Welcome to 3.091

Lecture 10

September 30, 2009

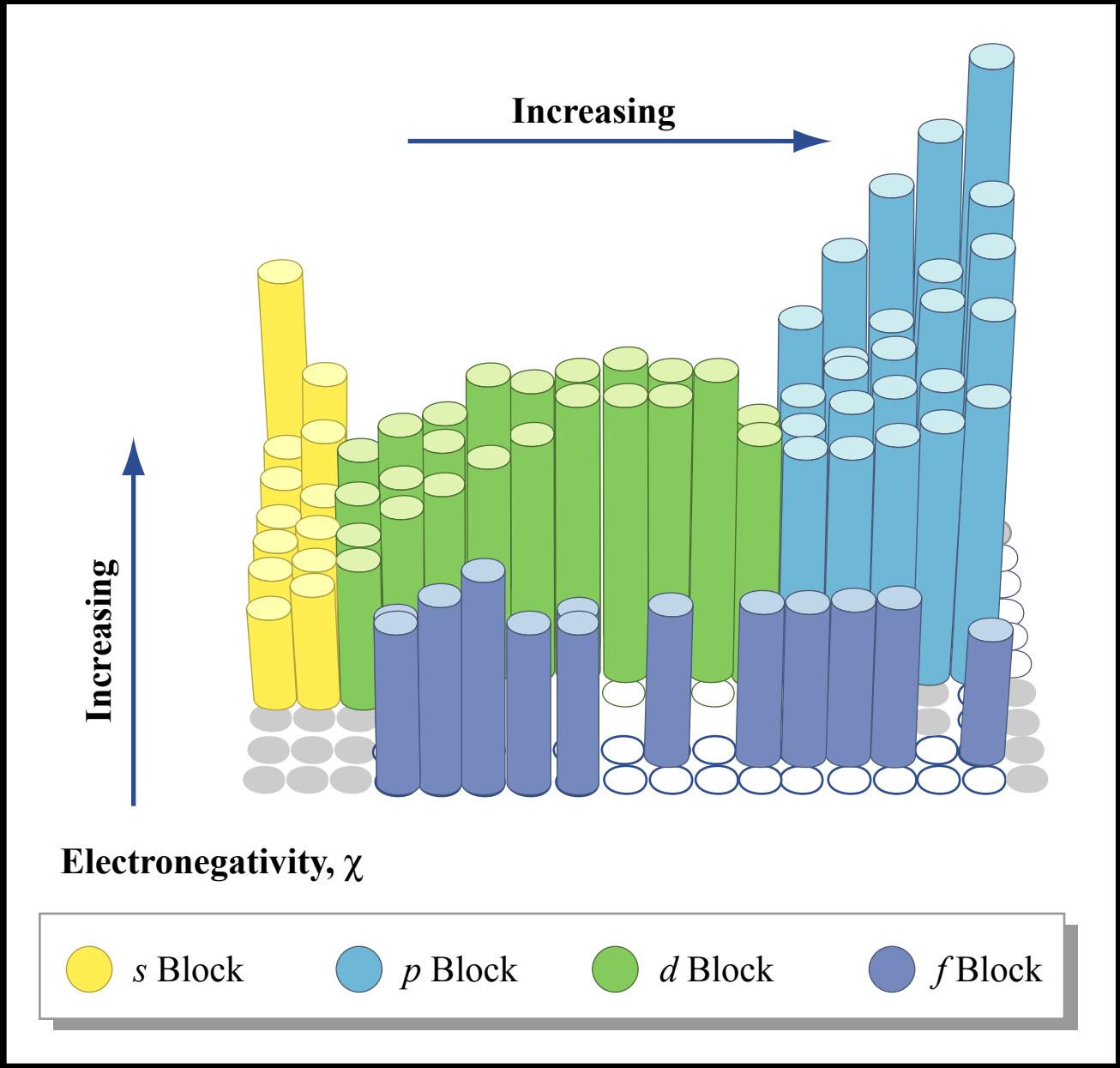
Hybridized & Molecular Orbitals; Paramagnetism

3.091 Test #1

Wednesday, October 7, 2009

Room Assignments

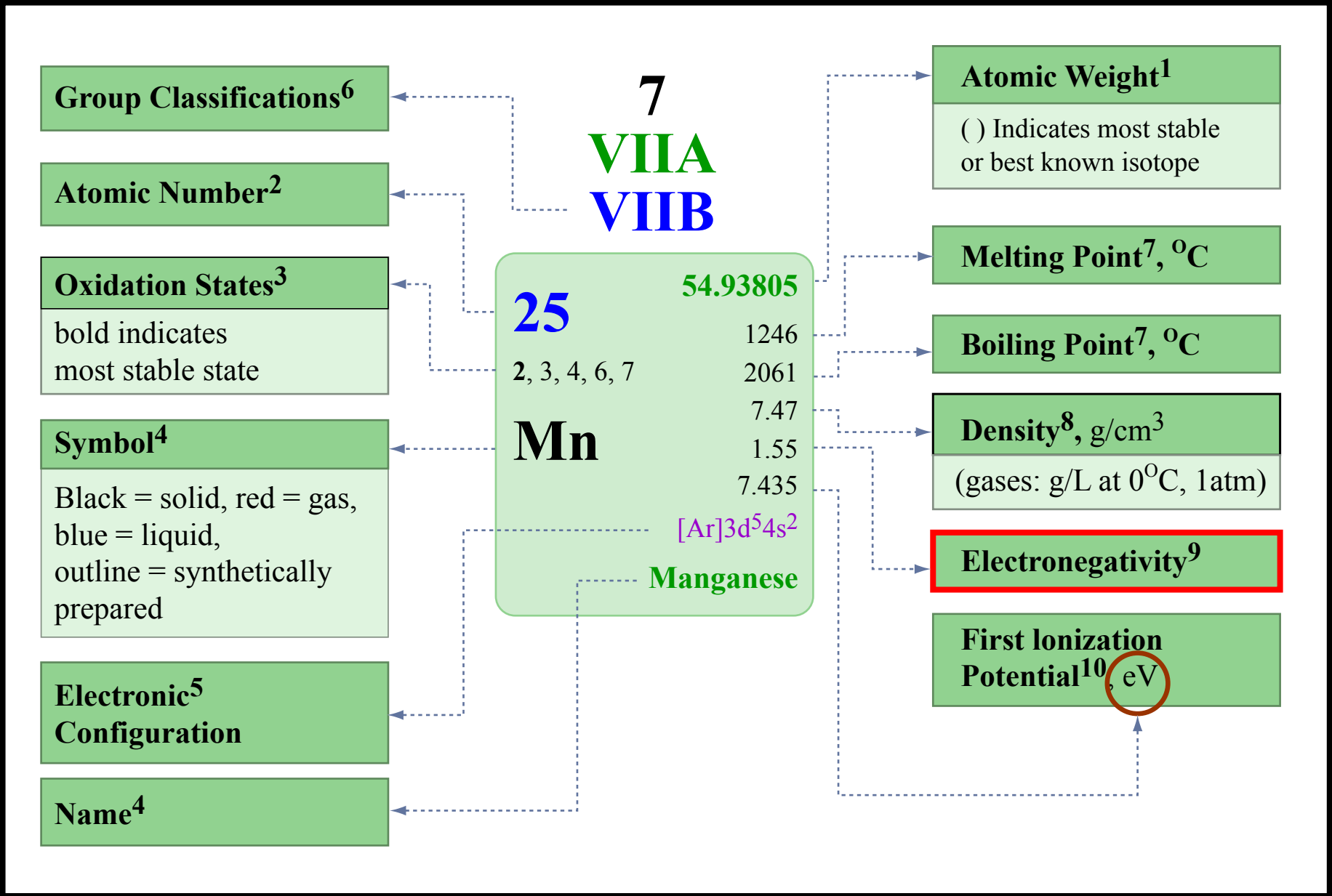
A – Ha:	10-250
He - Sm:	26-100
So - ∞:	4-270

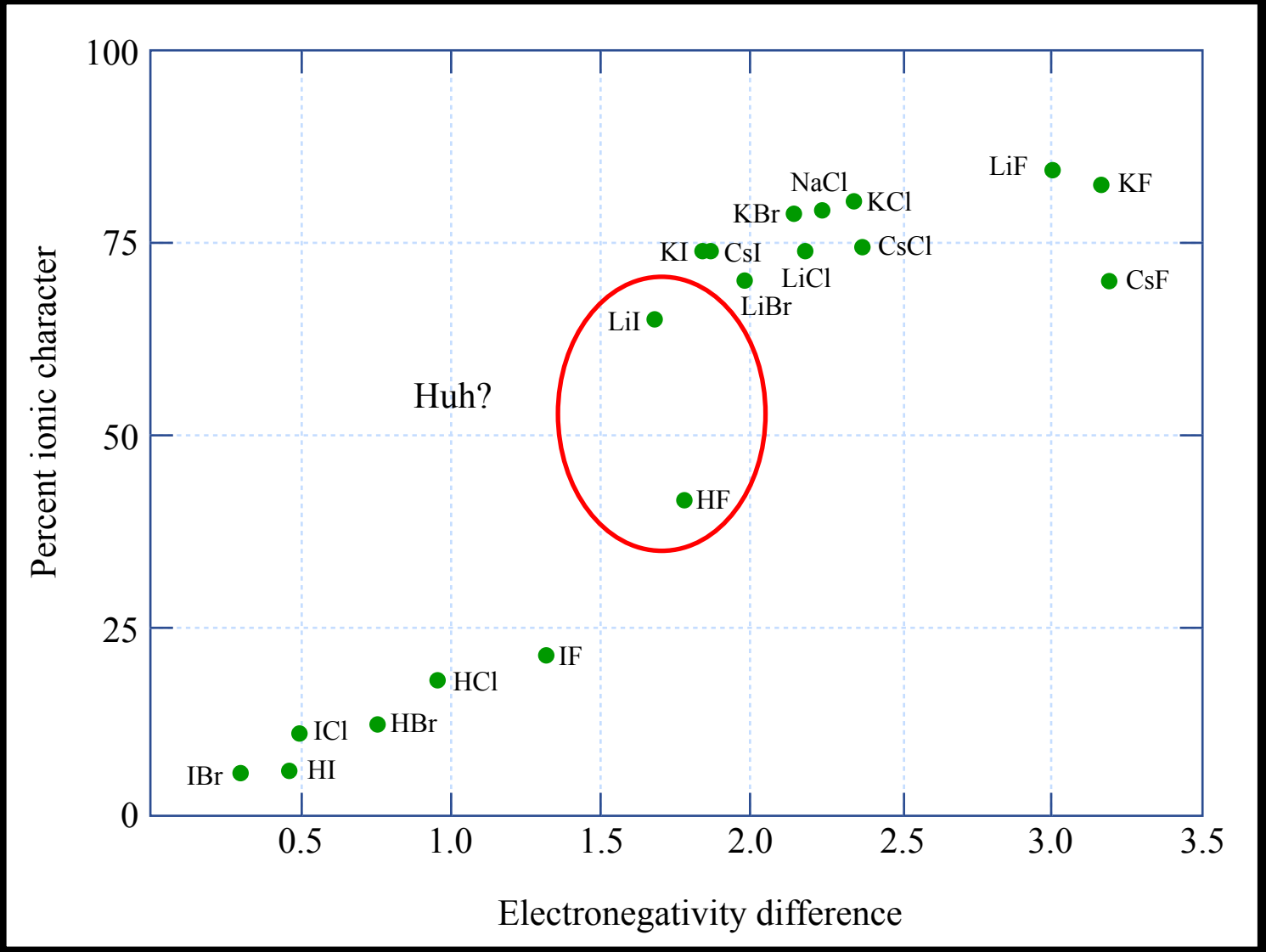


$$\% \text{ ionic character} = \left\{ 1 - \exp\left(-\frac{1}{4}(\Delta X)^2\right) \right\} \times 100$$

