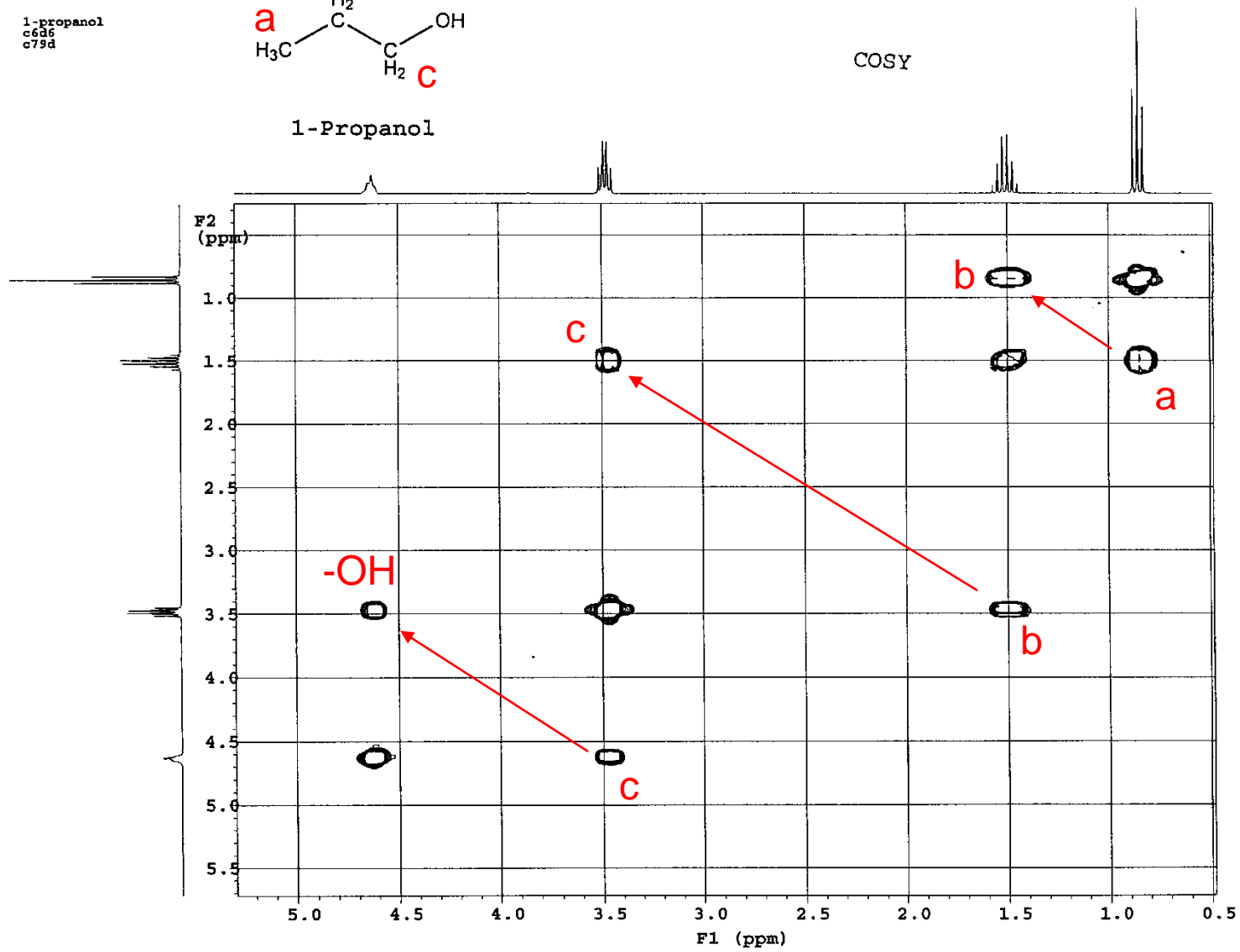


1-propanol  
c6d6  
c79d

