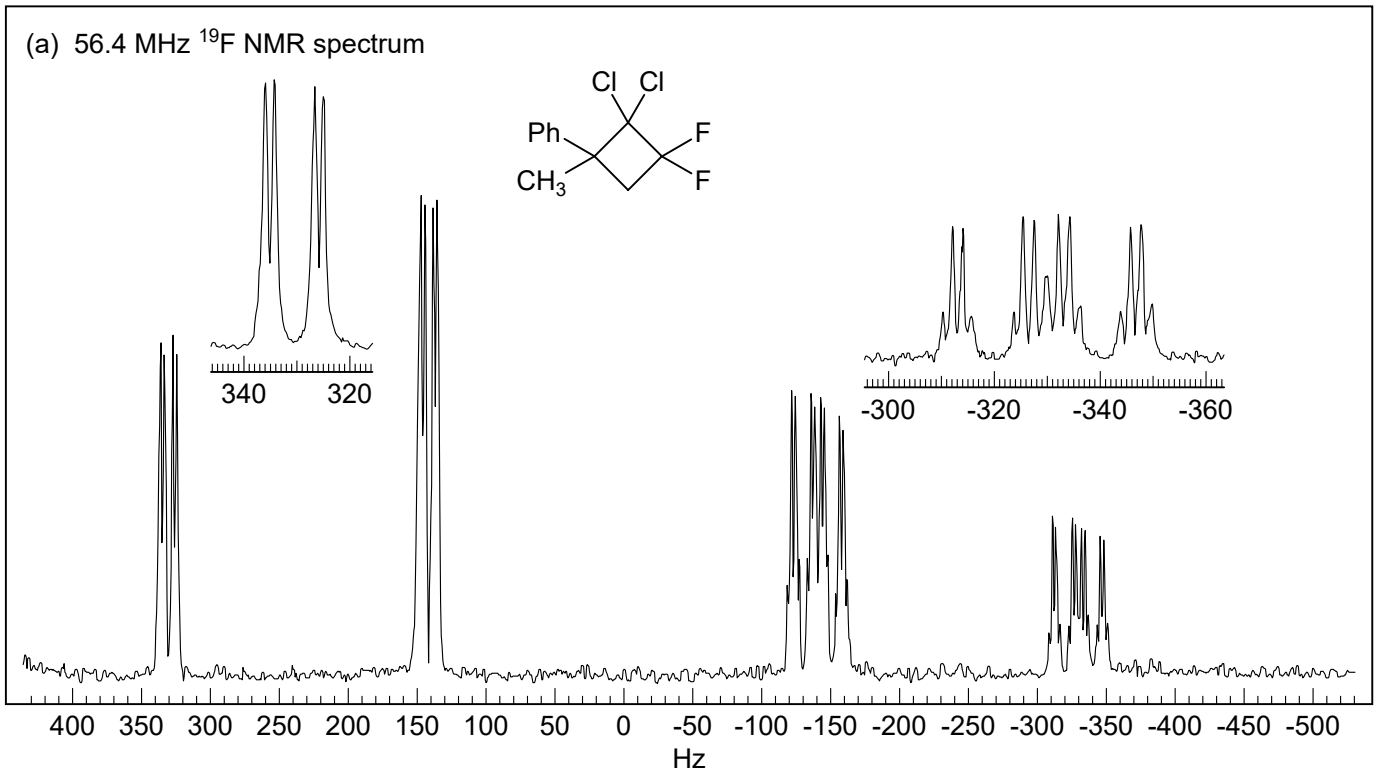
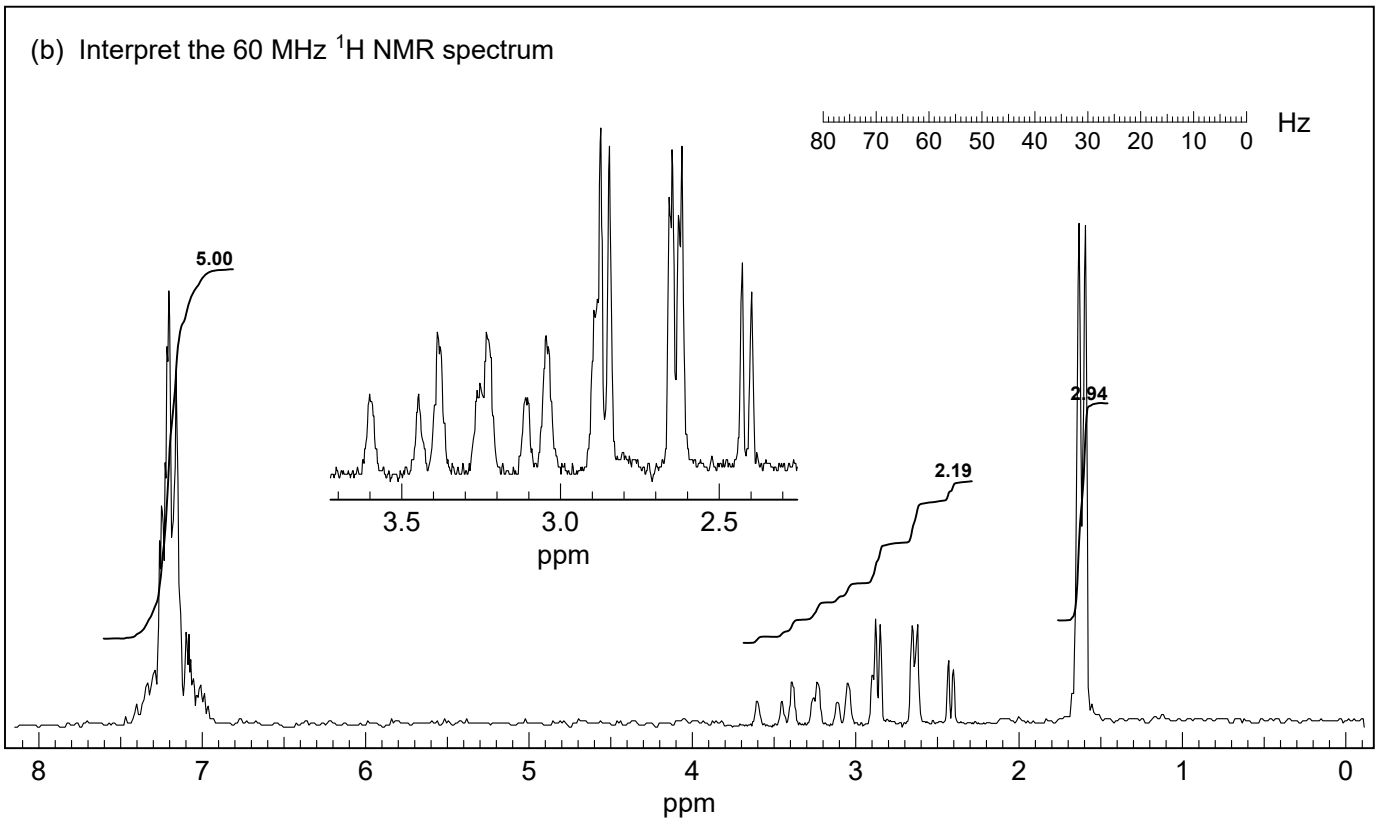
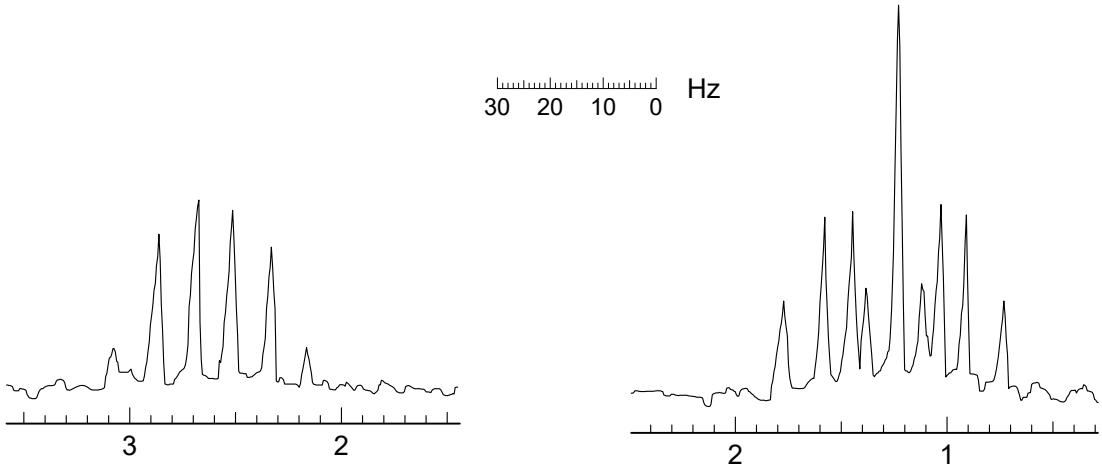
Problem R-310 ($C_{11}H_{10}Cl_2F_2$). Interpret the 56.4 MHz ^{19}F NMR spectrum and 60 MHz ^{1}H NMR spectrum below (CCl_4 solvent). Determine the chemical shifts of the fluorines, and estimate the various coupling constants. Consider conformations of the cyclobutane ring (*J. Am. Chem. Soc.* **1962**, *84*, 2935).

