Condensed Matter	Pulsed Nuclear Magnetic Resonance	Lab logo: *pNMR*

- **Response of magnetic nuclei in a uniform magnetic field and subjected to a time-dependent continuous radio frequency (RF) magnetic field tuned through resonance**

- **First observed by Bloch and Purcell independently in 1946**

The Nobel Prize in Physics 1952

Felix Bloch

Edward Mills Purcell

- **NMR is observed in certain nuclei, in our case the proton, with both a magnetic moment (μ) and an angular momentum (J)**

$$\mu = \gamma J \qquad \gamma: \text{gyromagnetic ratio}$$

$$J = \hbar I \qquad I: \text{intrinsic spin of proton}$$

- In an external uniform field B_0 in the z-direction, magnetic energy of nucleus U:

$$U = -\mu \cdot B_0 = -\gamma J \cdot B_0 = -\gamma \hbar I \cdot B_0 = -\gamma \hbar I_z B_0$$

Condensed Matter	Pulsed Nuclear Magnetic Resonance	Lab logo: *pNMR*

- **Developed by Erwin Hahn in 1950 (UIUC)**

- **Using RF pulses with same frequency as the Larmor precession frequency for a specific duration to flip the sample magnetization to a desired angle from the equilibrium z-direction**
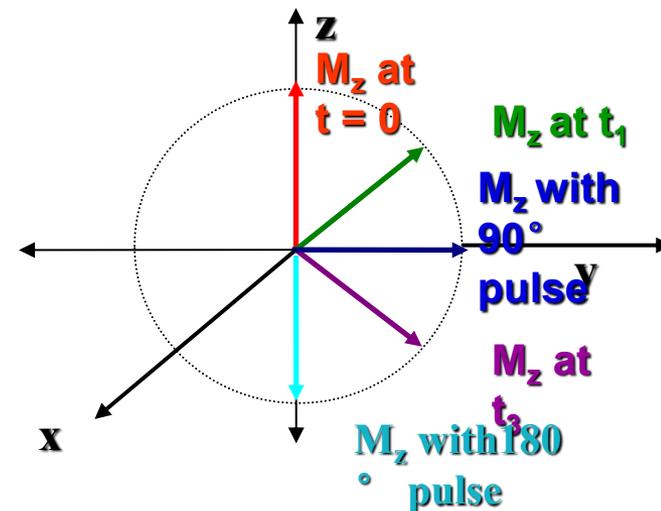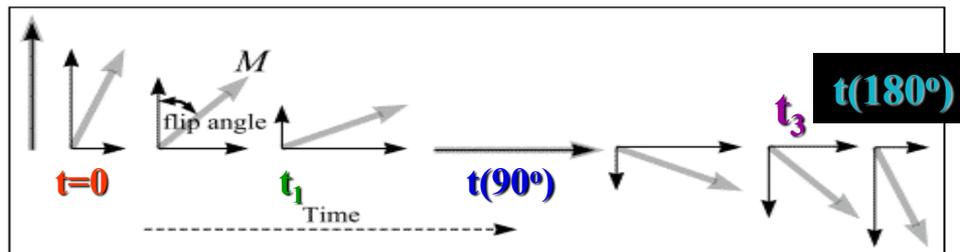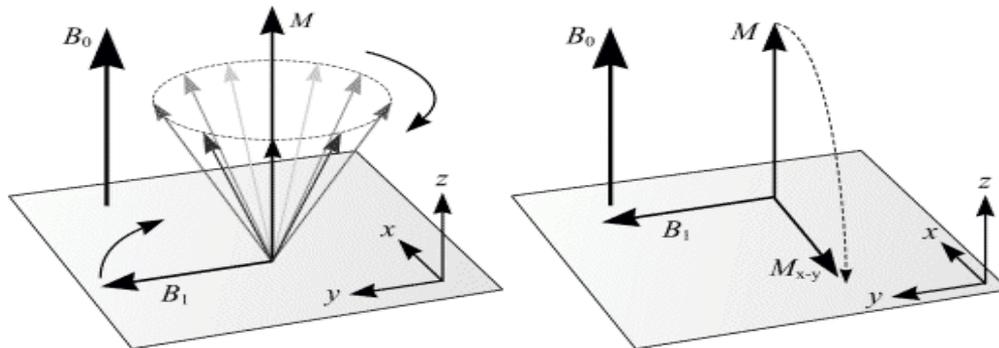
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Spin Echoes*†