▼ % Ionic Character of a Single Chemical Bond

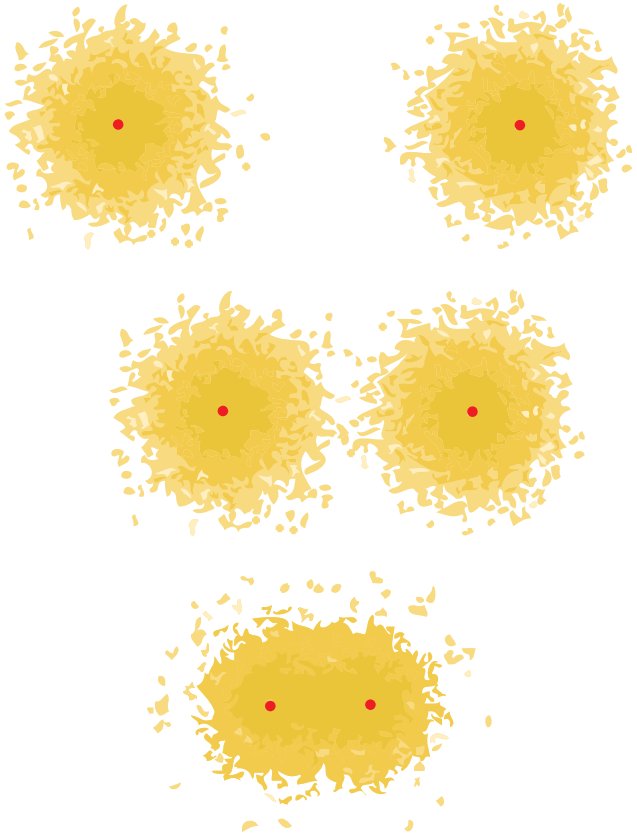
Difference in Electronegativity	%IC (by L. Pauling)	%IC (by Hannay & Smyth)
0.1	0.2	1.6
0.2	1.0	3.3
0.3	2.2	5.1
0.4	3.9	7.0
0.5	6.1	8.9
0.6	8.6	11
0.7	12	13
0.8	15	15
0.9	18	17
1.0	22	20
1.1	26	22
1.2	30	24
1.3	34	27
1.4	39	29
1.5	43	32
1.6	47	35
1.7	51	37
1.8	56	40
1.9	59	43
2.0	63	46
2.1	67	49
2.2	70	52
2.3	73	55
2.4	76	59
2.5	79	62
2.6	82	65
2.7	84	69
2.8	86	72
2.9	88	76
3.0	89	80
3.1	91	83
3.2	92	87



