Lecture 15
Magnetic Resonance Imaging II: NMR

Functional MRI SCAN of Physics 290 Student (Winter 2000)

Magnetic Resonance

- Nuclei (Protons, ^{13}C, ^{129}Xe …) have **SPIN**
- **TWO STATES** (Quantum Mechanics)

upper

lower

- Energy is **PROPORTIONAL TO MAGNETIC FIELD**
  - Upper Energy Level (SPIN DOWN)
  - Lower Energy Level (SPIN UP)

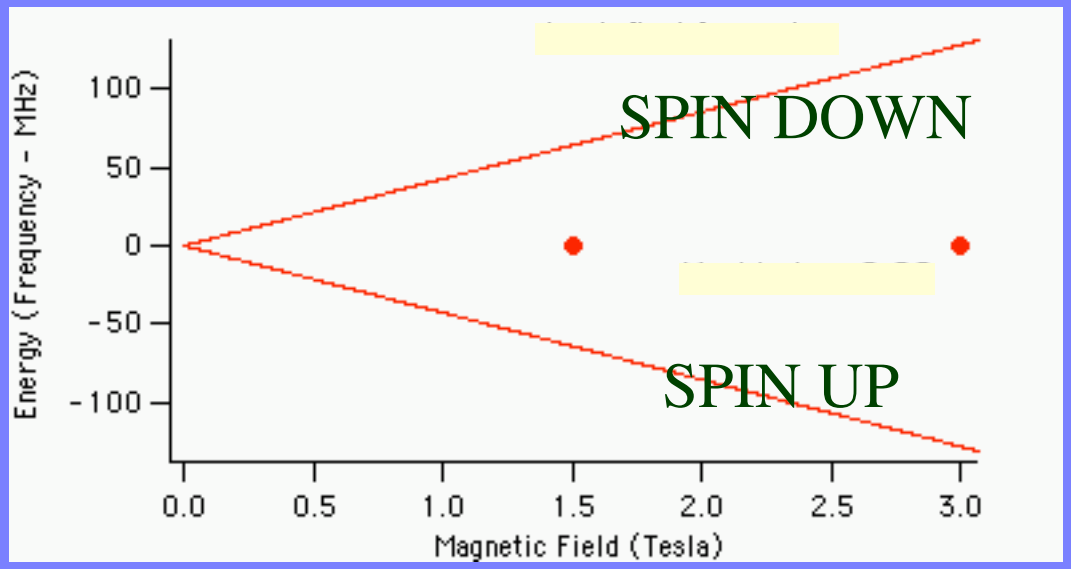
$f = E/h$

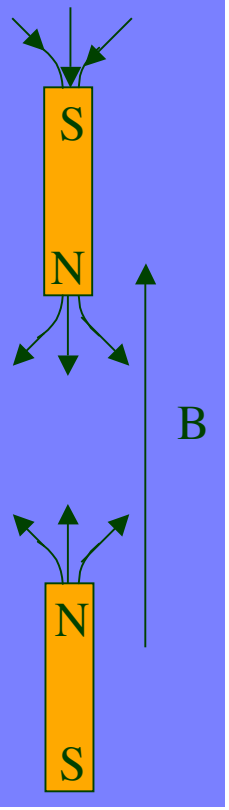
$h=6.6\times10^{-34}$ J/Hz

Planck's Constant

$f=42.6$ MHz/T

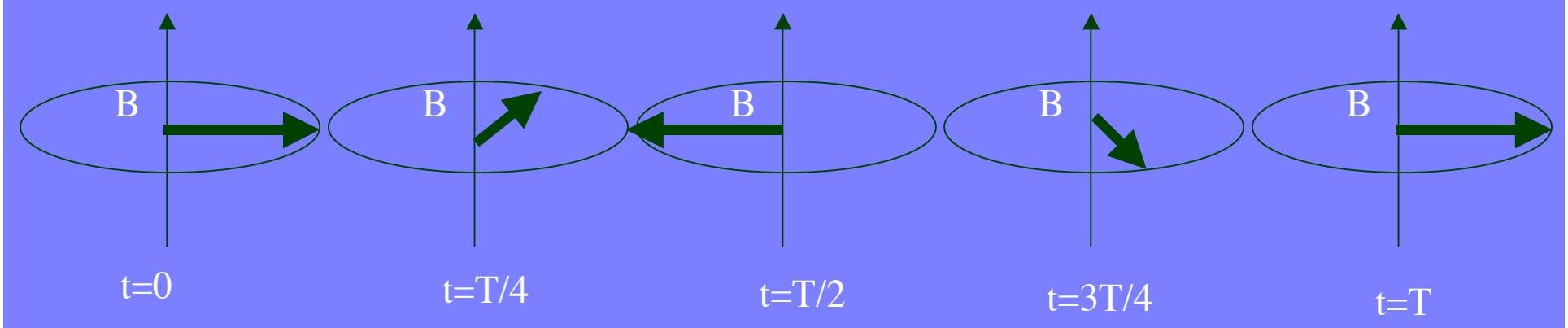
for protons



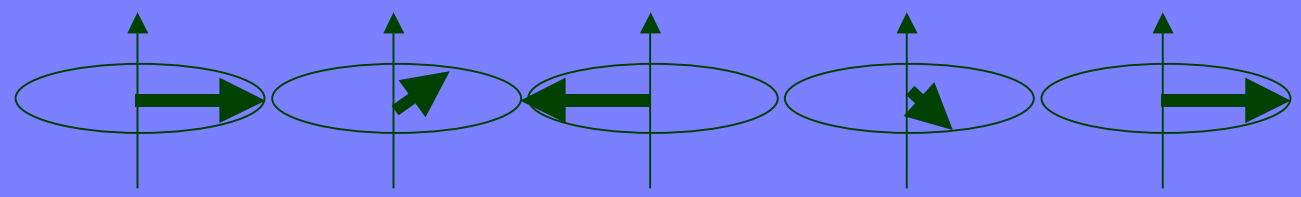


Magnetic Resonance

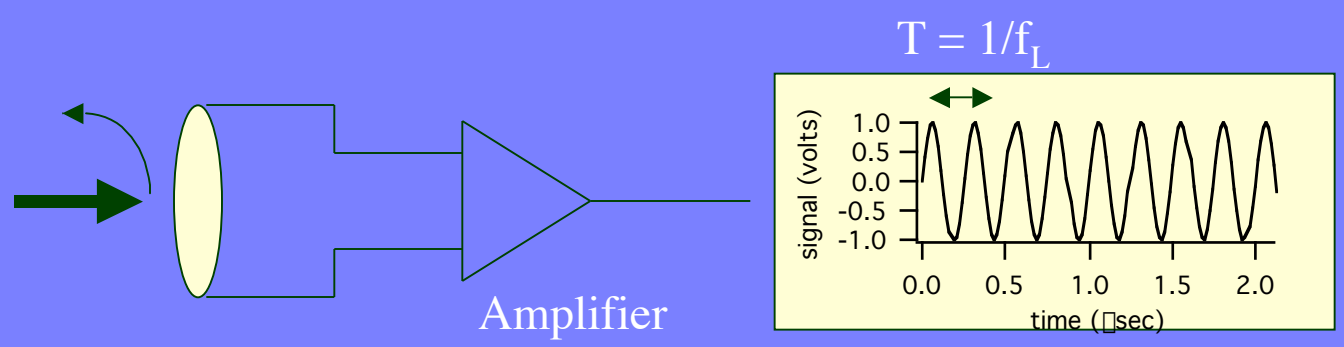
M PRECESSES in the plane perpendicular to B



