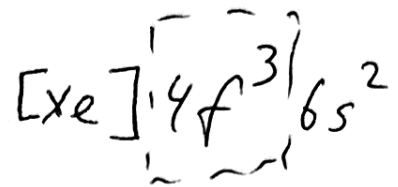


2.2  $L = \sum l_i$  is maximized (subject to 2.1)

Example: Pr 4f shell



$$m_2 = \begin{matrix} - & - & - & - & \frac{1}{1} & \frac{1}{2} & \frac{1}{3} \end{matrix} \quad \begin{matrix} \sum l_i = 6 \\ \sum s_i = \frac{3}{2} \end{matrix}$$

### 2.3 Relative alignment of $\vec{L}$ and $\vec{S}$

either  $\vec{L} \parallel \vec{S}$  or  $-\vec{L} \parallel \vec{S}$

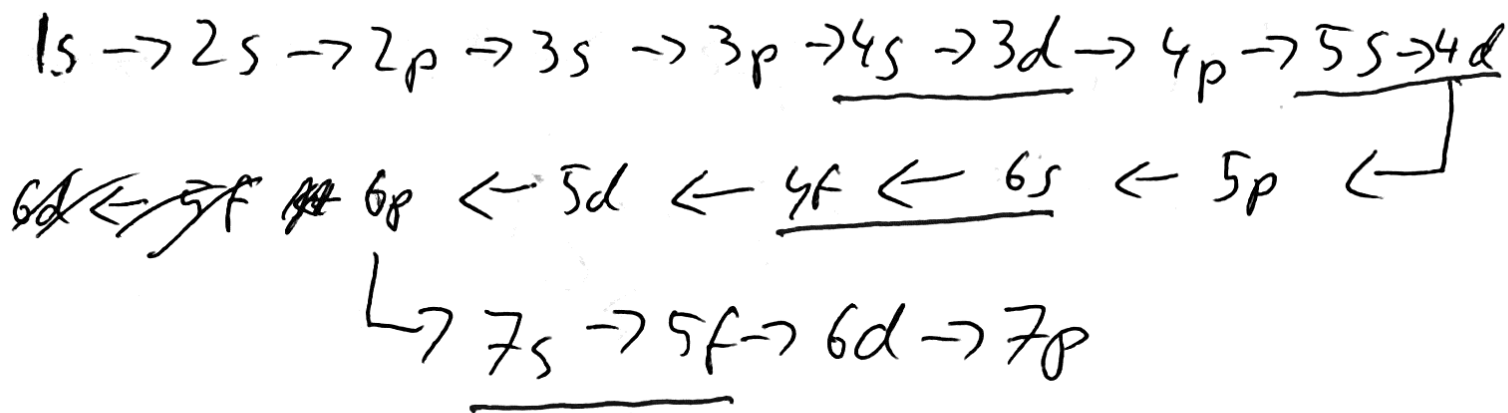
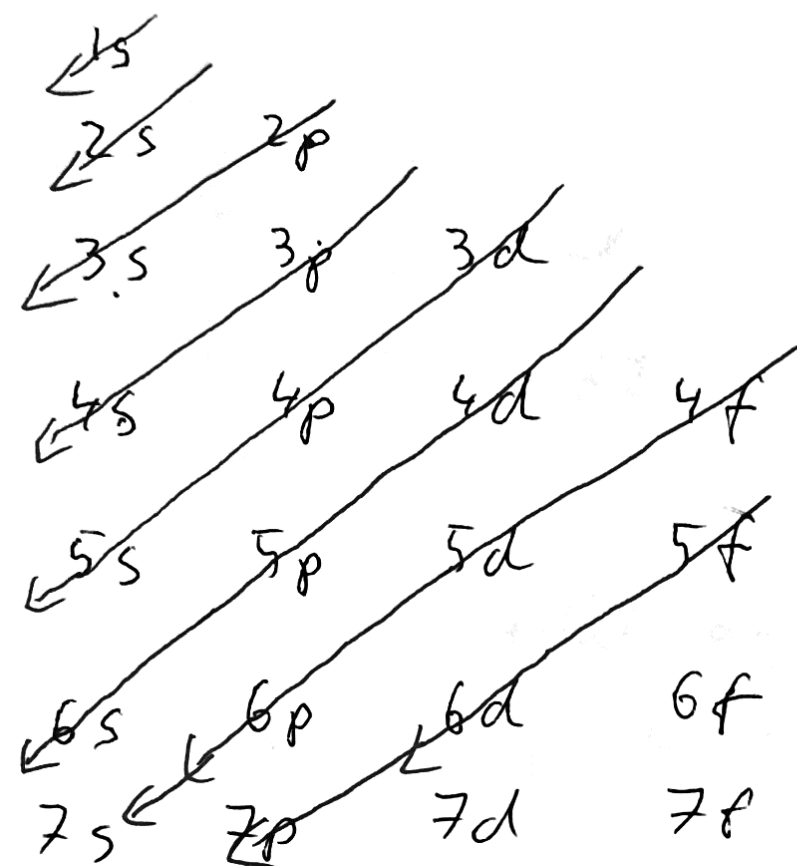
$|J| = |L| \pm |S|$   
 $\nwarrow$  more than half full  
 $\nearrow$  less than half full

(driven by spin-orbit coupling)

Example :

$P_r: J = L - S = \frac{9}{2}$

# Order of orbitals



Example: Sodium

7 3s

7 7 7 2p

7 2s

7 1s



# Spectroscopic notation for atoms

$$2S+1$$

$\begin{matrix} L \\ \text{---} \\ J \end{matrix}$

total spin  $S = \sum s_i$

total orbital angular momentum

$$L = \sum l_i$$

$$L = \begin{matrix} 0 & 1 & 2 \\ \downarrow & \downarrow & \downarrow \\ S & P & D \end{matrix}$$

total angular momentum

$$|J| = |S \pm L|$$

Example: Sodium  $S = \frac{1}{2}$ ,  $L = 0$ ,  $J = \frac{1}{2}$

$$^2S_{\frac{1}{2}}$$

Example: Manganese



in reality:  $[\text{Ar}] 3d^5 4s^2$

Group Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be												6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
			57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb		
			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No		