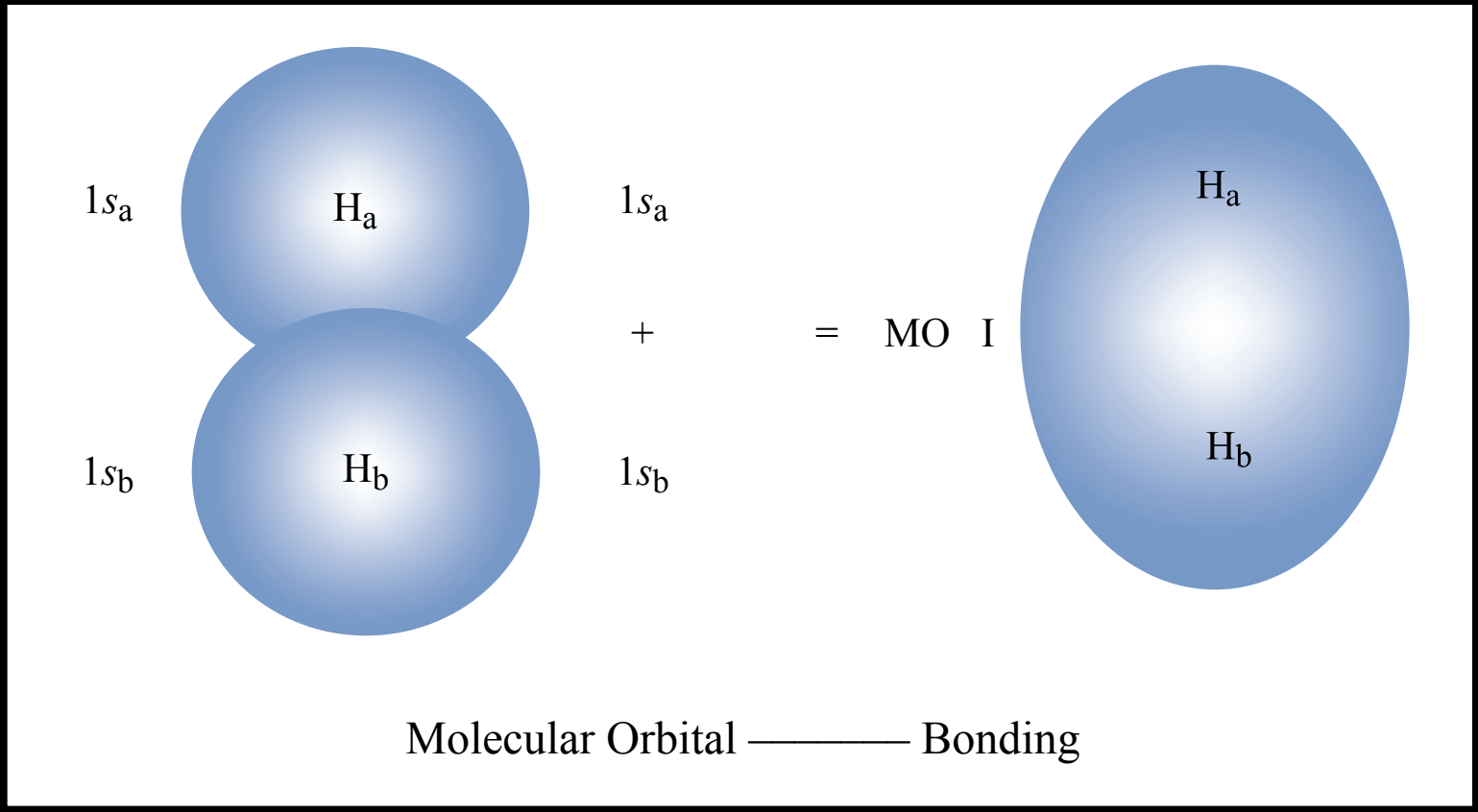


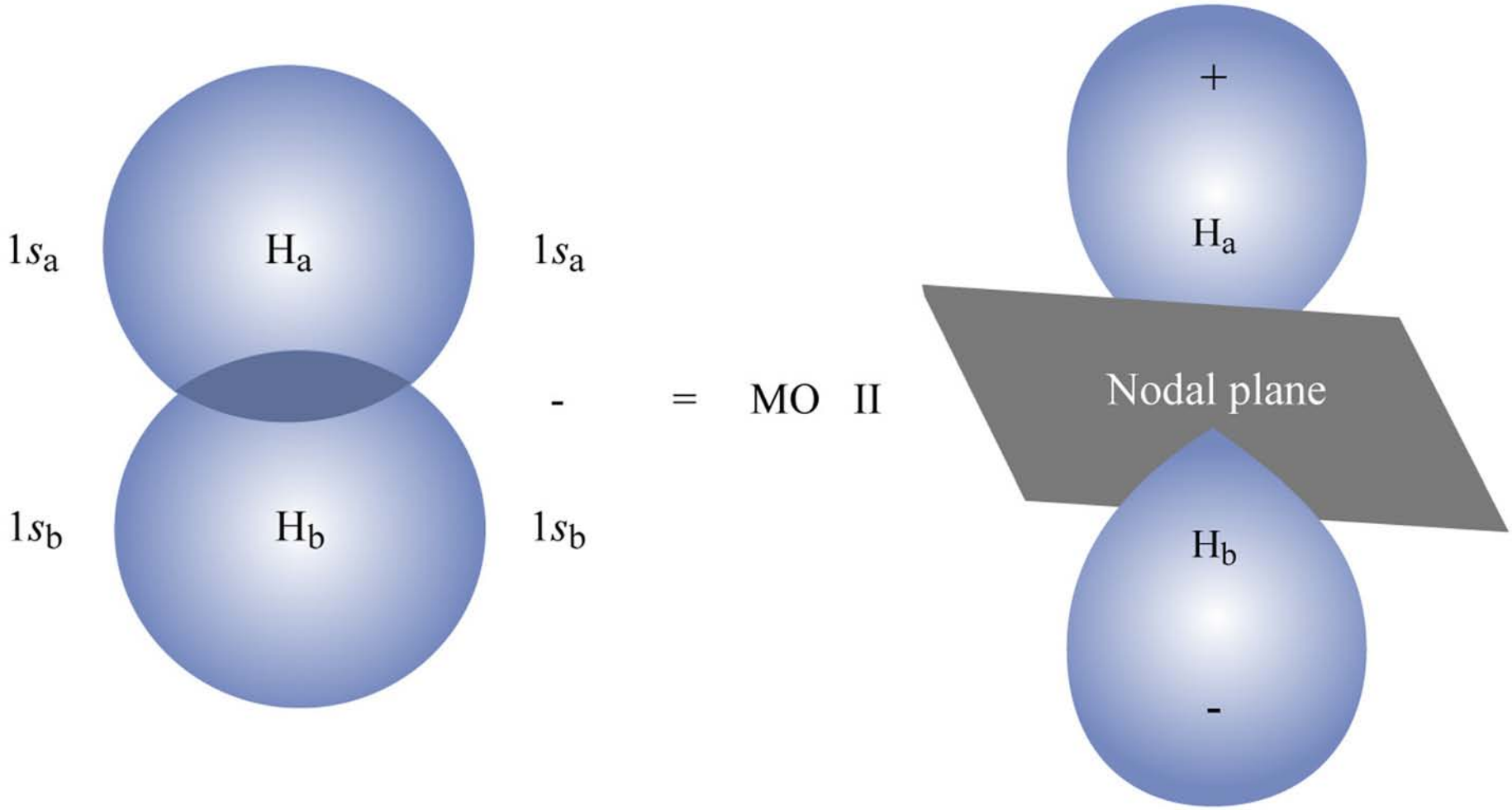
Electron-Pair Bond

H 1s H 1s

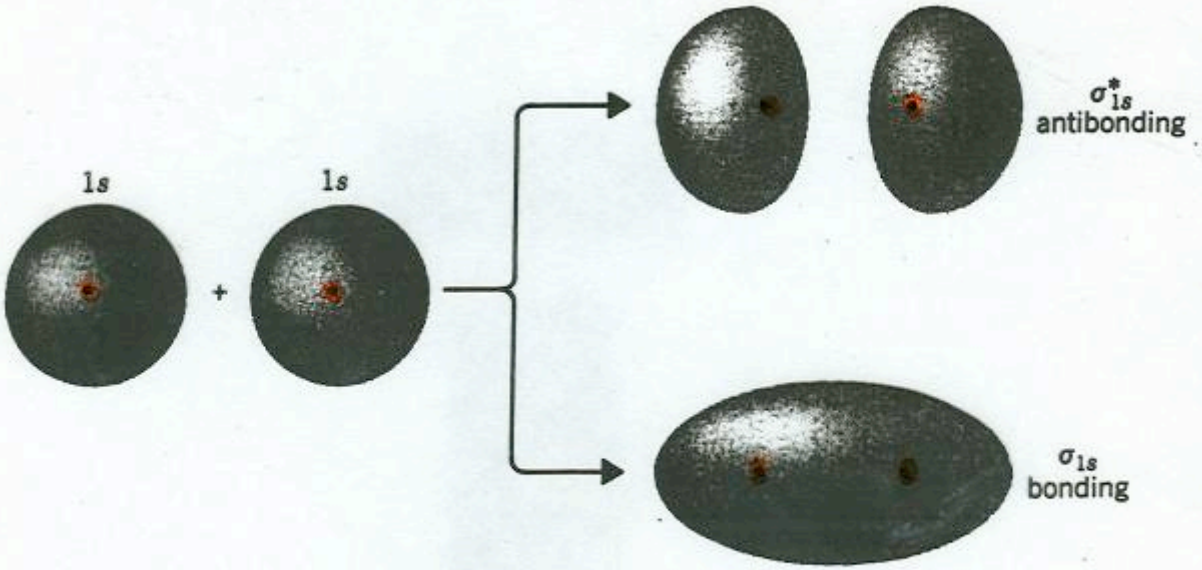


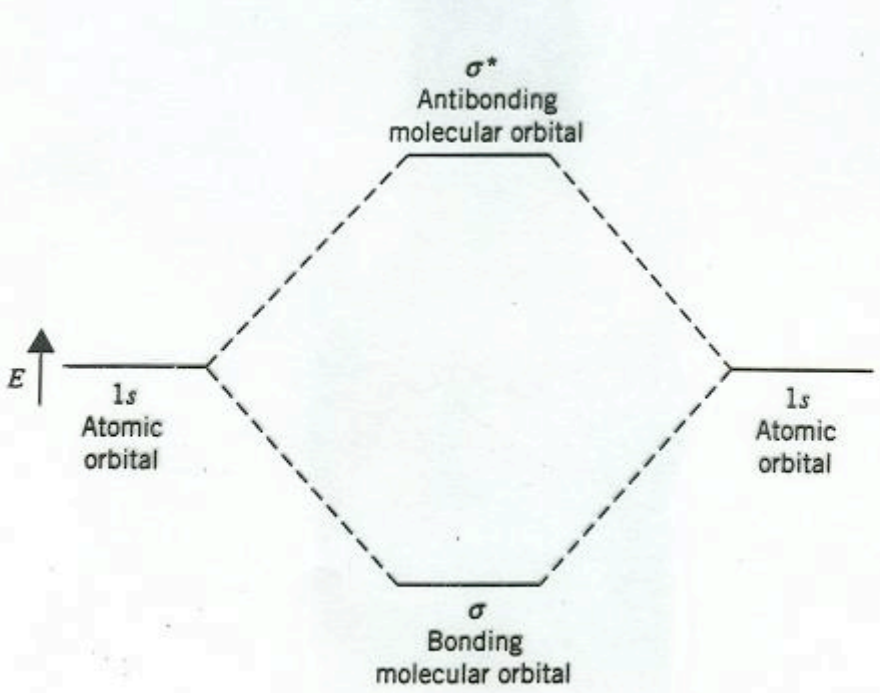
H_2



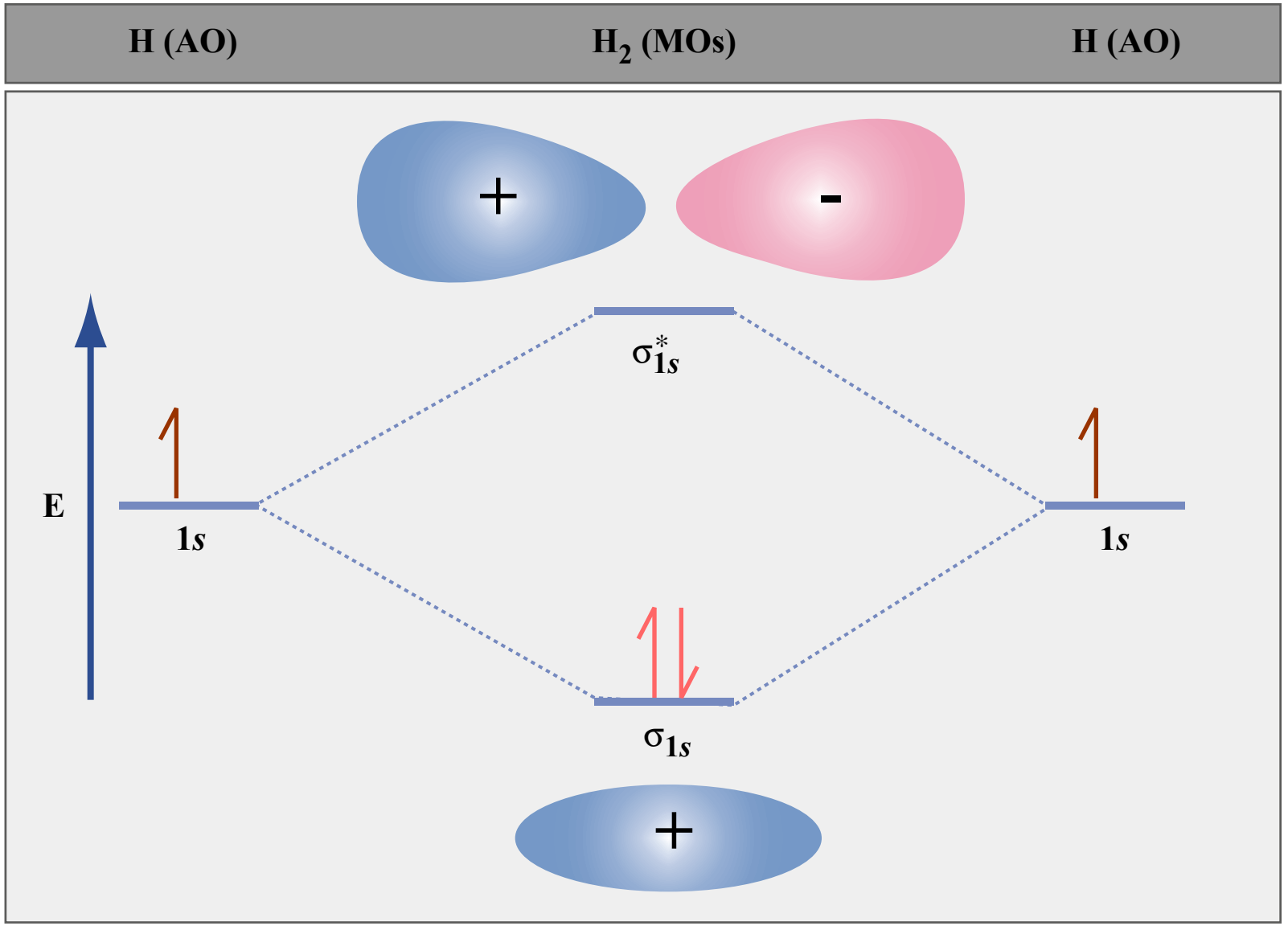


Molecular Orbital ——— Antibonding