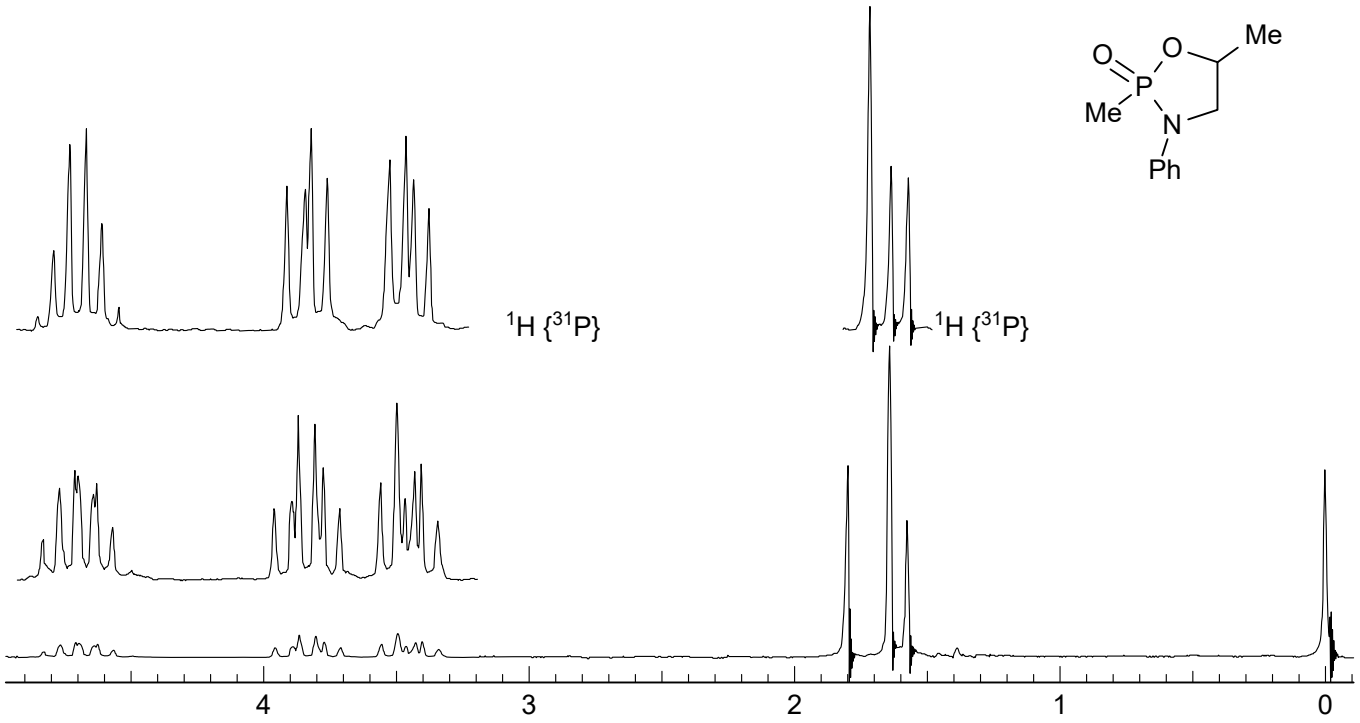




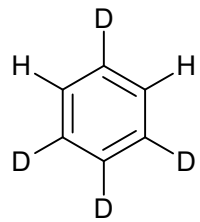
Problem R-308 (C_8H_{10}). Below is the ^3H NMR spectrum of the ethyl region of randomly tritium (^3H) labeled ethylbenzene. Interpret the splitting pattern. Note: <1% of the molecules are labeled (Tiers,G. V. D.; Brown, C. A.; Jackson, R. A.; Lahr, T. N. J. Am. Chem. Soc. 1964, 86, 2526-7).

