

Supplementary Information: Double nutation cross polarization between heteronuclear spins in solids

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1 Examples of DONUT waveforms

1.1 Amplitude

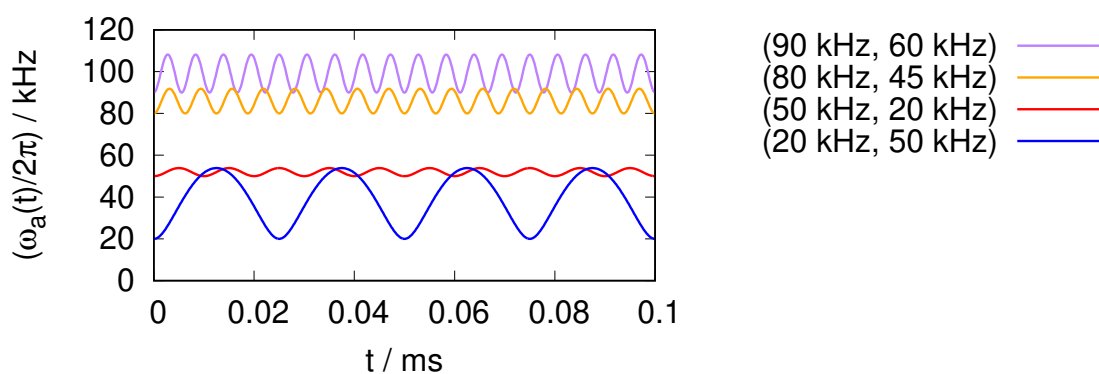


Figure S1: Profiles of the amplitude $\omega_a(t)$ given in Eq. (32) for $(\omega_{1I}/2\pi, \omega_{2I}/2\pi)$ of (20 kHz, 50 kHz), (50 kHz, 20 kHz), (80 kHz, 45 kHz), and (90 kHz, 60 kHz).

1.2 Phase

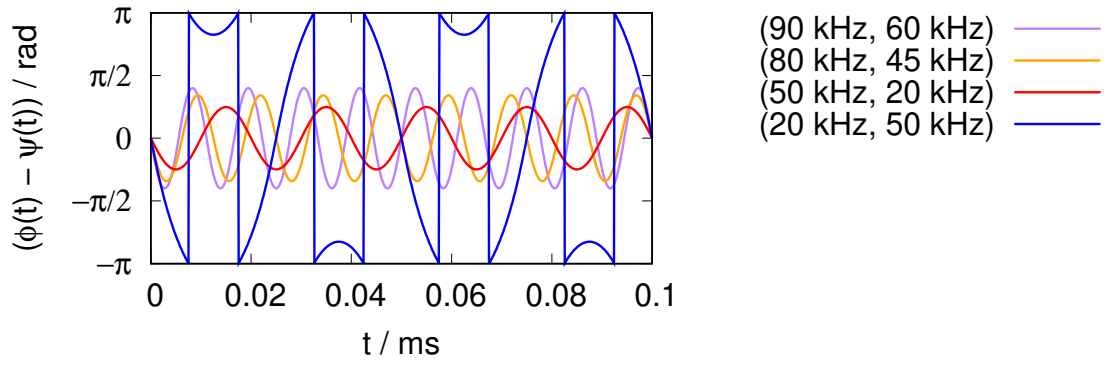


Figure S2: Profiles of the phase $\phi(t) - \psi(t)$ given in Eqs. (33) and (42) for $(\omega_{1I}/2\pi, \omega_{2I}/2\pi)$ of (20 kHz, 50 kHz), (50 kHz, 20 kHz), (80 kHz, 45 kHz), and (90 kHz, 60 kHz).

1.3 Gnuplot script for Fig. S1

```
set xrange [0:0.1]
set yrange [0:120]
set xl "t / ms"
set yl "(Symbol w_a(t))/2/Symbol p) / kHz"
set key outside
set samples 1000
set size ratio 0.5
set terminal aqua size 640,480
# You may want to change "aqua" to the terminal type you prefer
f(nu1,nu2,x)=sqrt(nu1**2+nu2**2*sin(2*pi*nu1*x)**2)
plot f(90.0,60.0,x) lw 3 lc "purple" title "(90 kHz, 60 kHz)"
replot f(80.0,45.0,x) lw 3 lc "orange" title "(80 kHz, 45 kHz)"
replot f(50.0,20.0,x) lw 3 lc "red" title "(50 kHz, 20 kHz)"
replot f(20.0,50.0,x) lw 3 lc "blue" title "(20 kHz, 50 kHz)"
set terminal postscript eps color "Helvetica" 20
set output "amp.eps"
replot
```

1.4 Gnuplot script for Fig. S2

```
set xrange [0:0.1]
set yrange [-pi:pi]
set ytics ("-p" -pi, "-p/2" -pi/2, "0" 0.0, "p/2" pi/2, "p" pi) font "Symbol"
set xl "t / ms"
set yl "(Symbol f(t) - /Symbol y(t)) / rad"
set key outside
set samples 1000
set size ratio 0.5
set terminal aqua size 640,480
# You may want to change "aqua" to the terminal type you prefer
f(nu1,nu2,x)=atan2(-nu2*sin(2*pi*nu1*x),nu1)-(nu2/nu1)*sin(2*pi*nu1*x)
plot atan2(sin(f(90.0,60.0,x)),cos(f(90.0,60.0,x))) lw 3 lc "purple" title "(90 kHz, 60 kHz)"
replot atan2(sin(f(80.0,45.0,x)),cos(f(80.0,45.0,x))) lw 3 lc "orange" title "(80 kHz, 45 kHz)"
replot atan2(sin(f(50.0,20.0,x)),cos(f(50.0,20.0,x))) lw 3 lc "red" title "(50 kHz, 20 kHz)"
replot atan2(sin(f(20.0,50.0,x)),cos(f(20.0,50.0,x))) lw 3 lc "blue" title "(20 kHz, 50 kHz)"
# IMPORTANT: ".0" is required to tell gnuplot that the values are float.
# 20/50 -> 0!, while 20.0/50.0 -> 0.4
set terminal postscript eps color "Helvetica" 20
set output "phase.eps"
replot
```