Source: Spencer, J. N., G. M. Bodner, and L. H. Rickard. *Chemistry: Structure and Dynamics*. 2nd edition. New York, NY: John Wiley & Sons, 2003.



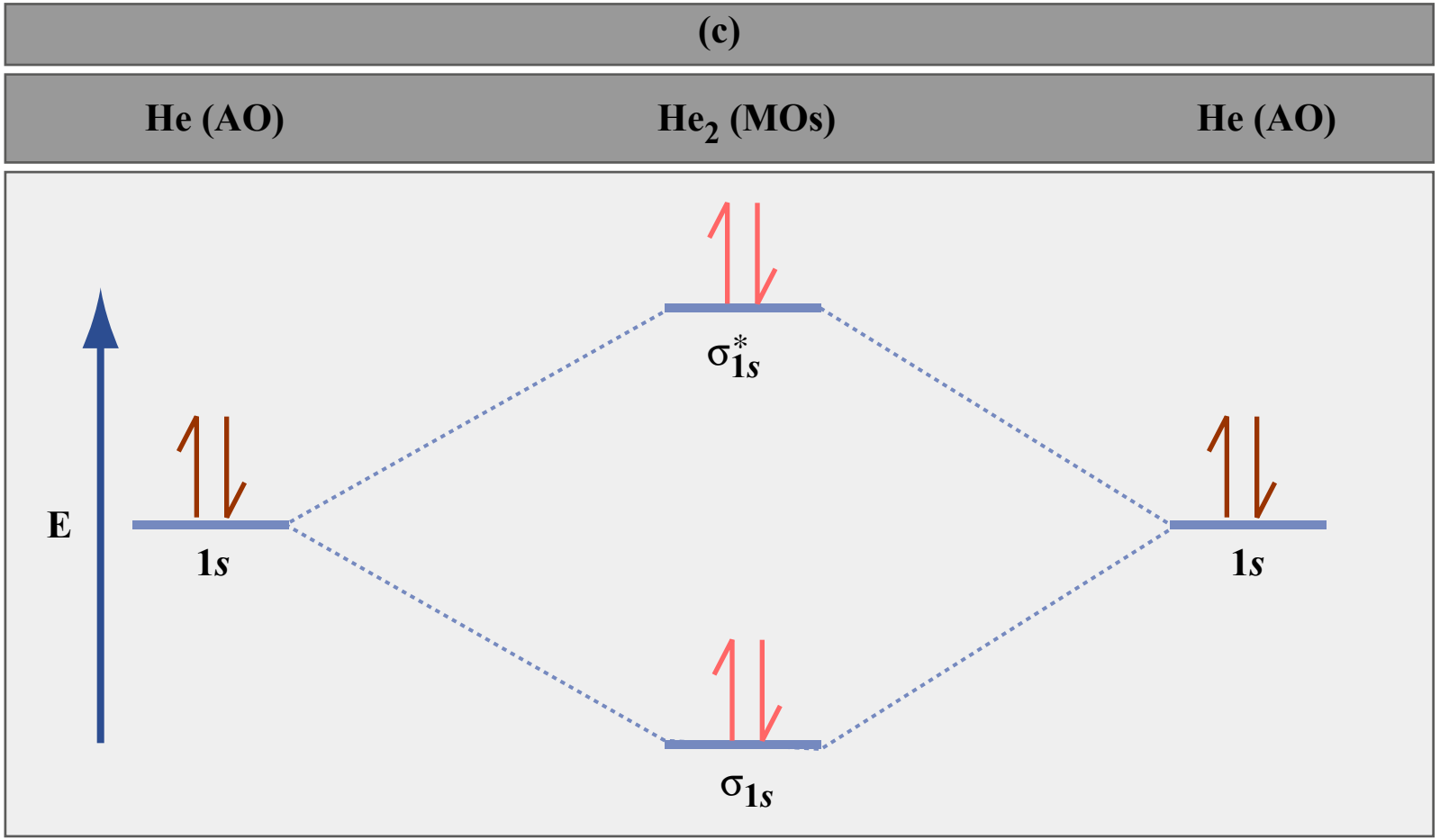
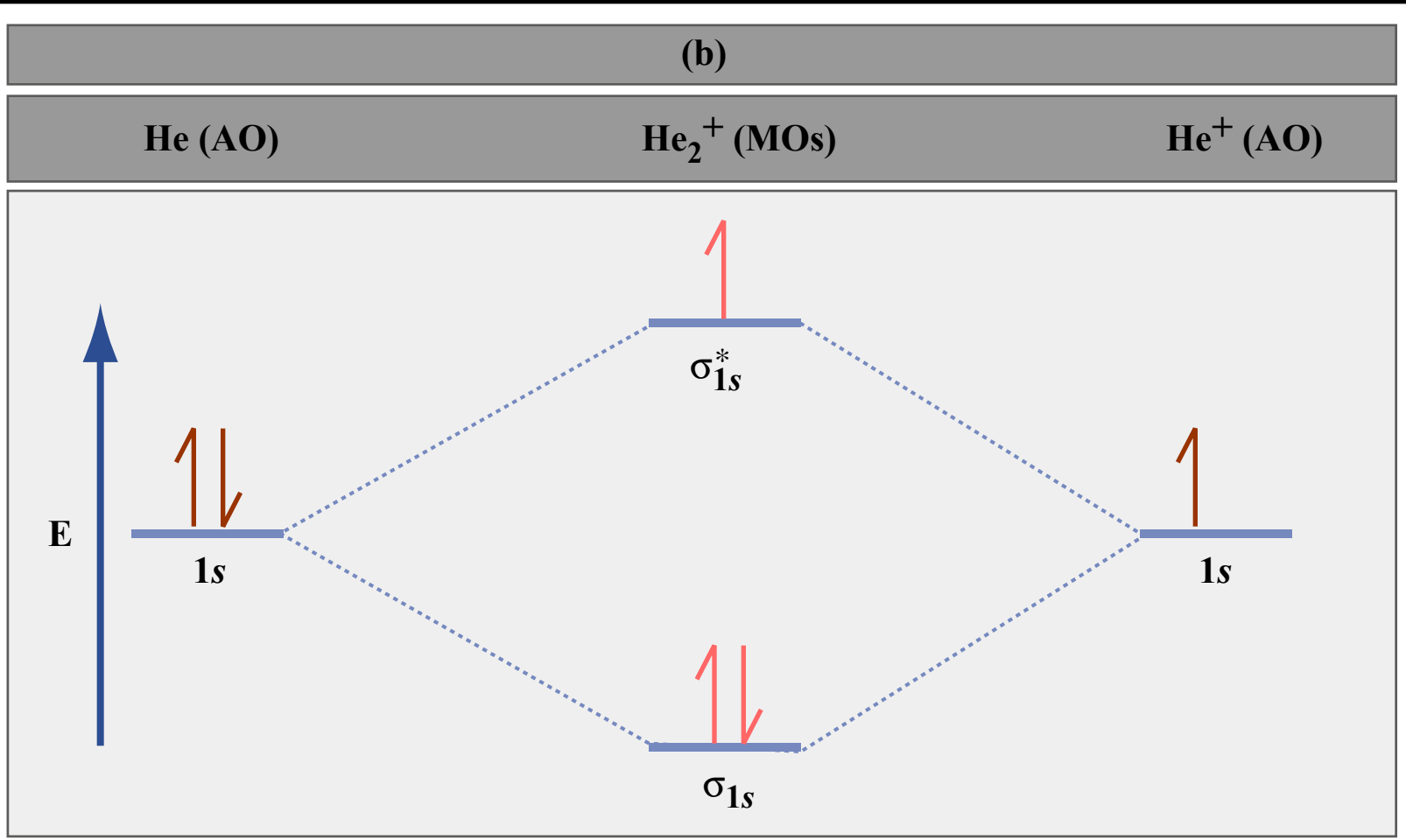


Image by MIT OpenCourseWare.



