nanalysis

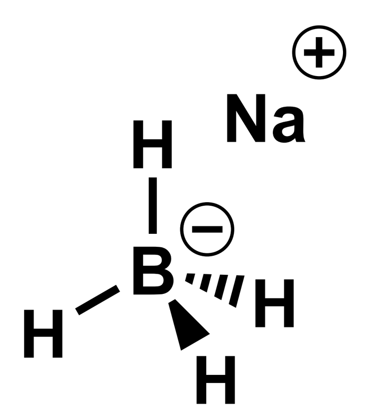
Determining Isotopic Ratio by Benchtop NMR: ^{10}B *vs* ^{11}B

^{5}B
Boron
10.81

In NMR, some nuclei have more than one NMR active isotope. ^{11}B (boron-11) and ^{10}B (boron-10) are the two stable isotopes of boron which are both NMR active. The ^{1}H NMR spectrum of sodium borohydride can be used indirectly to observe both nuclei in a single spectrum through their coupling to proton. The relative percentages of each isotope can be calculated from integrations. The spectrum shows a quartet (for $Na^{11}BH_4$) and septet (for $Na^{10}BH_4$). In the presence of a boron atom, more electropositive compared to a typical methyl carbon, the protons are shielded and appear at a lower frequency at about δ = 0.03 ppm in D_2O. The spectrum shows that the experimentally determined ratio of 81.2 : 18.8 corresponds quite well to the known ratio of 80.1 : 19.9. Determining isotopic ratios of different nuclei demonstrates one of the uses of NMR beyond structural characterization.

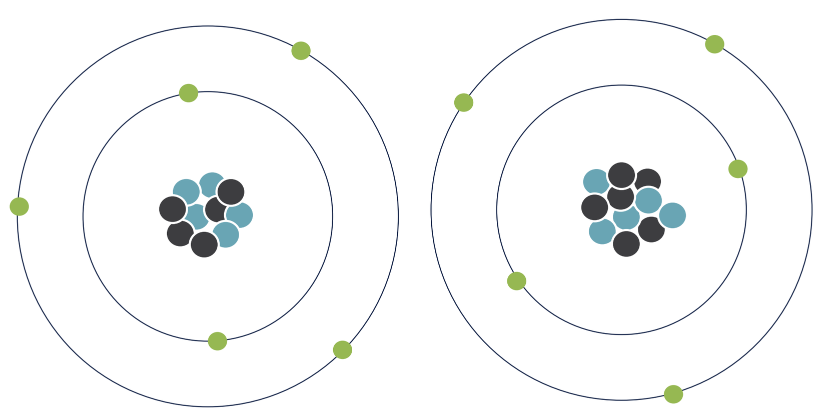
$2nI + 1$

Splitting and multiplicity rule
where ***n*** is the number of coupled nuclei, and ***I*** is their nuclear spin



Nuclei	Nuclear Spin, *I*	Natural Abundance	NMR Active
^{10}B	3	19.9%	✓
^{11}B	3/2	80.1%	✓