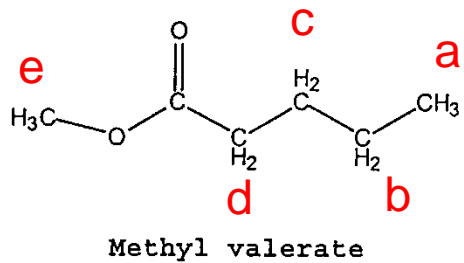


1-Propanol

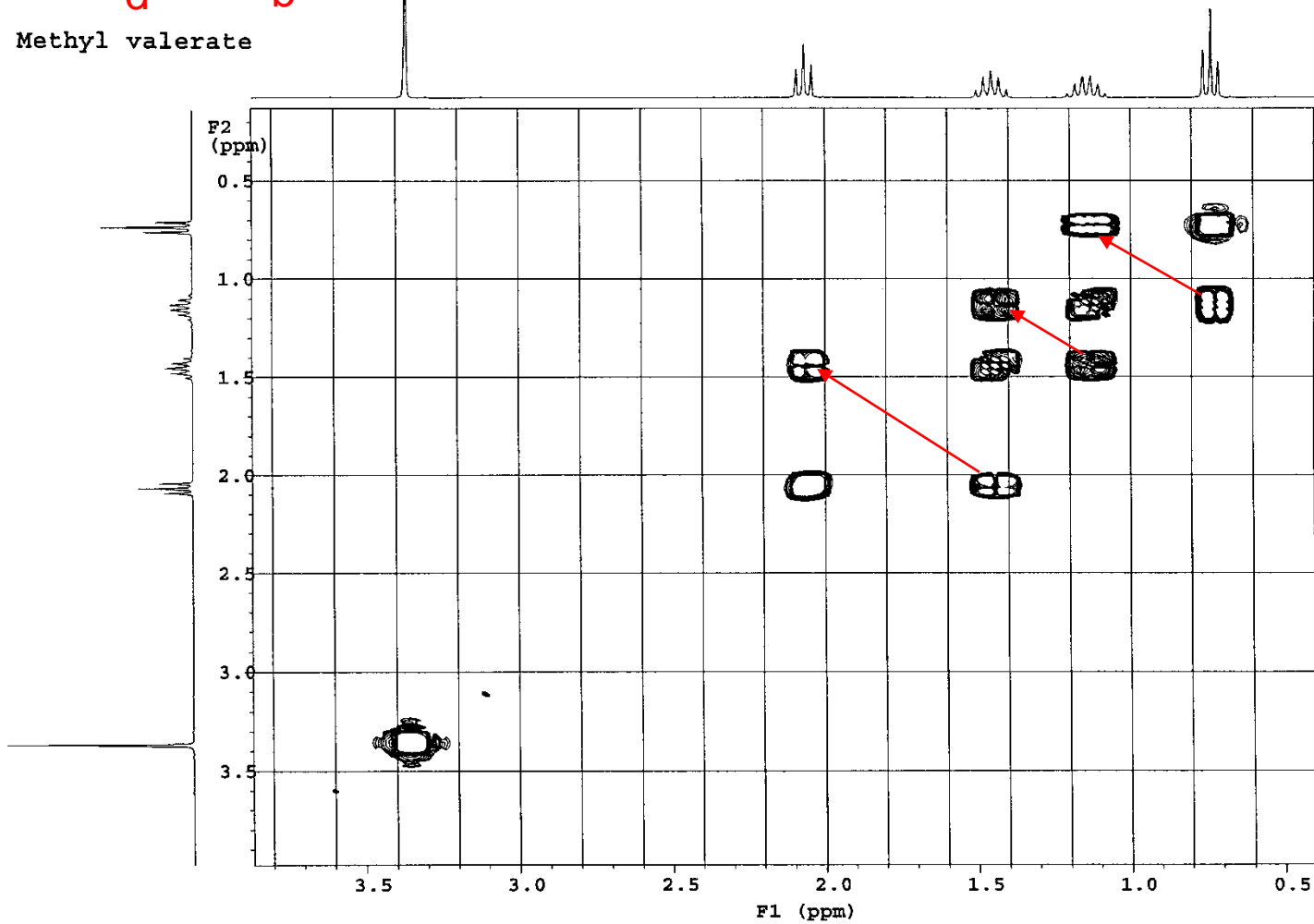
COSY