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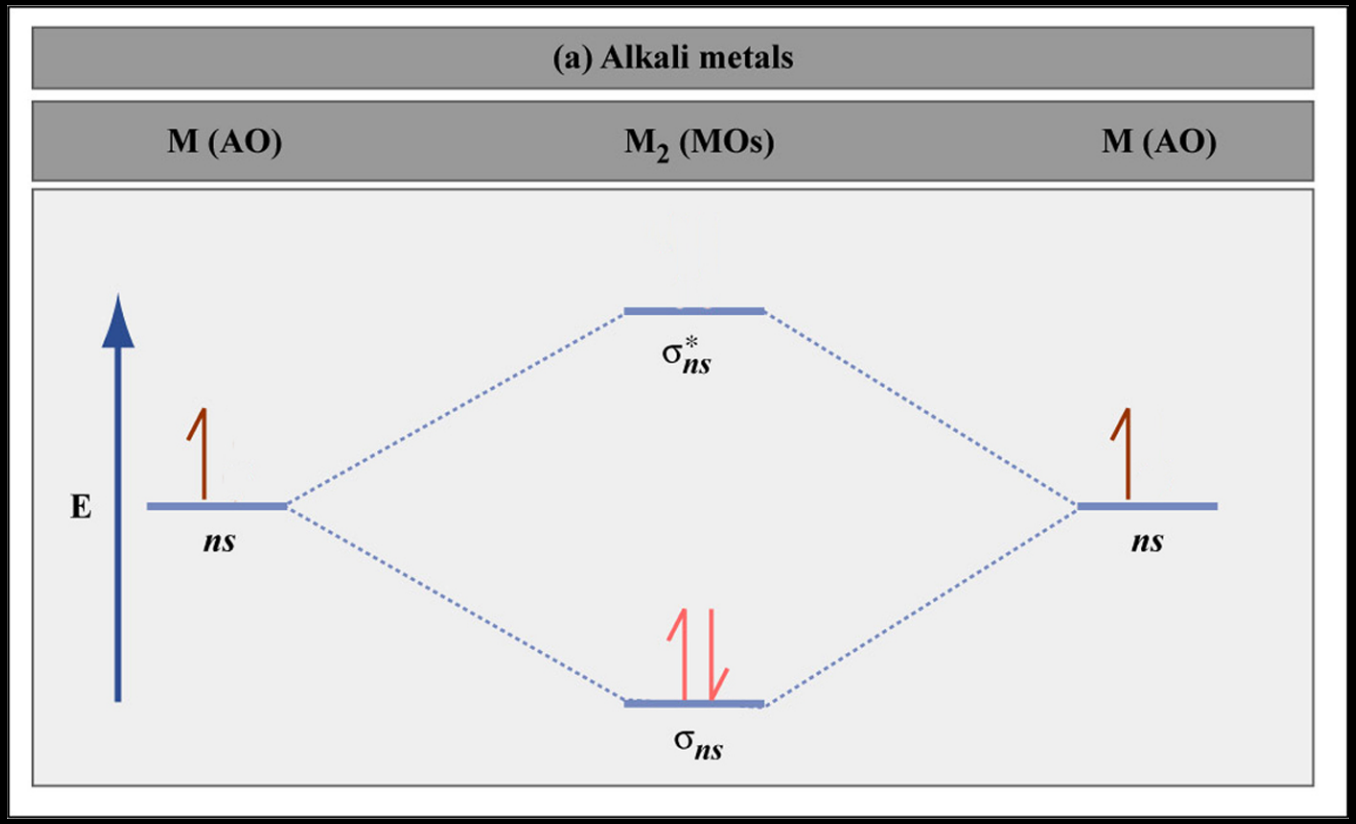

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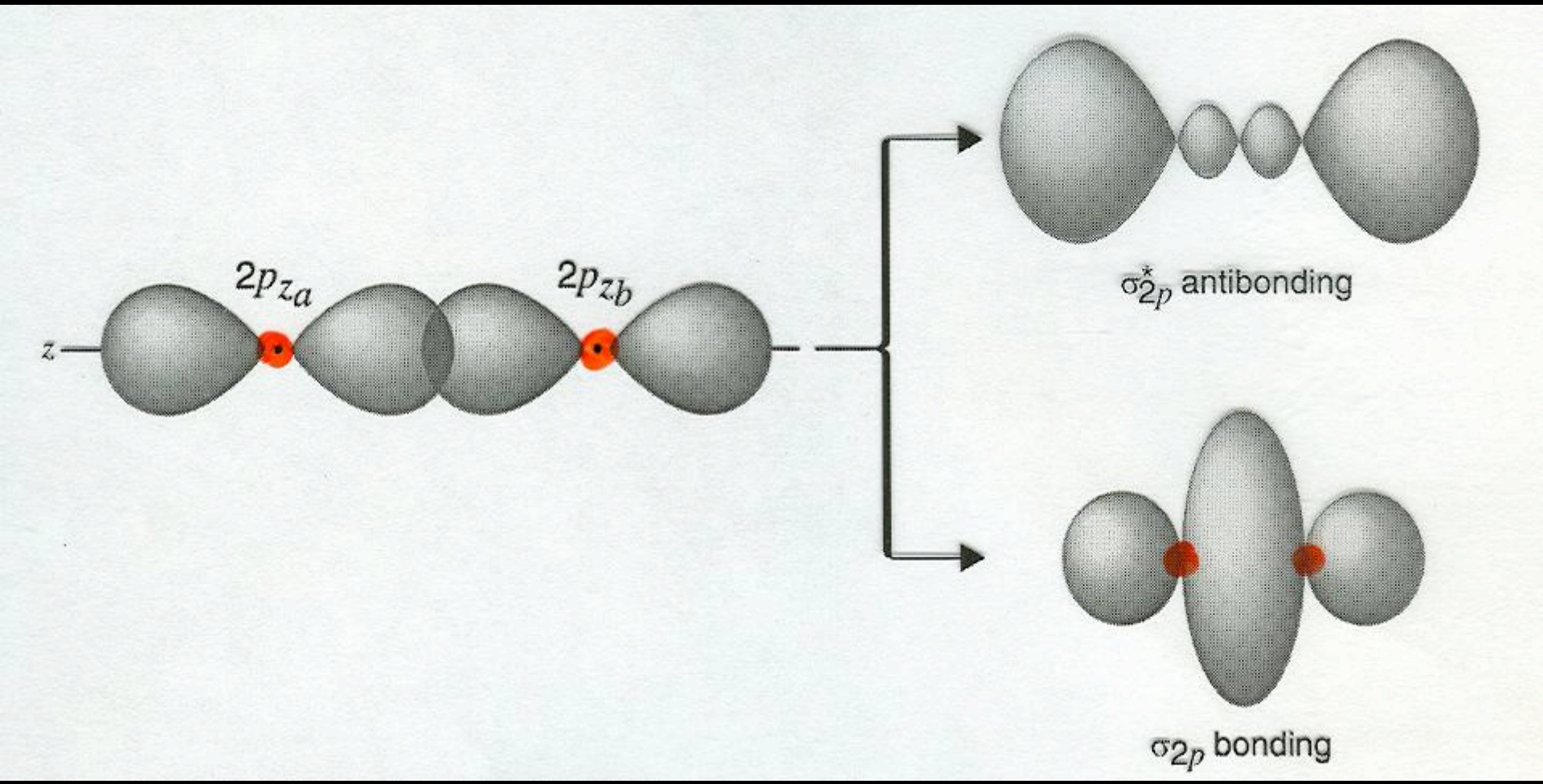
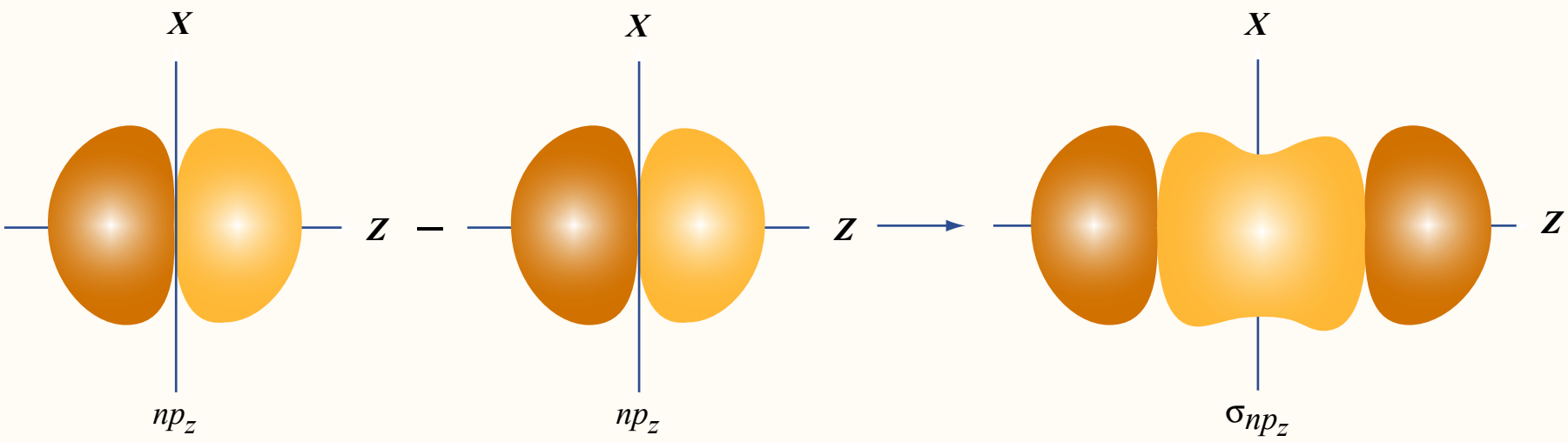
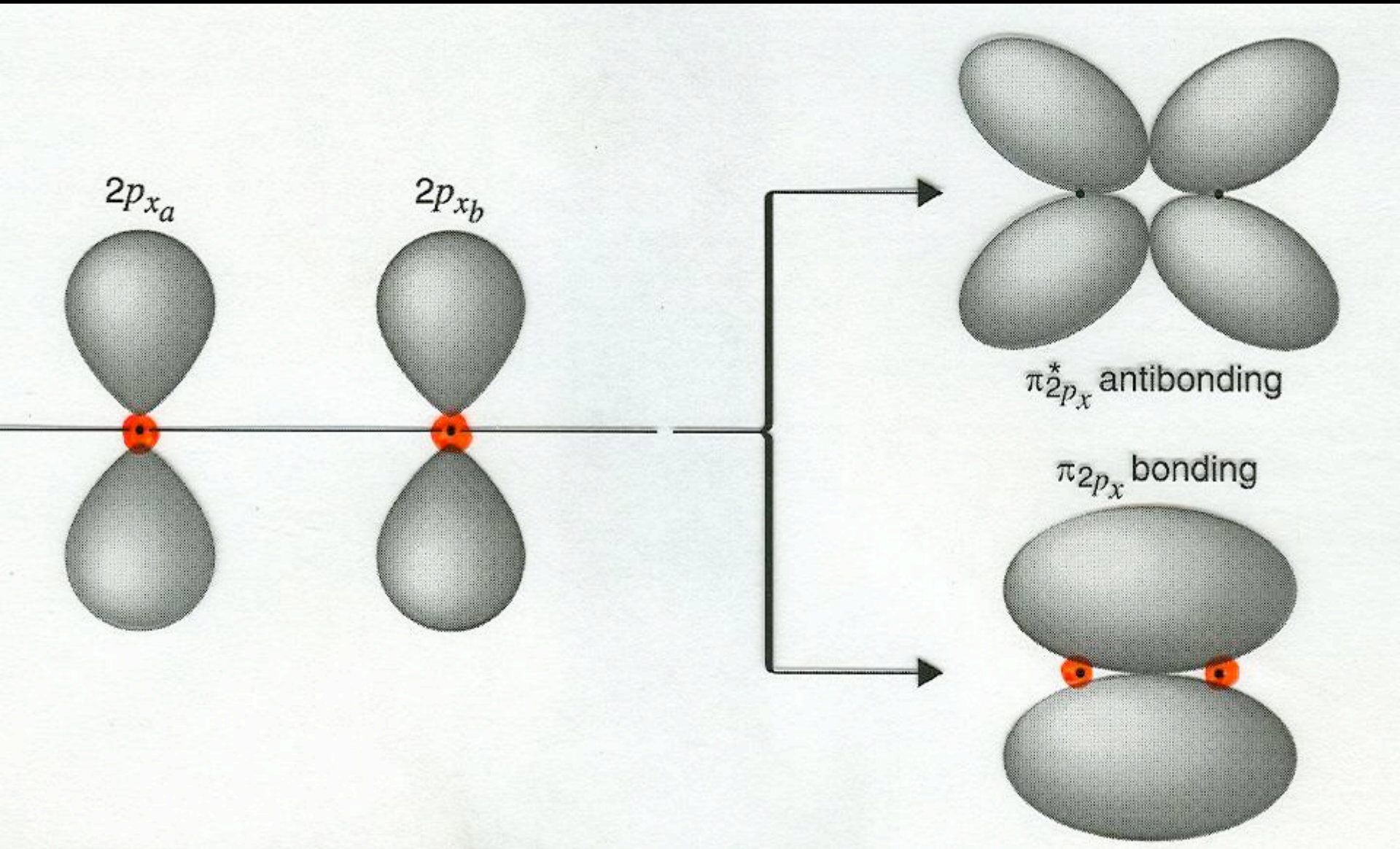
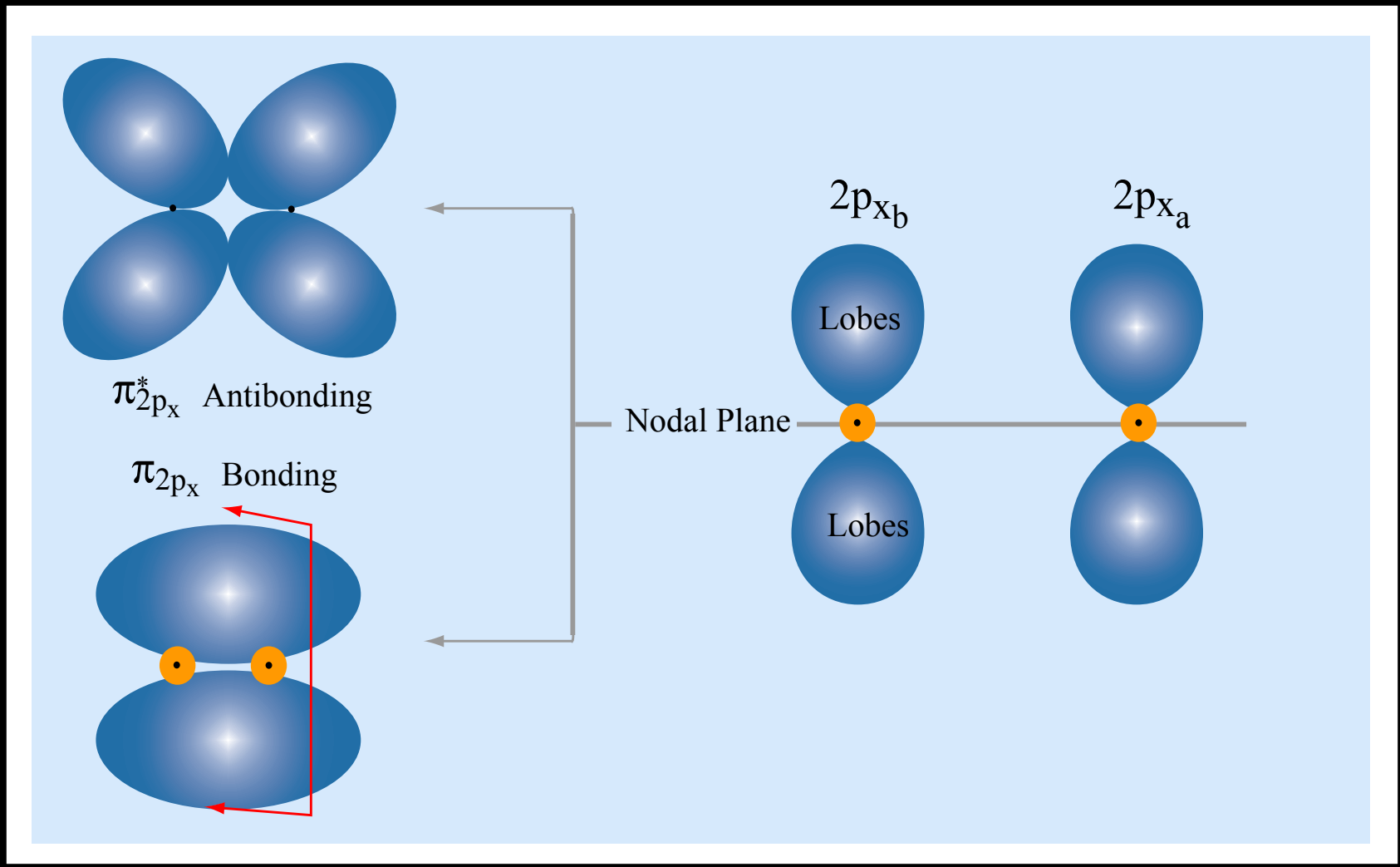