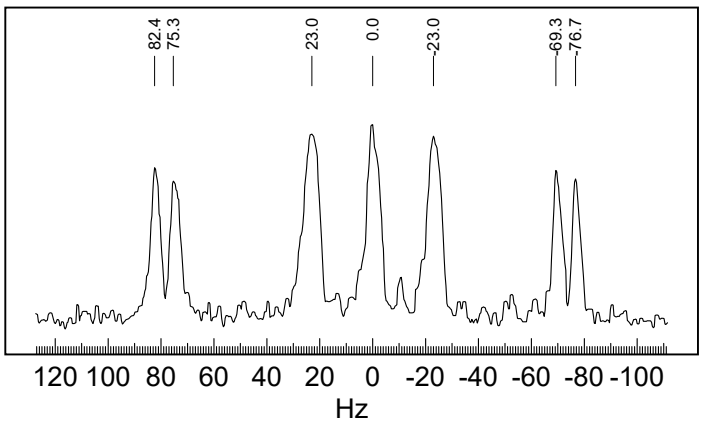


Problem R-309 ($C_9H_{14}NOP$). Interpret the 100 MHz ^1H NMR spectrum below. The phenyl region is not shown. $\{^{31}P\}$ signifies decoupling of the phosphorus signal (*Org. Magn. Res.*. **1980**, *13*, 165)

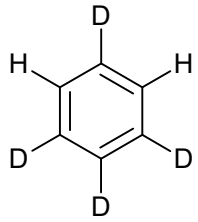


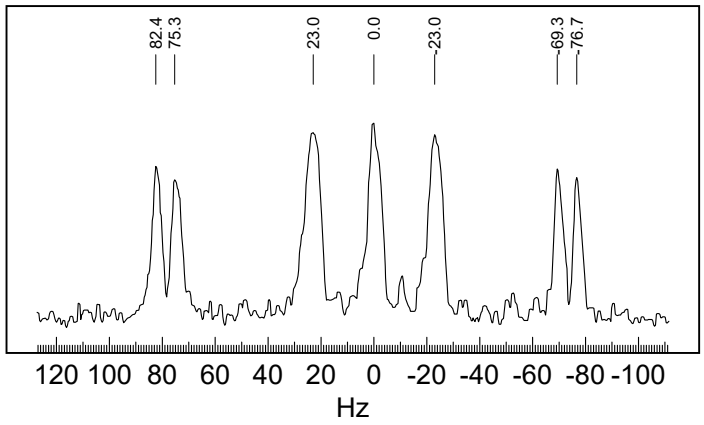
Problem R-311 ($C_6H_3D_3$). Assign the peaks in the ^{13}C NMR spectrum below. The spectrum is not ^1H decoupled. Estimate the coupling constants (*J. Am. Chem. Soc.* **1967**, *88*, 2967).





Problem R-311 ($C_6H_2D_4$). Assign the peaks in the ^{13}C NMR spectrum below. The spectrum is not ^{1}H decoupled. Estimate the coupling constants (*J. Am. Chem. Soc.* **1967**, *88*, 2967).





Problem R-82E ($C_{16}H_{30}Sn$). Consider carefully the ^{1}H NMR spectrum of R-82E shown on the next page (the compound contains a tri-n-butyltin group, tin is tetravalent).

(a) DBE?_____ What is the structure of R-82E?