Magnetic Resonance Detection

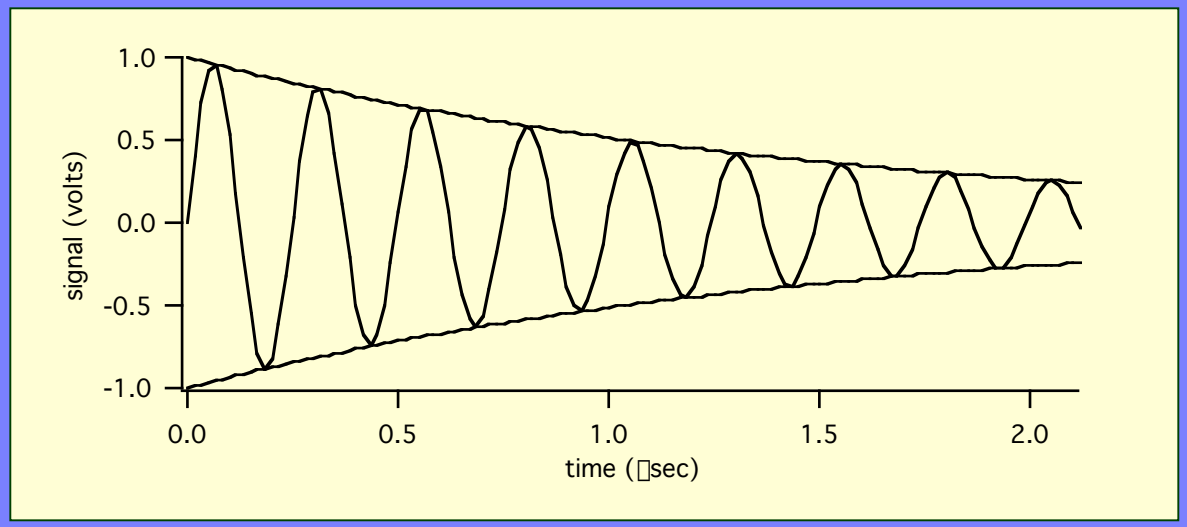


Pick-up Coil Detects Changing M by FARADAY INDUCTION



Real Signals Decay

T_2^* Relaxation

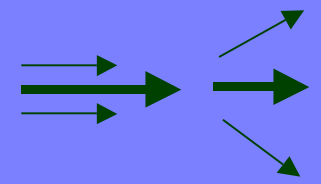


$S(t)=S_0e^{-t/T2^*}$

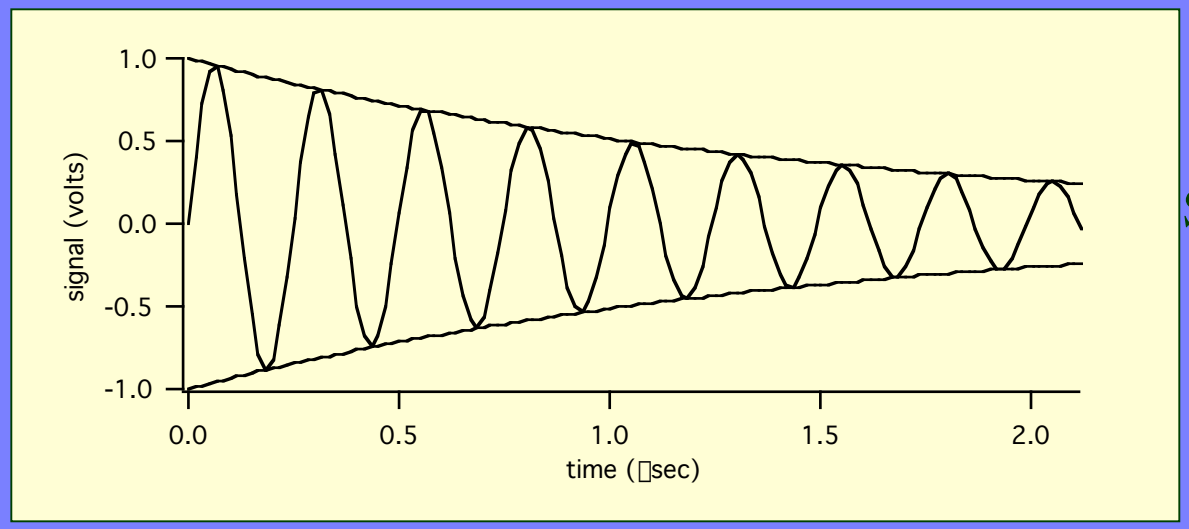
Exponential Decay

Relaxation of Nuclear Magnetization

T=0 later

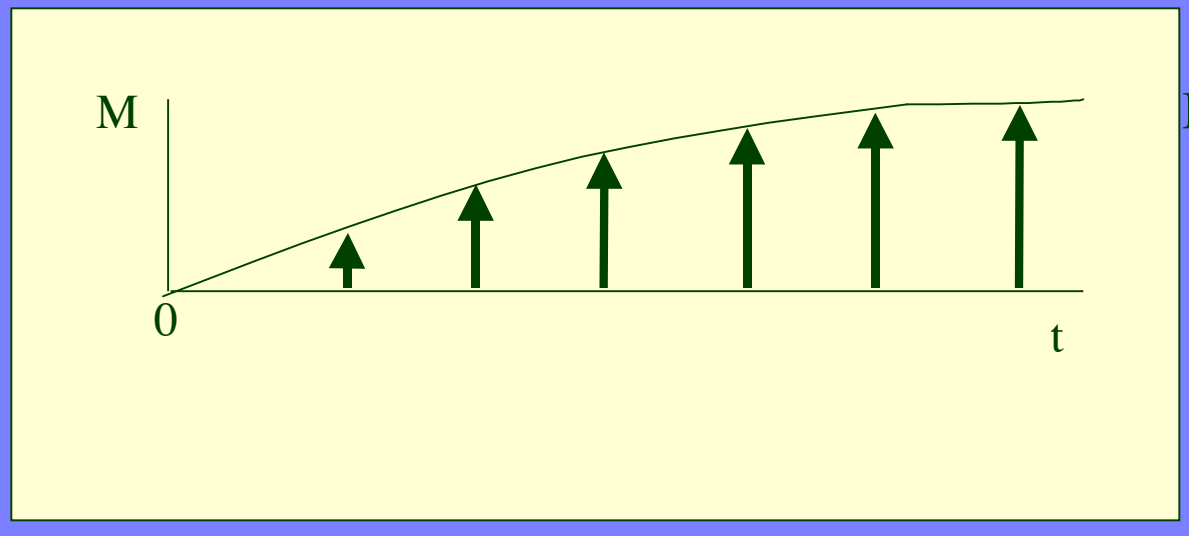