Bonding

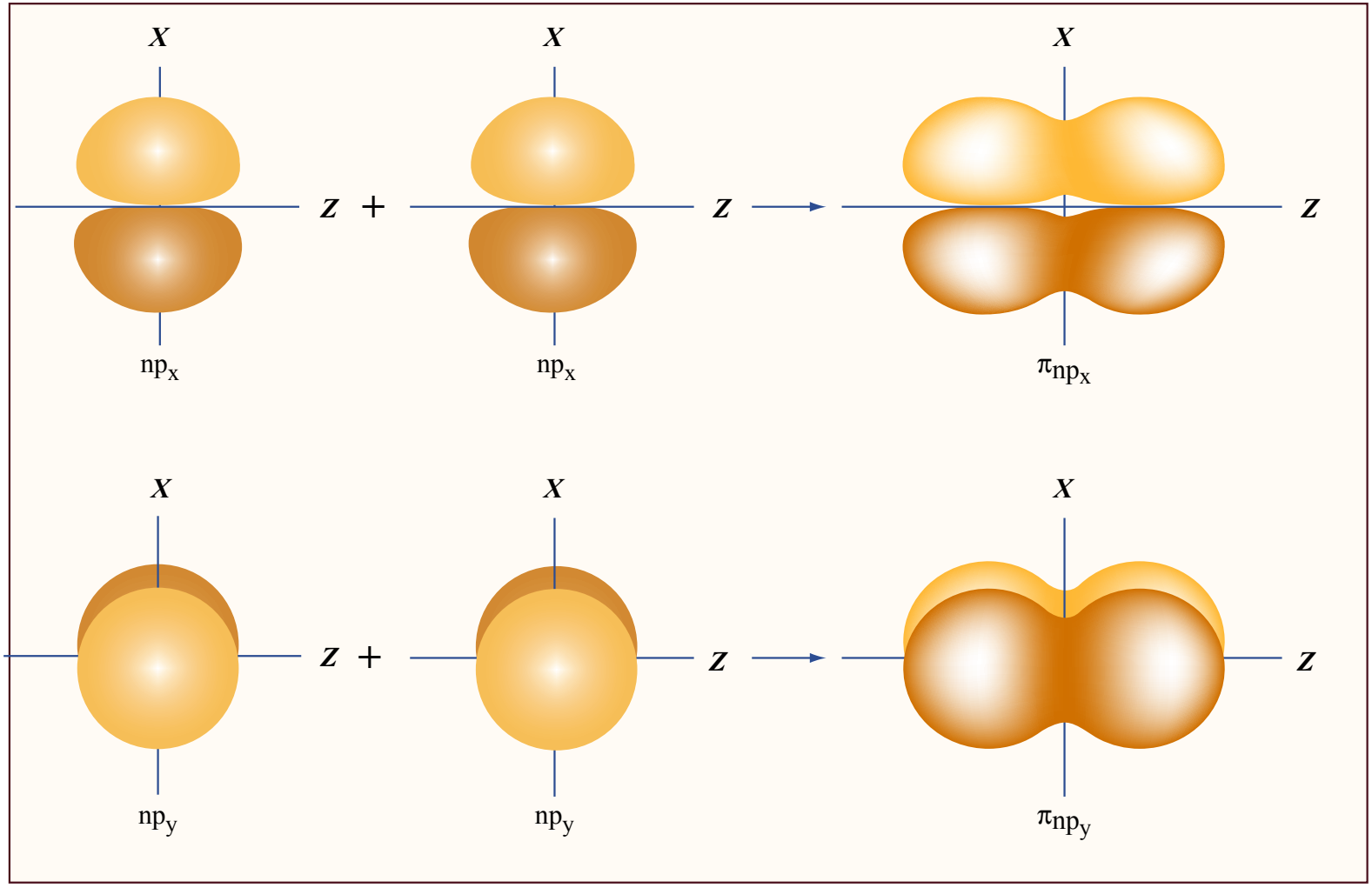
Atomic orbitals — Molecular orbital

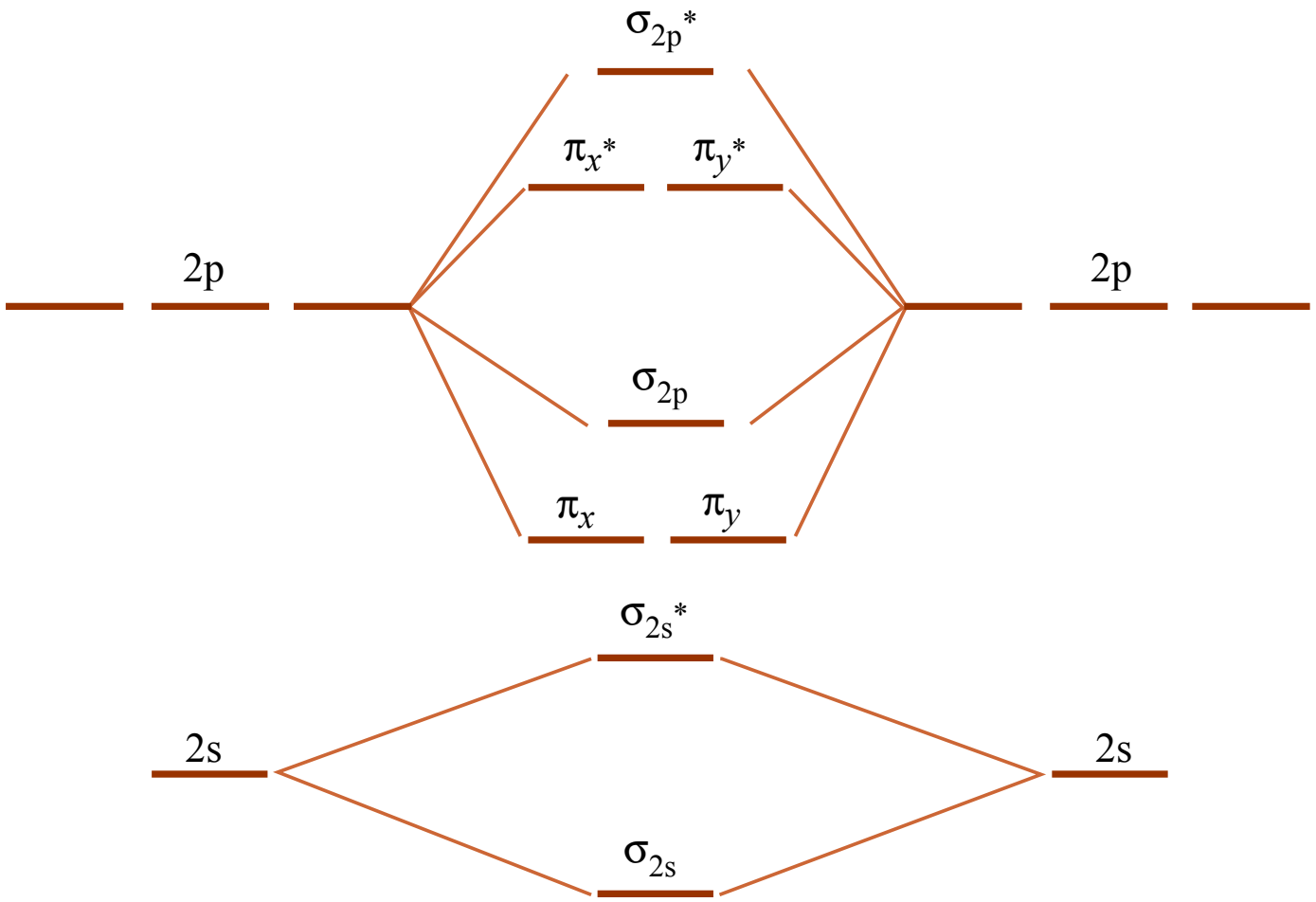






Bonding





e.g. N_2, B_2, C_2

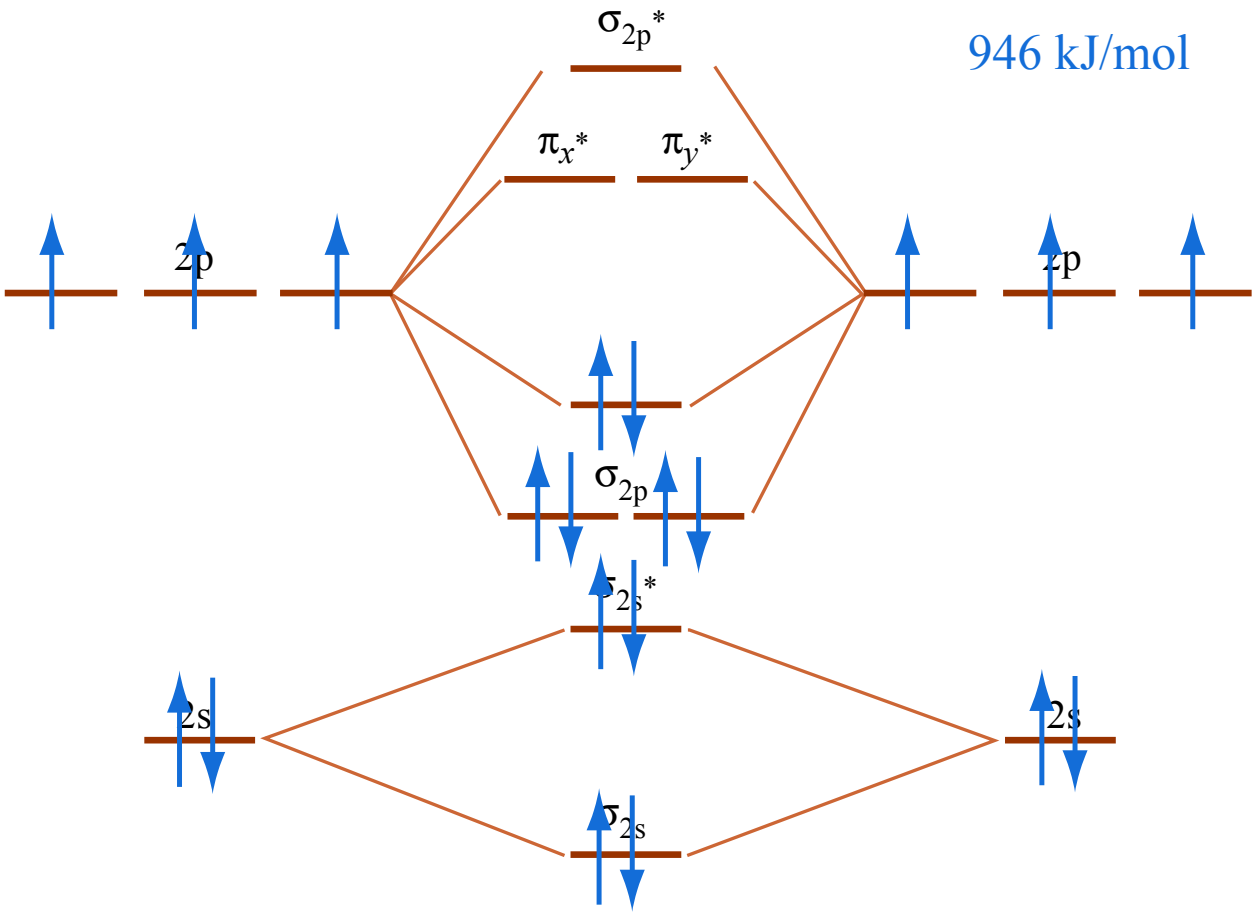
N_2

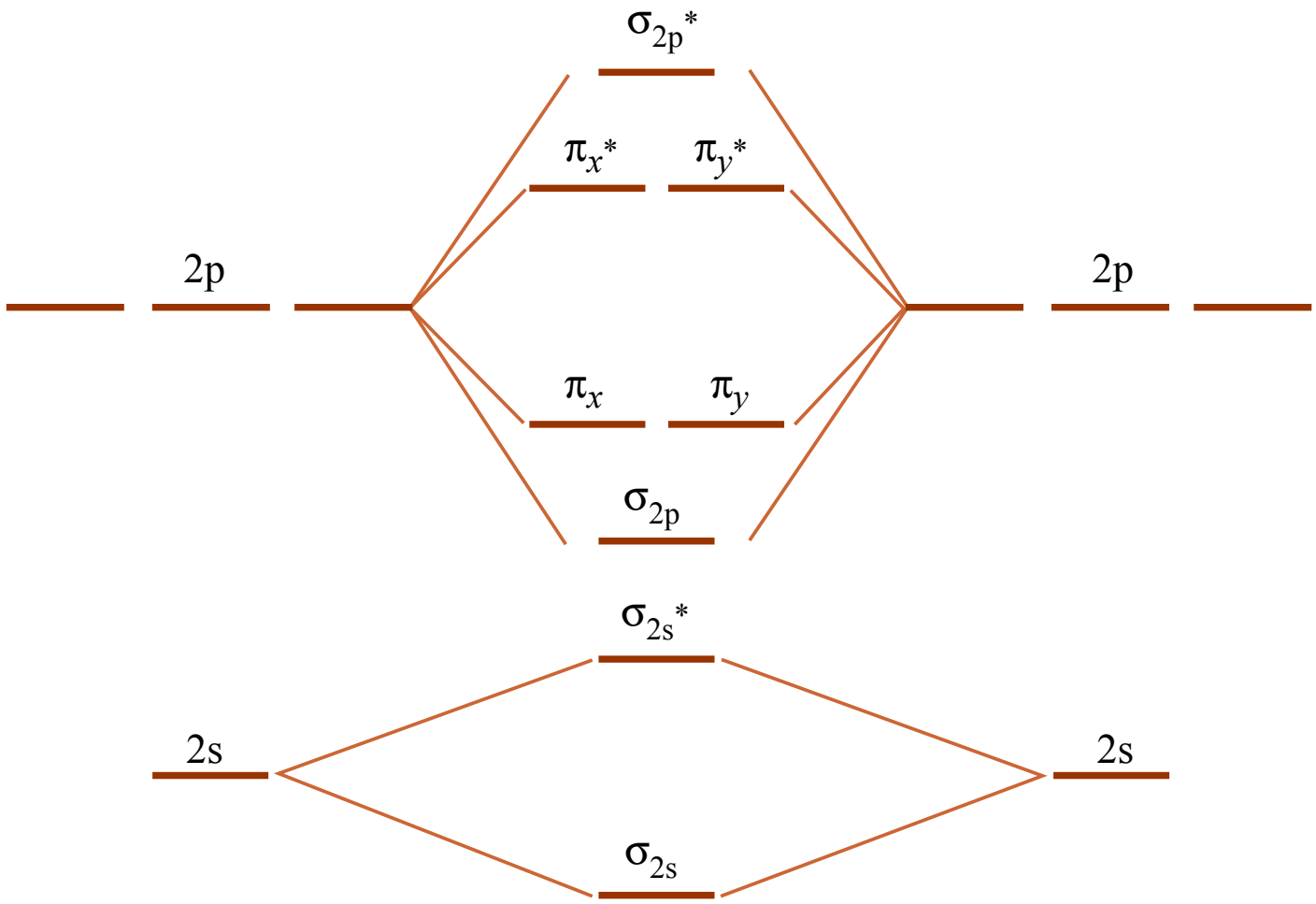
6 bonding electrons

$\Rightarrow$ triple bond

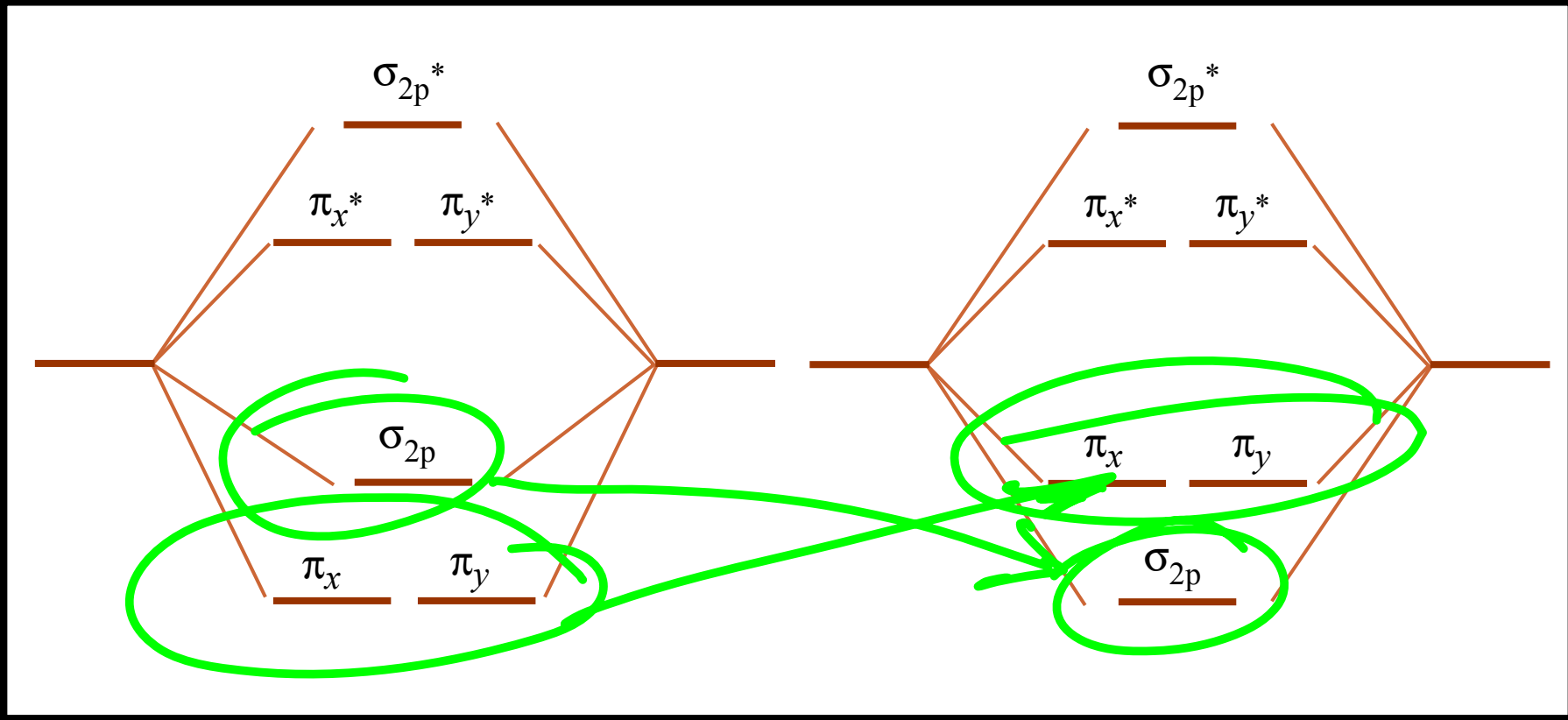
$N \equiv N$