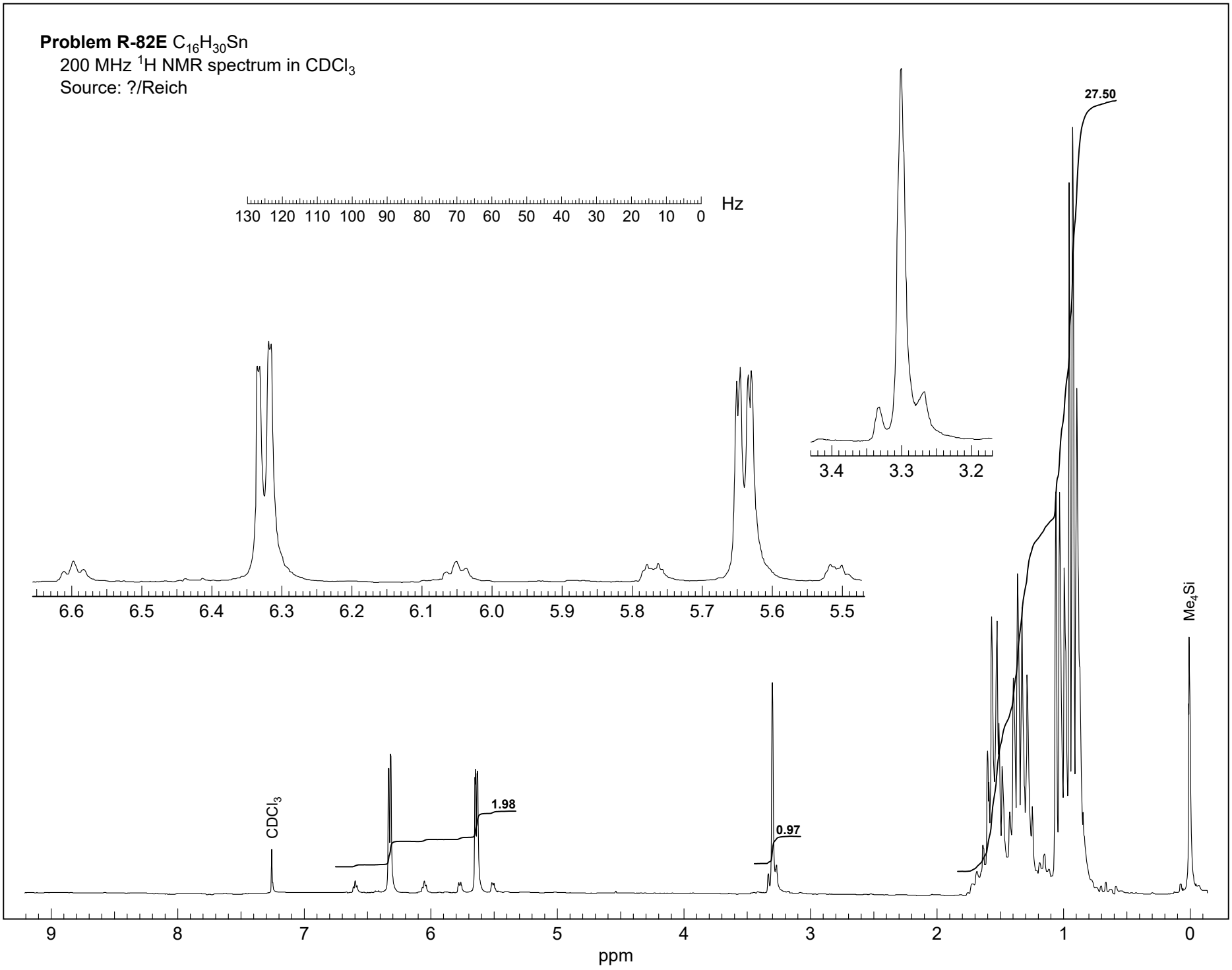
(b) Explain the origin and shape of the multiplets at δ 6.05 and 6.6.

(c) Determine (approximately) <u>all</u> coupling constants that can be obtained from the spectrum. Identify them in the form $^{4}J_{XY}$ = Z Hz. Label your structure so that it is clear which atom you are referring to.

