


tested 190817 using *SpinDynamica* 3.0.1 under *Mathematica* 11.0

## spin echo

calculate a set of magnetization vector trajectories for an ensemble of magnetic fields, and add the trajectories together to form an ensemble average

```
Needs["SpinDynamica`"]
```

```
SetSpinSystem[1]
```

 **SetSpinSystem:** the spin system has been set to  $\{\{1, \frac{1}{2}\}\}$

generate a set of 100 resonance frequencies and weights to use in the ensemble average, using a normal distribution centred at 0 with standard deviation 50 Hz.

```
nensemble = 100;
```

```
 $\omega_0$ ensemble =
```

```
Table[{{RandomReal[NormalDistribution[0, 2  $\pi$  50]]}, 1/nensemble}, {nensemble}];
```

define the echo pulse sequence:

```
 $\tau$  = 40  $\times$  10-3;
```

```
EchoSequence =
```

```
{RotationSuperoperator[{ $\pi$ /2, "x"}],  
 {None,  $\tau$ },  
 RotationSuperoperator[{ $\pi$ , "y"}],  
 {None, 4  $\tau$ }}  
}
```

```
{RotationSuperoperator[{1}, { $\frac{\pi}{2}$ , x}],
```

```
{None,  $\frac{1}{25}$ }, RotationSuperoperator[{1}, { $\pi$ , y}], {None,  $\frac{4}{25}$ }}
```

```
T = EventDuration[EchoSequence]
```

```
 $\frac{1}{5}$ 
```


calculate the signal during the echo sequence, averaged over the ensemble

```
 $\omega_0$  = .;
```

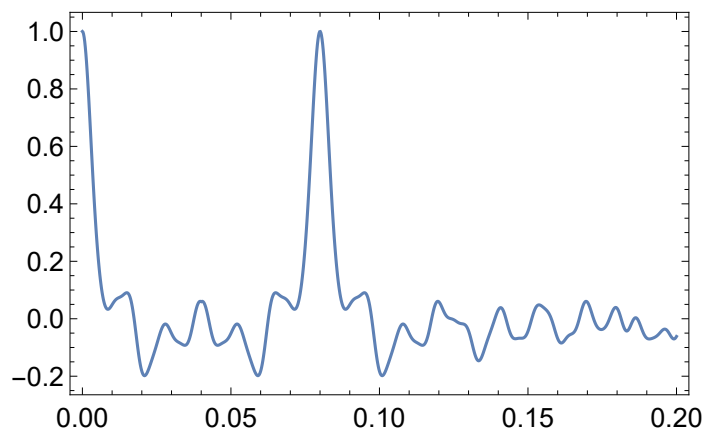
```
nsample = 1024;
```

```
sig = Signal1D[  
 {0, T, T/nsample},  
 EchoSequence,  
 BackgroundGenerator  $\rightarrow$   $\omega_0 \times \text{opI["z"]}$ ,  
 EnsembleAverage  $\rightarrow$  { $\omega_0$ ,  $\omega_0$ ensemble},  
 InitialDensityOperator  $\rightarrow$   $\text{opI["z"]}$ ,  
 Preparation  $\rightarrow$  None,  
 LineBroadening  $\rightarrow$  None  
];
```

 **Signal1D:** Using SignalCalculationMethod  $\rightarrow$  Direct

 **Signal1D:** the last sampling point has been dropped in order to get an even number of points.

```
ListPlot[Re@sig, Frame → True, PlotRange → All, Joined → True]
```



this shows the spin echo