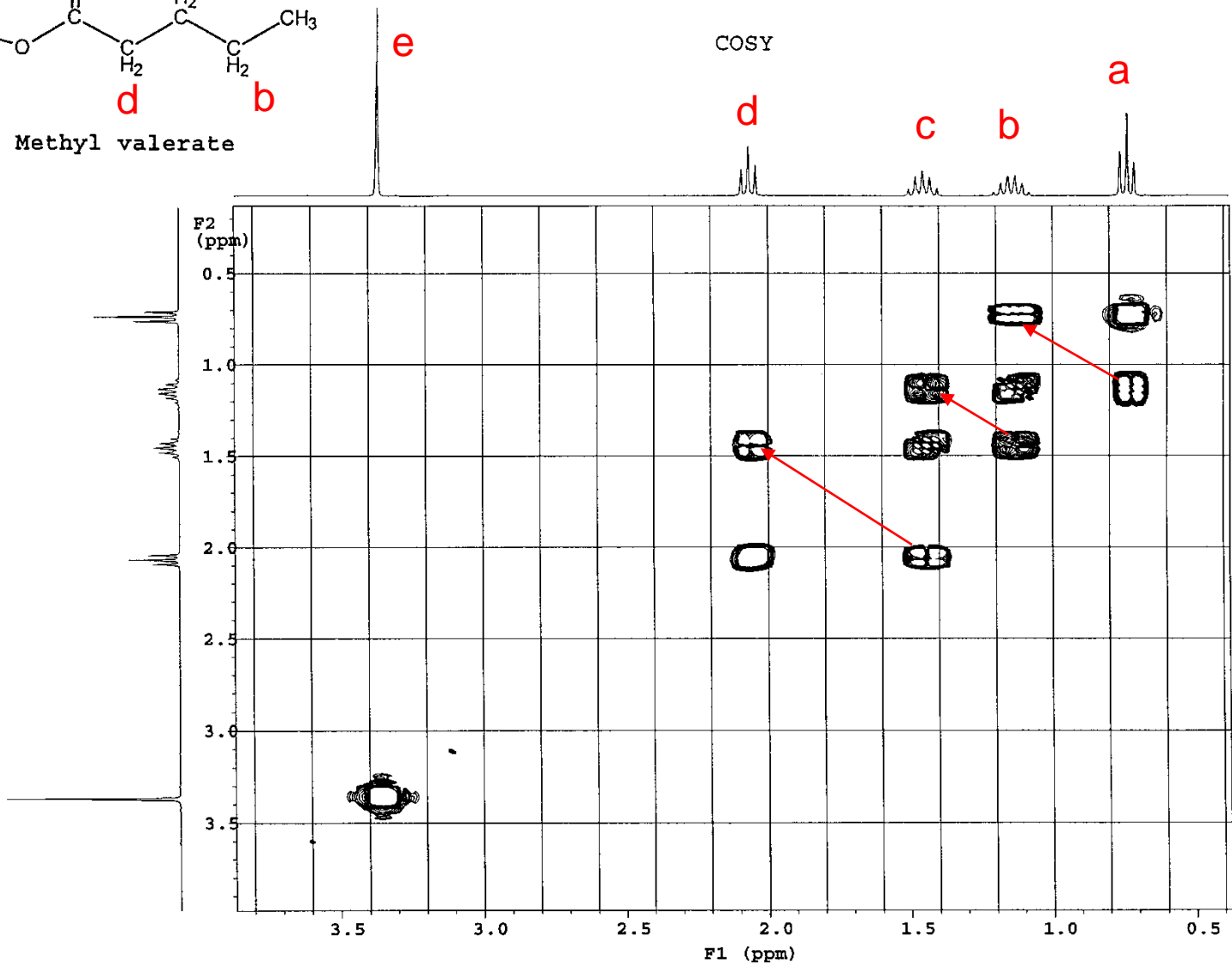
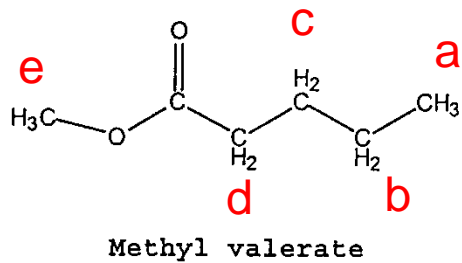