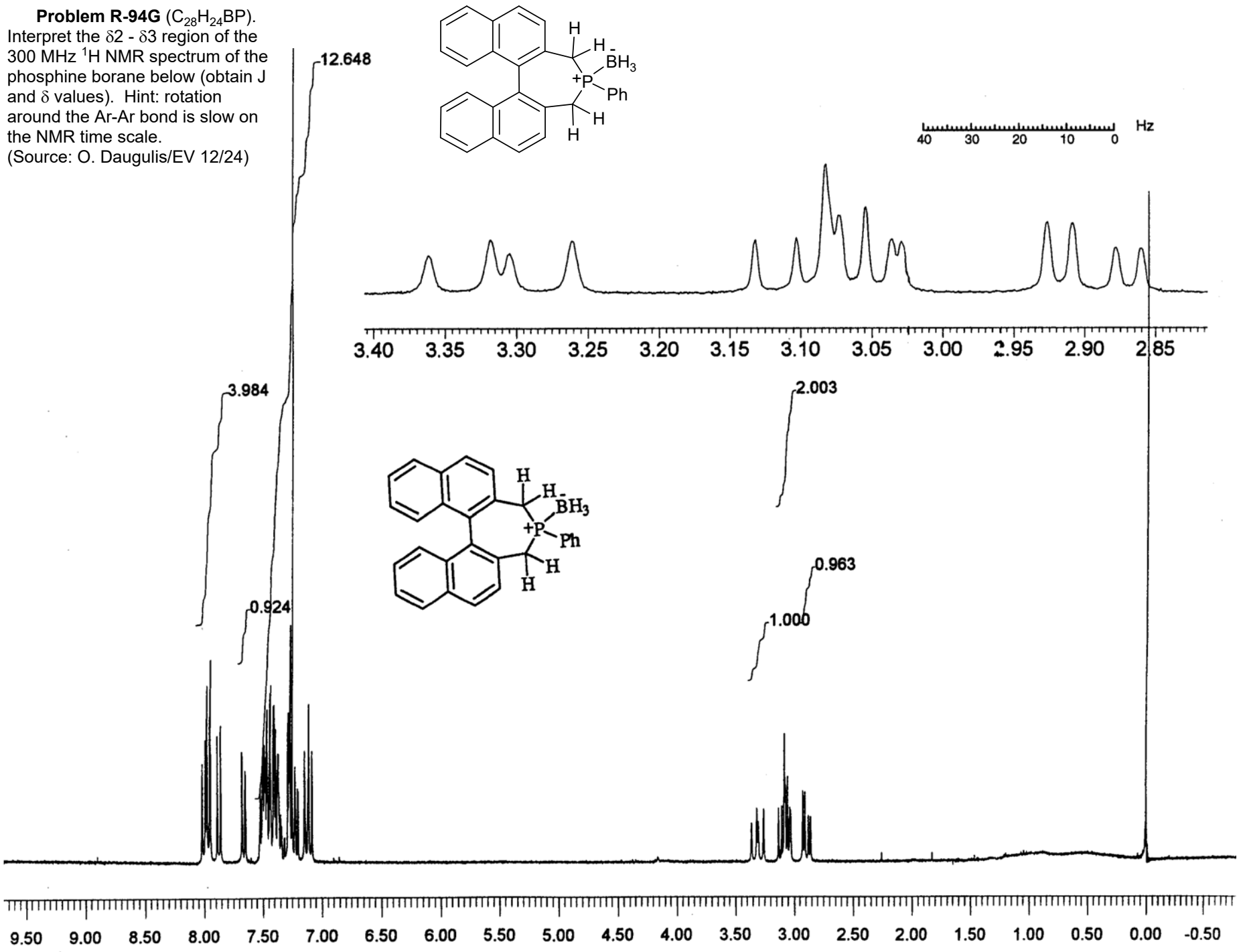
Problem R-82E $C_{16}H_{30}Sn$

200 MHz ^1H NMR spectrum in $CDCl_3$

Source: ?/Reich



Problem R-94G ($C_{28}H_{24}BP$). Interpret the $\delta 2$ - $\delta 3$ region of the 300 MHz ^1H NMR spectrum of the phosphine borane below (obtain J and δ values). Hint: rotation around the Ar-Ar bond is slow on the NMR time scale.
(Source: O. Daugulis/EV 12/24)



Problem R-28D ($C_{13}H_{14}O_2$)
500 MHz ^{1}H NMR in $CDCl_3$
Source: Wilds/C. Fry (C82)

Assign all protons in this molecule, using the 500 MHz ^{1}H NMR spectrum, and the 300 MHz COSY spectrum. The 300 MHz ^{1}H spectrum is also provided. Explain specifically why some of the peaks are more complicated in the 300 compared to the 500 MHz spectrum. Draw a conformation, and label with chemical shifts.