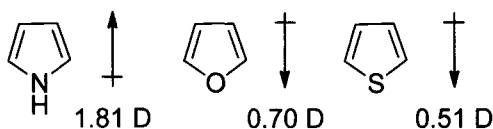
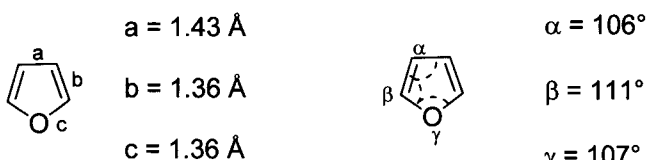


Furan has a dipole moment of 0.70 D, while thiophene has a dipole moment of 0.51 D. The dipole moments of furan and thiophene are in the opposite direction of pyrrole due largely to the relatively strong inductive effect caused by the oxygen and sulfur in relation to weaker resonance effects. In the case of pyrrole, as described in Chapter 2, the resonance hybrids of the molecule result in the inversion of the dipole.



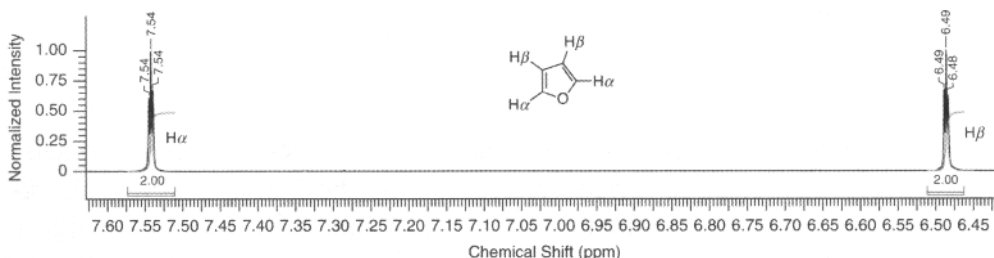
Dipole Moments of Pyrrole, Furan, and Thiophene

Furan is a planar aromatic compound with bond angles and lengths that are affected by the atomic radius of the oxygen atom. This is evidenced by observing the length of the C–O bonds and the slightly exaggerated bond angle.



Bond Lengths and Angles of Furan

The $^1\text{H-NMR}$ of furan has two distinct peaks corresponding to the two separate sets of nonequivalent hydrogens in the ring system. The two α -protons (adjacent to the oxygen) are deshielded by the inductive effect of the oxygen atom and can be found at 7.54 ppm. The two β -protons are further upfield (effectively less deshielded than their α -proton neighbors) at 6.49 ppm.



Predictably, the $^{13}\text{C-NMR}$ of furan shows two signals. As expected, the α -carbons are located further downfield (142.5 ppm) due to the inductive