**Aromaticity**: 4n+2 rule applies to completely conjugated monocyclic compounds

1. nmr evidence – shift due to extra field caused by diamagnetic ring current

2. aromatic system has induced ring current in a magnetic field, neither double or single bond lengths



3. nuclei outside ring shifted downfield, inside or above shift upfield



4. structural identity – n =1, sextet of electrons in ring

5. 6 membered rings - benzene, pyridine and fused six membered rings, naphthalene (6 and 4)

6. 5-membered rings - pyrrole, thiophene, furan, cyclopentadienide anion, pyrrole better base than pyridine?



7. tropylium versus cycloheptatrienide



8. equivalent bonds in cyclopentadienide anion and tropylium

9. cyclopentadienone unstable, tropone stable (properties)



10. pentalene (5 and 5) and heptalene (7 and 7) are unstable

11. azulene (5 and 7) and pentalene dianion are stable

**Alternate and nonalternate hydrocarbons**



1. even alternate- equal numbered starred and unstarred, # antibonding = # bonding, no non-bonding, orbital energies symmetrically displaced about 0 energy (), build energy diagram

2. odd alternate - # antibonding = # bonding plus non-bonding, orbital energies symmetrically displaced about 0 energy

3. nonalternate - energies not equal and opposite (pentalene)

**annulenes** - contiguous p orbitals in cyclic structure

1. 2 e: cyclopropenyl cation, cylcobutadienyl dication



2. 4 e: cyclobutadiene, unconjugated, only stable if hindered sterically or substituted with ewg/edg, 3 *t*-butyl groups

cyclopropene less acidic than cyclopropane, cyclopentadienyl cation is unstable

3. 8e:cyclooctatetraene - non planar

4. 10e: [10] annulene has angle strain and unstable, cyclooctatetraene dianion is stable

5. >10e?: dehydro[14]annulene, [18]annulene: protons at 9 and -3 ppm



**Homoaromatic** - sp3 carbon intervenes unsaturated carbons



homotropylium ion, diamagnetic ring current: -0.3 and 5.1 ppm for methylene protons