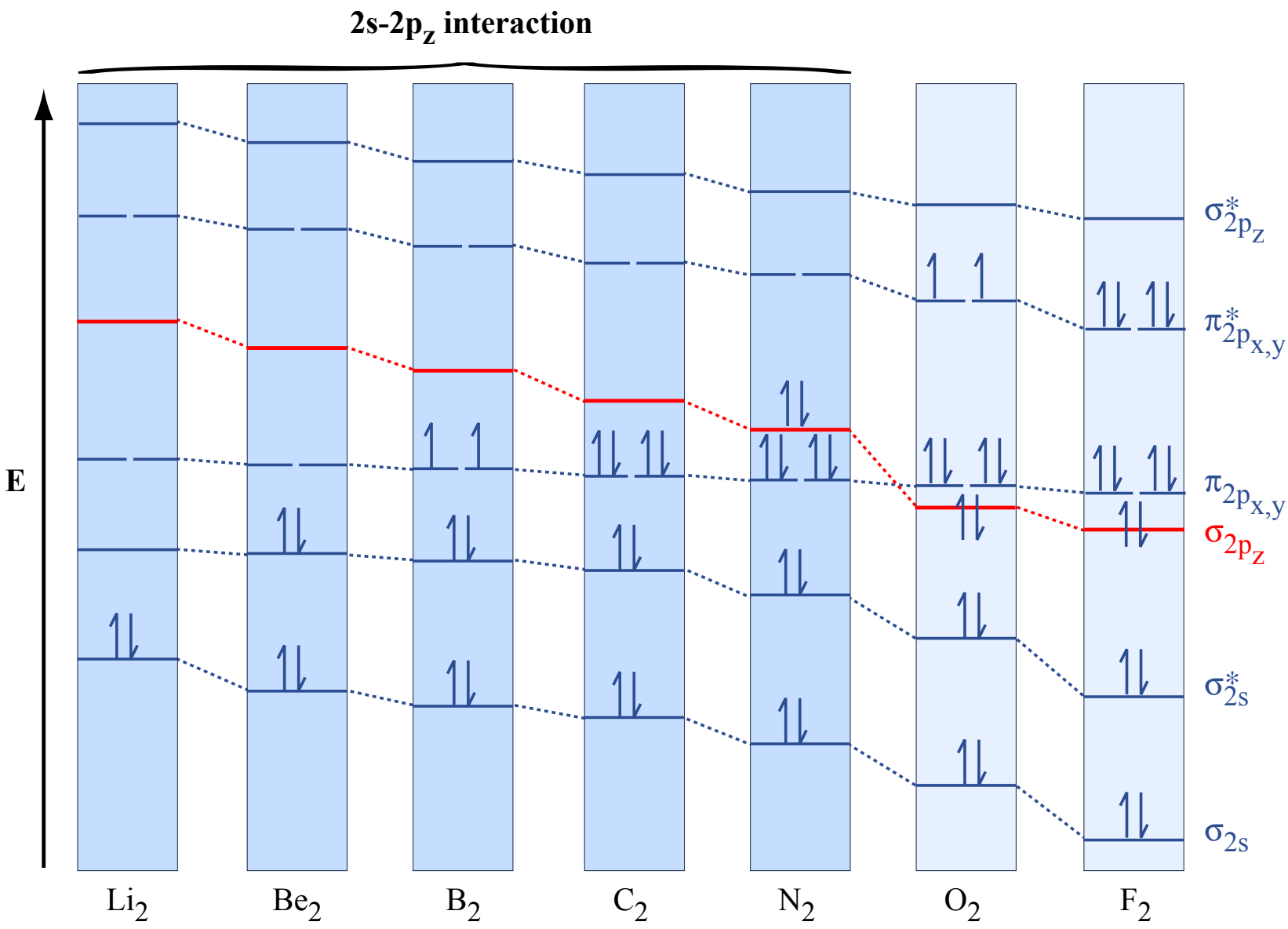
946 kJ/mol





e.g. O_2 & F_2



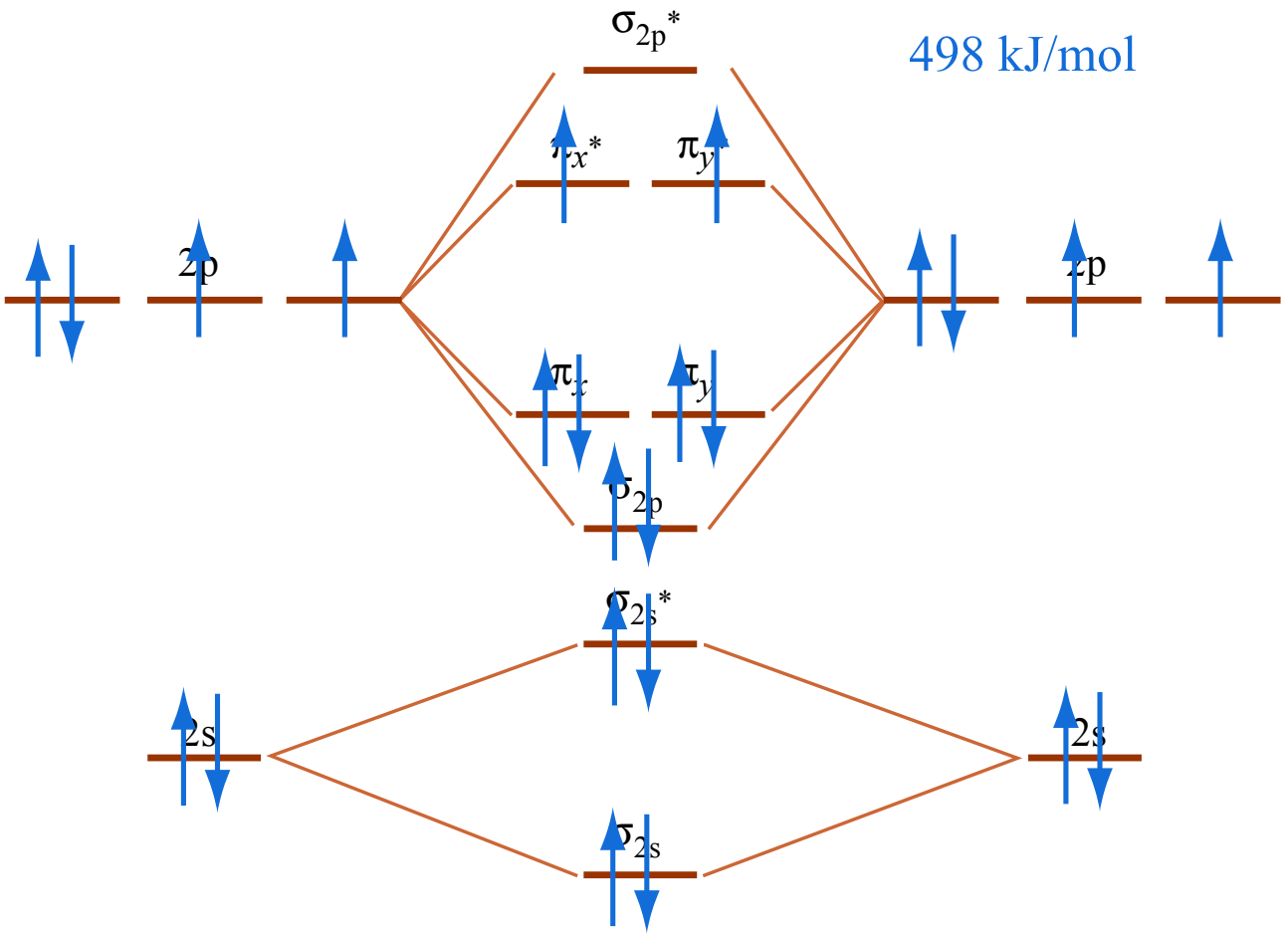


O_2

6 bonding electrons
2 anti bonding electrons
⇒ double bond

0 = 0

498 kJ/mol

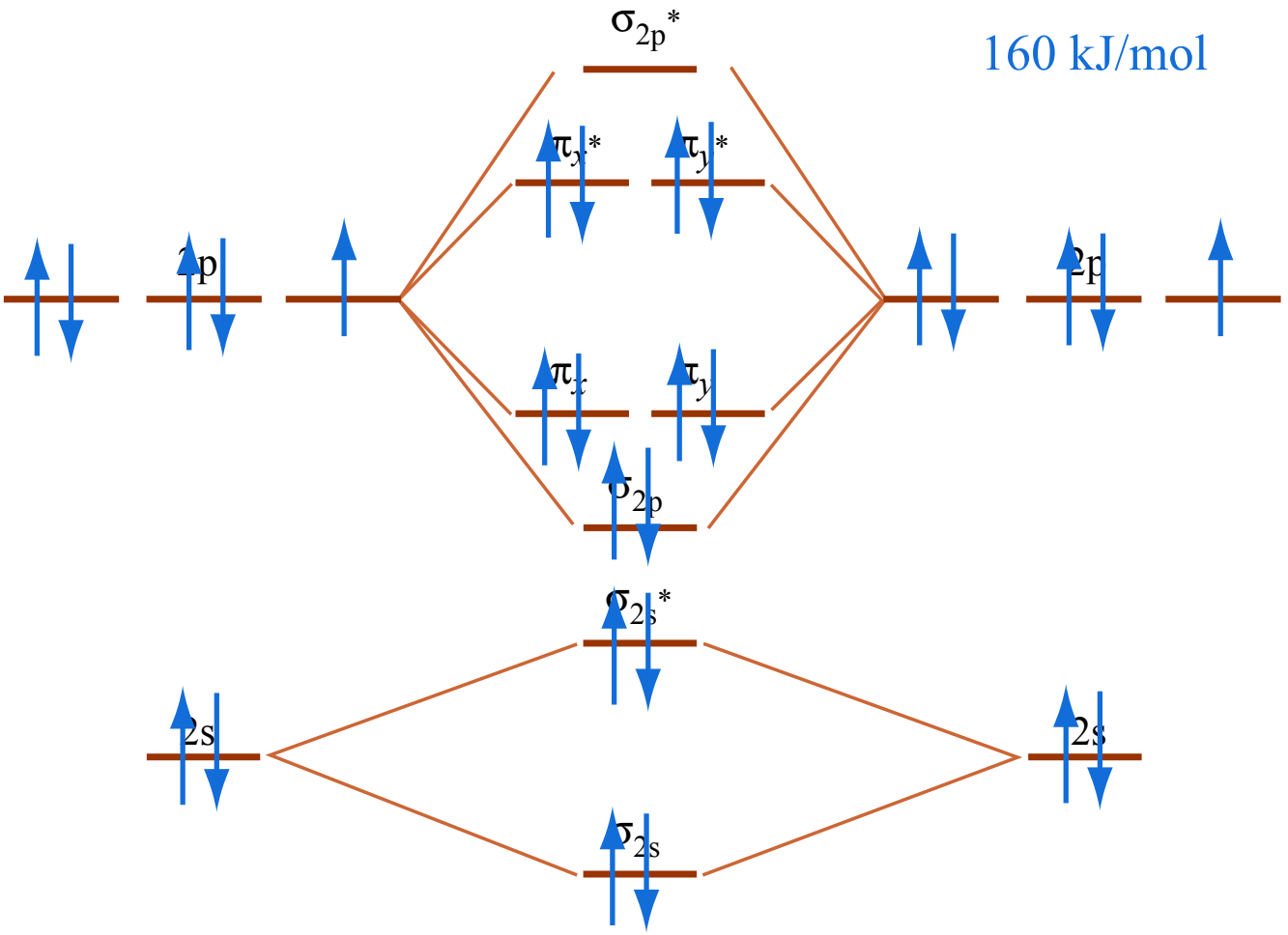


F_2

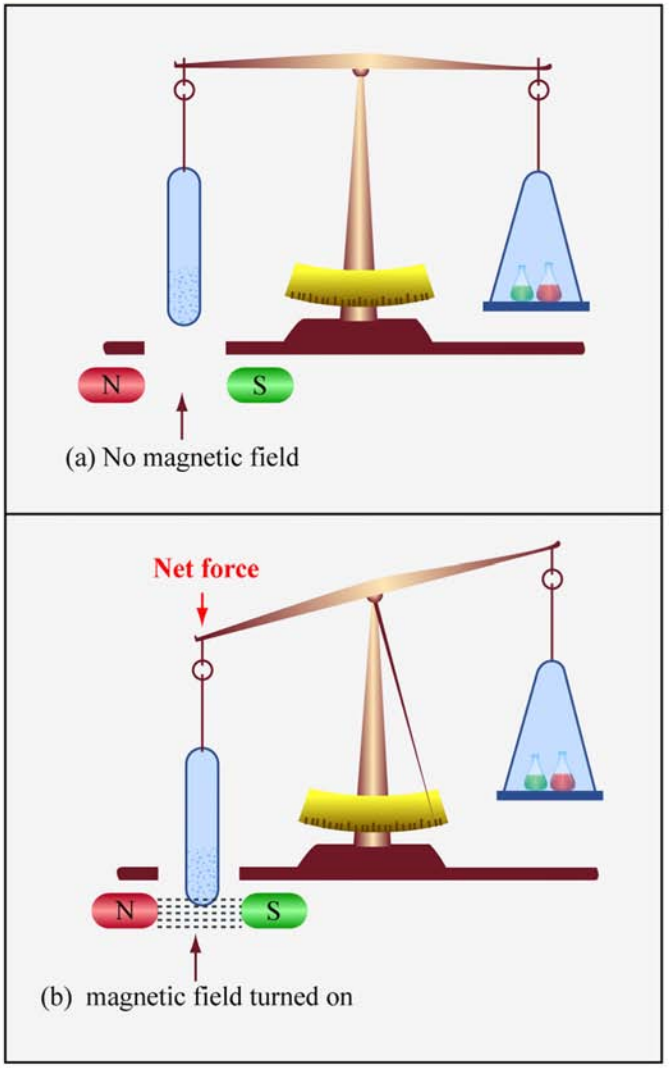
6 bonding electrons
4 anti bonding electrons
⇒ single bond

