This Week's Citation Classic

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Hahn E L. Spin echoes. *Phys. Rev.* **80**:580-94, 1950.
[Physics Department, University of Illinois, Urbana, IL]

Ensembles of nuclear magnetic moments lined up by the action of a radio frequency pulse appear to misalign or lose order. Hidden order of transient nuclear precession oscillations can be restored by the action of a second or additional pulses. The nuclear magnets then refocus or align to produce electromagnetic echo signals. [The *SCI®* indicates that this paper has been cited over 610 times since 1961.]

E.L. Hahn
Department of Physics
University of California
Berkeley, CA 94720

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"The often cited nuclear spin echo effect was discovered by accident because I happened to be the first to use radio frequency pulses of the right sort to look at nuclear magnetic resonance (NMR) signal transients. I learned about radar and sonar in the Navy during World War II, so I was inclined to fool around with pulse techniques when I carried out my physics thesis. later in NMR at the University of Illinois. My thesis did not reveal spin echoes however, but instead involved the measurement of NMR transient signals during the action of a driving pulse of radio-waves. The signal was seen only on the top of a pulse pedestal. My thesis problem was scooped by Henry Torrey at Rutgers who published the same experiment on nutations of the nuclear moment.[1] I stayed at Illinois as a one-year postdoctoral research associate to make better measurements with apparatus improved to give shorter, sharper, and more intense pulses.

"One day a strange signal appeared on the oscilloscope, in the absence of a pulse pedestal, so I kicked the apparatus and breathed a sigh of relief when the signal went away. A week later, the signal returned, and this time it checked out to be a real spontaneous spin echo nuclear signal from the test sample of protons in the glycerine being used. In about three weeks, I was able to predict mathematically what I suspected to be a constructive interference of precessing nuclear magnetism components by solving the Bloch nuclear induction equations. Here for the first time, a free precession signal in the absence of driving radiation was observed first, and predicted later. The spin echo began to yield information about the local atomic environment in terms of various amplitude and frequency memory beat effects, certainly not all understood in the beginning.

"As I look back at this experience, it was an awesome adventure to be alone with the apparatus showing one new effect after another at a time when there was no one at Illinois experienced in NMR with whom I could talk.

"Little did the early NMR resonance community realize that the analogue of spin echo hidden memory contained in excited phases of condensed matter, including plasmas, would be obtained today by use of optical laser, electric, and acoustic pulses as well."

1. Torrey H C. Transient nutations in nuclear magnetic resonance. *Phys. Rev.* **76**:1059-75, 1949