- Protons
- Neutrons
- Electrons



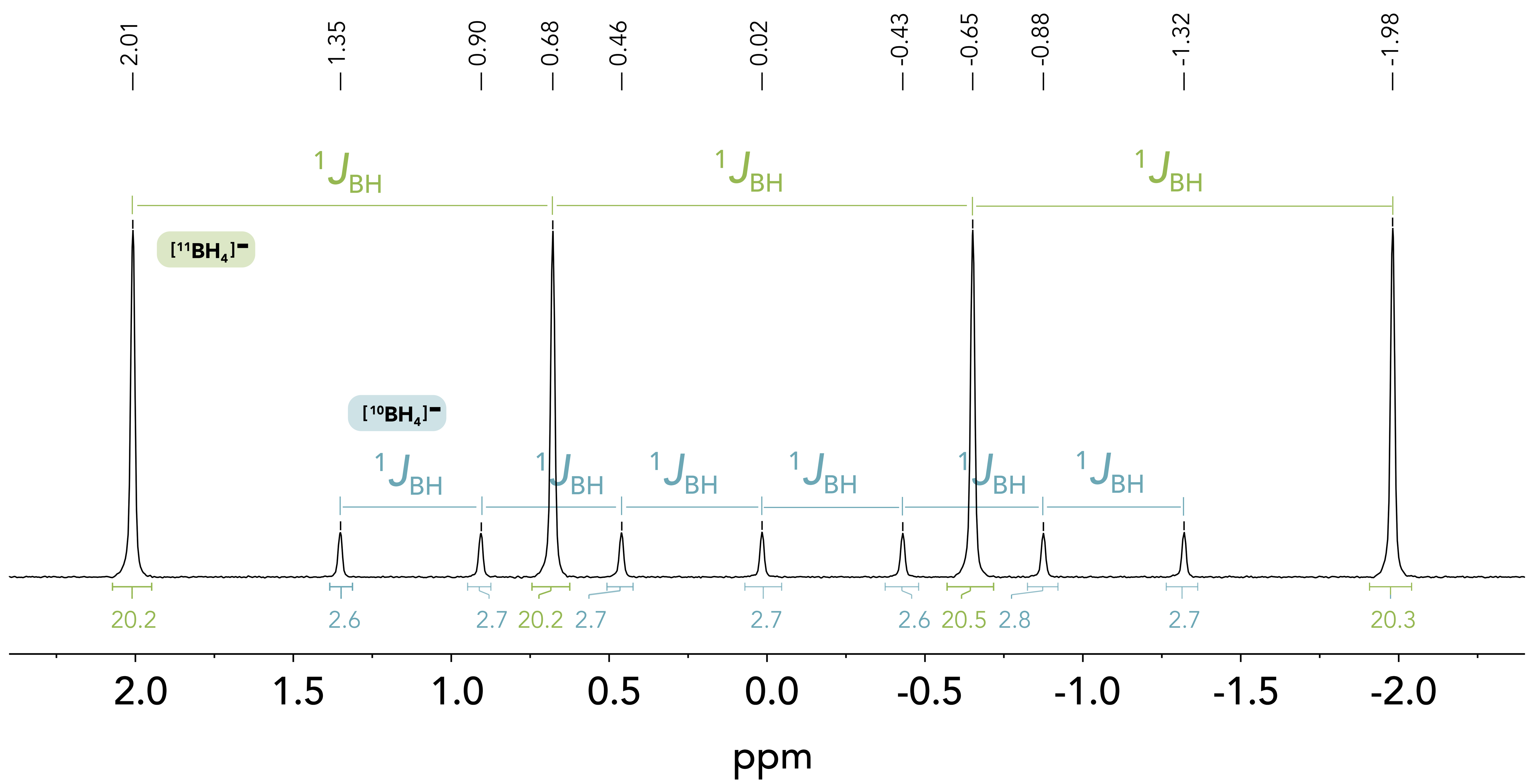
$[^{10}BH_4]^-$ $[^{11}BH_4]^-$

Quadrupolar nuclei
have a nuclear spin greater than ½

Sodium borohydride

^{1}H NMR
(60 MHz, D_2O)

^{10}B	^{11}B
septet	*quartet*
1:1:1:1:1:1:1	1:1:1:1
($^{1}J_{BH}$ = 27.0 Hz)	($^{1}J_{BH}$ = 80.6 Hz)



Read more about the isotopic ratio of boron through benchtop NMR here:
https://www.nanalysis.com/nmready-blog/2021/11/2/eat-your-heart-out-mass-spec-measuring-10b11b-isotopic-ratio-by-nmr-spectroscopy
https://www.quantanalitica.com/wp-content/uploads/2021/06/NMR_B-isotopes_ENG.pdf