E. L. Hahn‡
Physics Department, University of Illinois, Urbana, Illinois

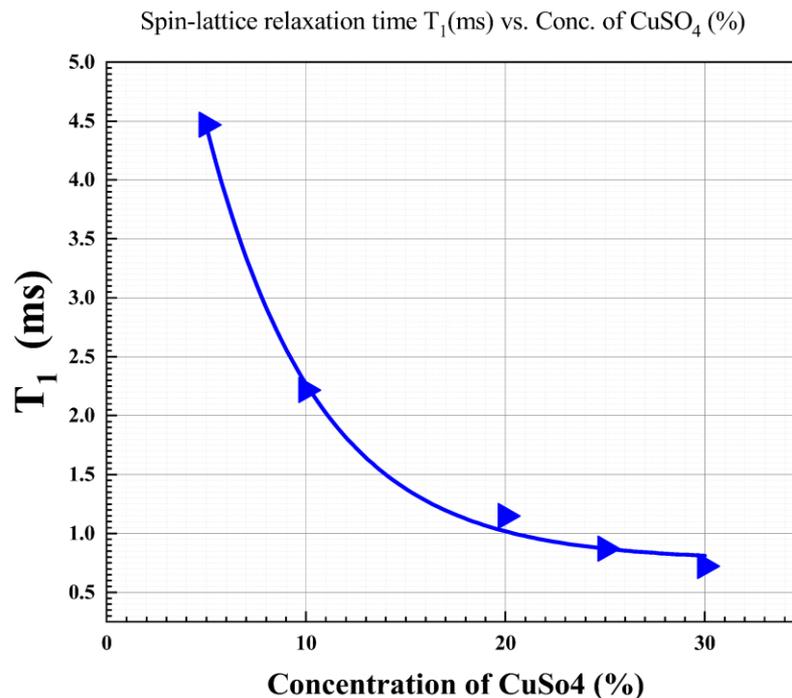**Erwin Hahn
1921-2016**

| Condensed Matter | Nuclear Magnetic Resonance | Lab logo: *pNMR* |

Experimental setup.