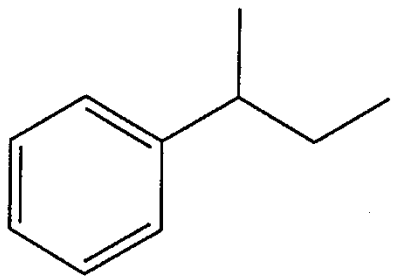




COSY

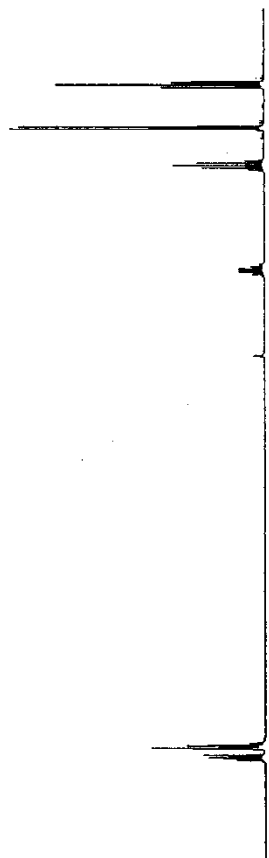




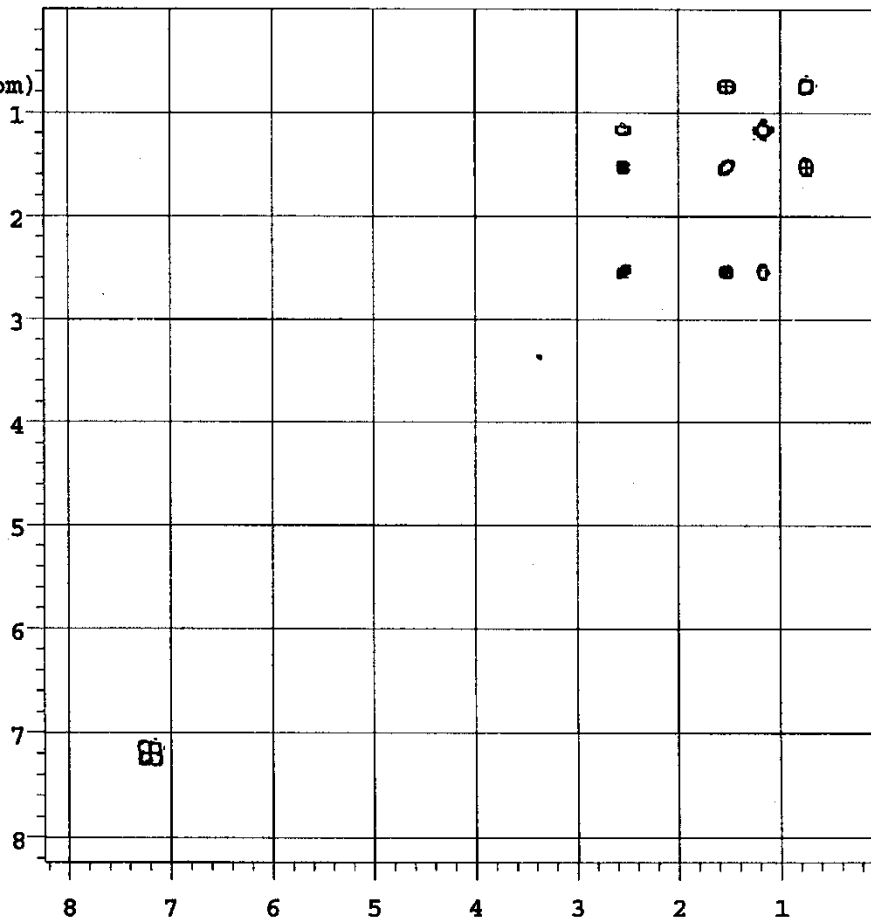


sec Butylbenzene

COSY

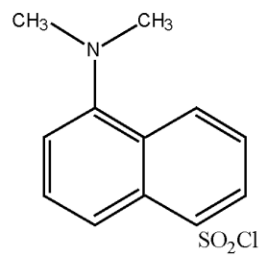


F2  
(ppm)