T_2 Relaxation
T_2^*



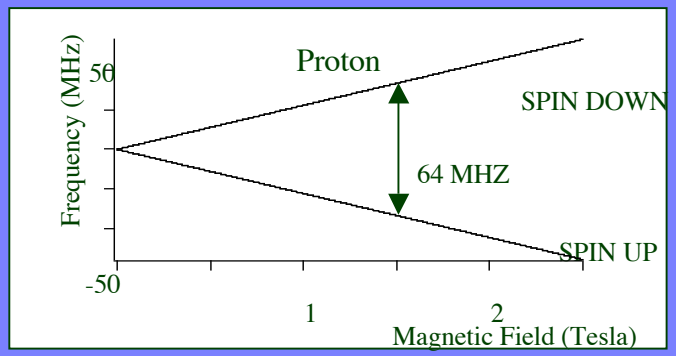
$S(t)=S_0e^{-t/T2^*}$

Recovery
After Pulse:
T_1 Relaxation



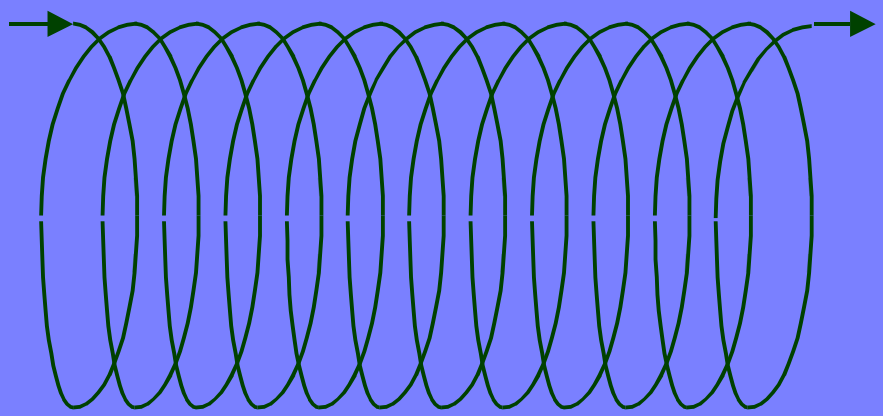
$M(t)=M_0(1-e^{-t/T1})$

1.5 Tesla



DC Current

1000 Amps



Solenoid Magnet

Conventional Magnet: Many kilowatts ($P=I^2 R$)

Superconducting Magnet: Zero Electrical Resistance