

UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN

# CHEM 233 Lecture 7

$^{13}\text{C}$  NMR Spectroscopy &  
Combining Spectroscopic Techniques

Spring 2014

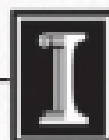


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# $^{13}\text{C}$ NMR

- Remember that the spin quantum number “I” is half-integral ( $\frac{1}{2}$ ,  $1\frac{1}{2}$ , etc.) if the atomic mass is odd. “I” is integral (0, 1, 2, etc.) if the atomic mass is even.
- Only  $I \neq 0$  nuclei are easily observable by NMR. Those with  $I = \frac{1}{2}$  give simplest NMR spectra.

$^1\text{H}$ has	1 proton	0 neutrons	$I = \frac{1}{2}$
$^{12}\text{C}$ has	6 protons	6 neutrons	$I = 0$
$^{13}\text{C}$ has	6 protons	7 neutrons	$I = \frac{1}{2}$



# Differences between $^1\text{H}$ and $^{13}\text{C}$ NMR

- $^{13}\text{C}$  is much less abundant than  $^{12}\text{C}$  (1% of total C in existence)
- $^{13}\text{C}$  NMR is therefore much less sensitive, takes longer to run than  $^1\text{H}$  NMR
  - $^1\text{H} > 99.9\%$  of all H atoms in existence
  - Thus much more protons per mole of molecules to detect than  $^{13}\text{C}$  atoms per mole of molecules
- $^{13}\text{C}$  nuclei resonate at a different frequency than  $^1\text{H}$ ; about 25% the frequency of  $^1\text{H}$ .
  - Scans performed in different, non-overlapping frequency ranges (for example, 75 MHz instead of 300 MHz)
  - Means that  $^1\text{H}$  and  $^{13}\text{C}$  NMR signals do not interfere with each other at all
    - Can always gather both sets of data for a given compound containing both C & H.