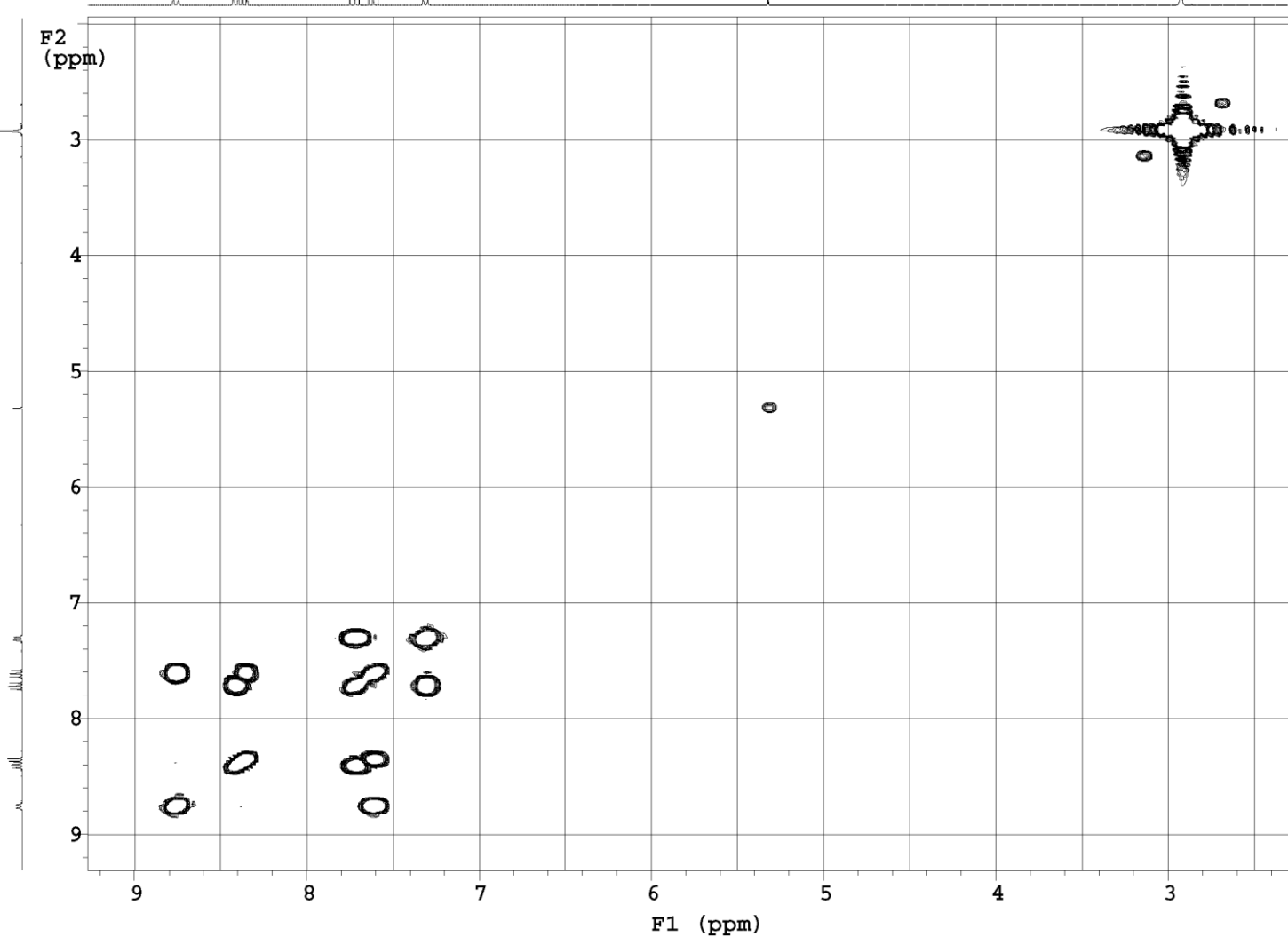


F1 (ppm)

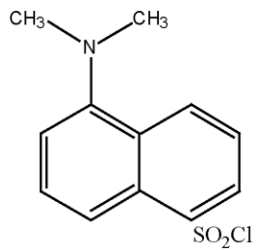
Dansyl Chloride  
CD<sub>2</sub>Cl<sub>2</sub>  
Shoulders  
y77e



Dansyl Chloride



Dansyl Chloride  
CD2Cl2  
Shoulders  
y77e



Dansyl Chloride

