1) ^{18}F has 2 nucleons in sd shell ($2s_{1/2}$, $d_{3/2}$, $d_{5/2}$) $\rightarrow$

Consider ψ_{space}

s	s

a) Using the A=6 argument (page 10, Lecture 13):

What (S, T) are possible? What $(J^\pi; T)$ in ^{18}F can you explain?

2 antisym nucleons: $(S; T) = (1; 0), (0; 1) \Rightarrow$

$J^\pi; T = 0^+; 1$ and $1^+; 0$ only, like the deuteron

Consider another symmetric configuration for ψ_{space}

s	d

b) What is the only possible total L (by inspection)? $|\vec{2} \pm \vec{0}|=2$

What $J^\pi; T = 1$? $2^+; T = 1$ (8th excited state)

(i.e. $\vec{J} = \vec{L} + \vec{S} = \vec{L} + \vec{0} = \vec{L} \Rightarrow$ for T=1, J=L only!)

What $J^\pi; T = 0$? $|\vec{2} \pm \vec{1}| \Rightarrow J^\pi = 1, 2, 3; T = 0$

Consider ψ_{space}

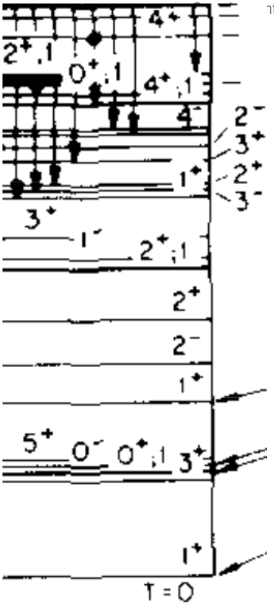
d	d

Only even L's are symmetric on the M-scheme table (next page).

c) Using only the even-numbered L's, what T=1 states do you predict this way (note they are all clustered together)? T=0?

$J^\pi = 0^+, 2^+, 4^+; T = 1$ and $J^\pi = 1^+, 2^+, 3^+, 4^+, 5^+; T = 0$

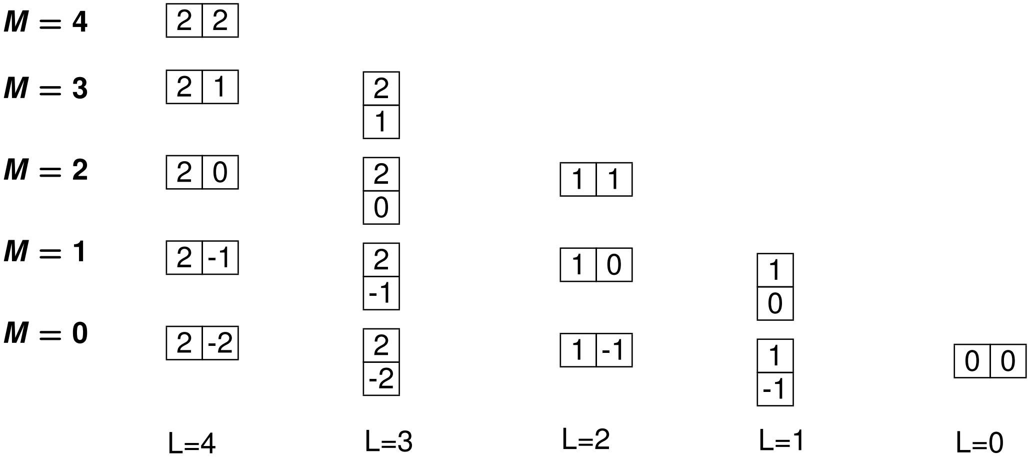
These account for all the $\pi = +$ states in the level diagram ☺



$^{18}_{9}$F$_9$

(The $\pi = -$ states include excitations from the 1p shell) **Only 'antisymmetric for 2 particles' (S,T)= (1,0) and (0,1) are allowed for the symmetric space configurations considered. Some states from naive jj coupling (notably T=1 J odd) are not seen– they don't have symmetric space configuration under permutation, so are expected to lie at much higher excitation.**

an M-scheme table for dd configuration (used on previous page) **HowTo $\rightarrow$**



The goal of an M-scheme table is to assign permutation symmetry to each possible value of L. (I left this implicit.) Here is how to make them (easier with a blackboard or a pencil):

• Write all the possible combinations of *m*'s that add up to a given *M*, with all allowed symmetries under permutation following the Young diagram rules.
(When I line them up in a nice table? I'm ignoring the actual work:)

• Grouping them by permutation symmetry, assign them to an *L*. (There is likely a formal proof that all configurations for a given L must have the same permutation symmetry– it seems plausible.) Handy tricks:
(Ignore negative *M*– these are obvious from nonnegative *M* and don't add info.)

First consider "the stretched state is always symmetric" and assign the max ℓ symmetric configuration to *L* = max *M*. Find the rest of the *M*'s needed, with same symmetry, to account for that max *L*. (Then I line them up in the nice table– traditionally one just crosses them off on a blackboard).

Continue to gather all the *M*'s one needs for each *L*, all with given permutation symmetry. The rest usually shake down from there.
One gets an orphan single M=0 state that one assigns to L=0.

This is just a plausibility argument. There is likely a formal proof that this procedure gives you the correct permutation symmetry for each L.