$$M_Z = M_{Z0}*exp(-t/T2) + y0$$

y0	-12.14	± 4.544
M_{Z0}	767.04	± 4.34
T2	1.10	± 0.02
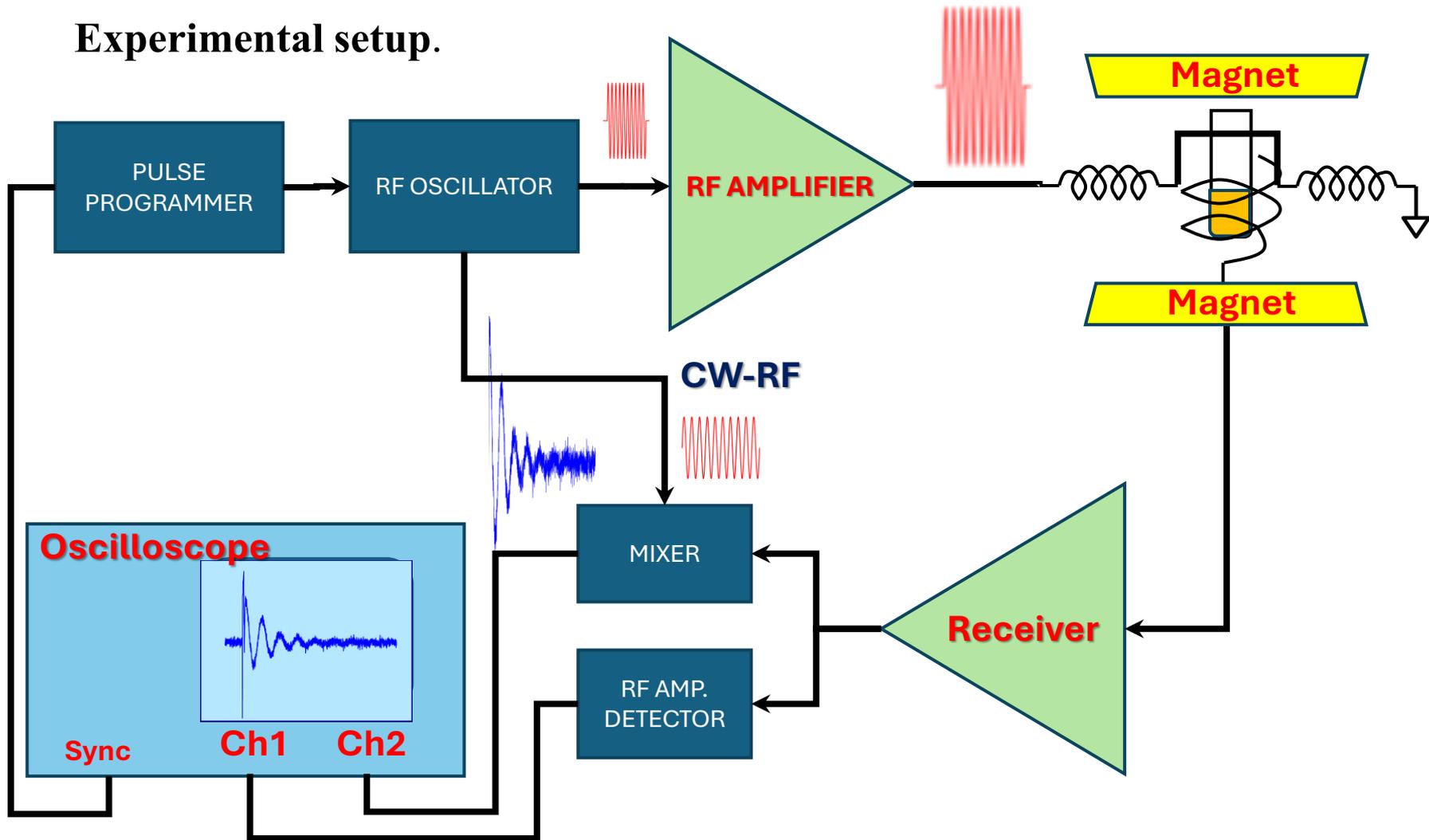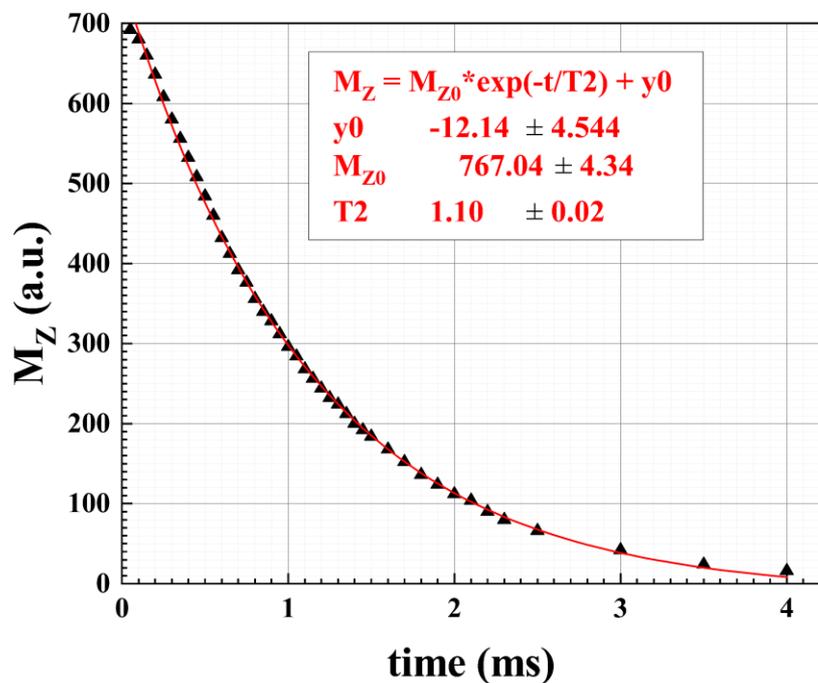
Amplitude of magnetization decay vs. delay time of pulses to find T_1 for $CuSO_4$ (10%)

Spin-lattice relaxation time T_1(ms) vs. Conc. of $CuSO_4$ (%)

Spin-lattice relaxation time T_1(ms) vs. Conc. of $CuSO_4$ (%)