F-F

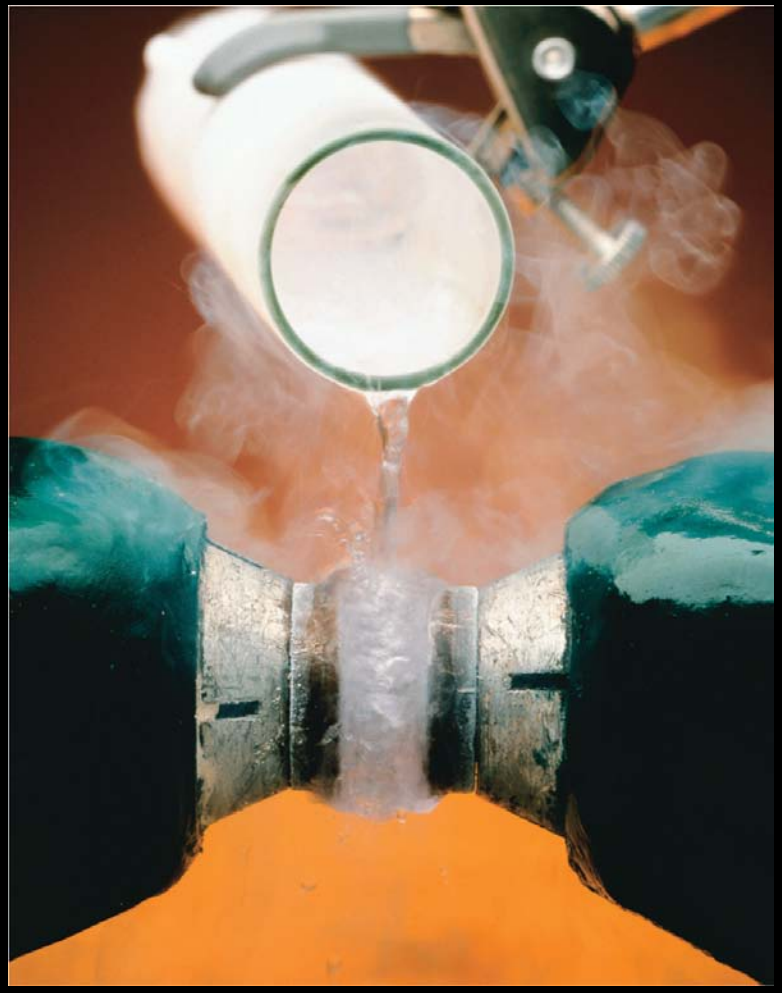
160 kJ/mol



Paramagnetism



unpaired electrons



Averill, B., and P. Eldredge. *Chemistry: Principles, Patterns, and Applications*. Flat WorldKnowledge, 2011. ISBN: 9781453331224.

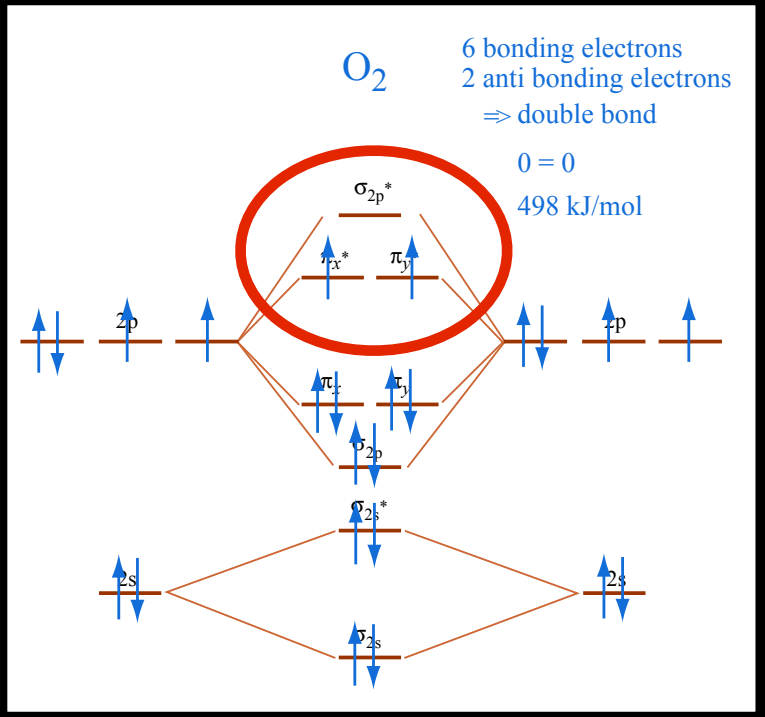
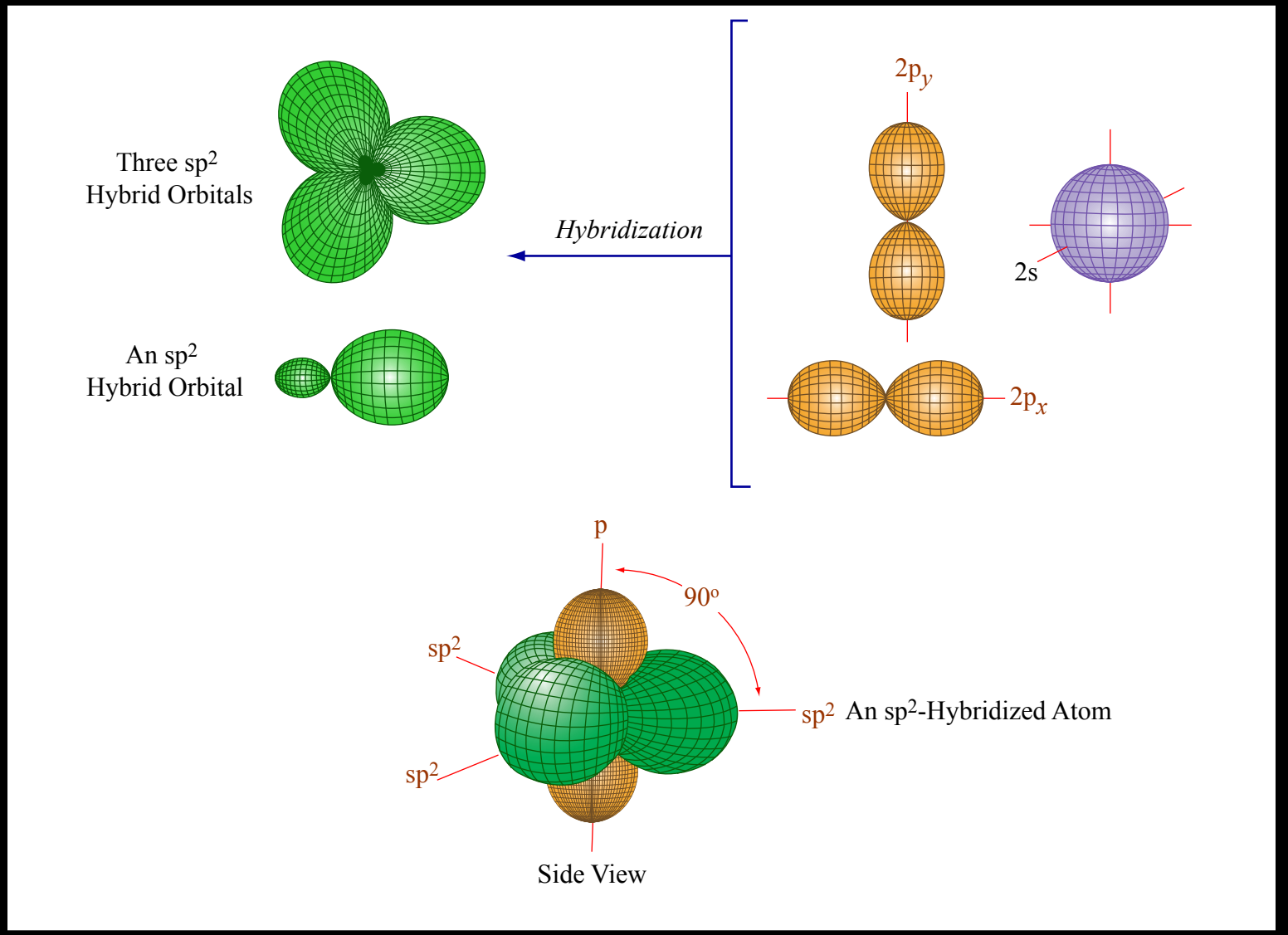
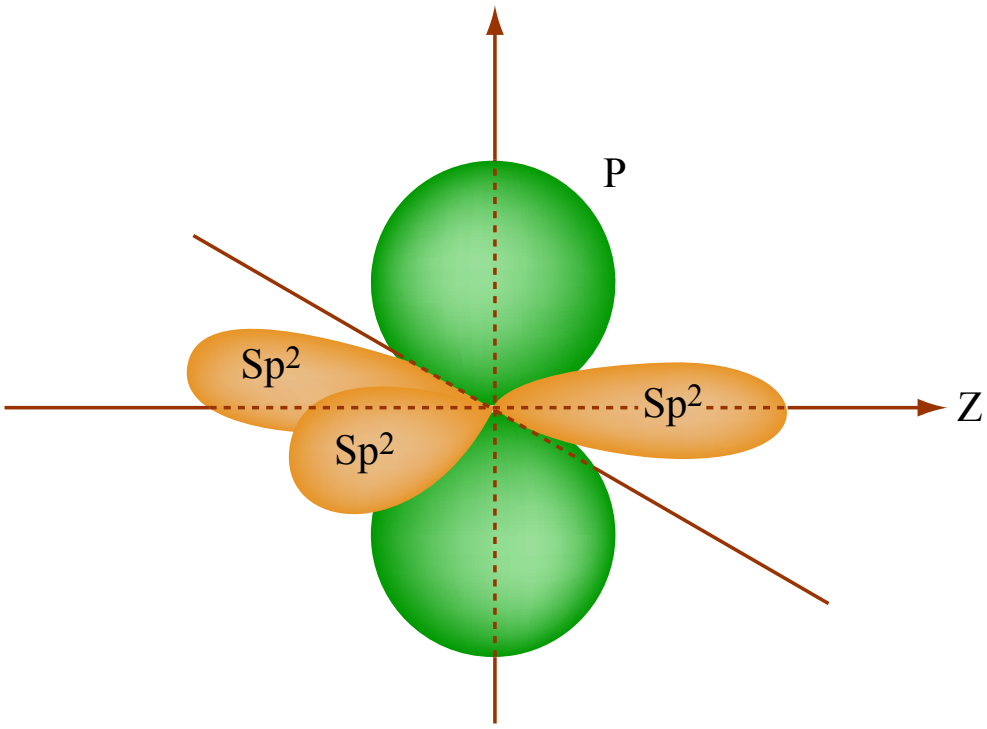


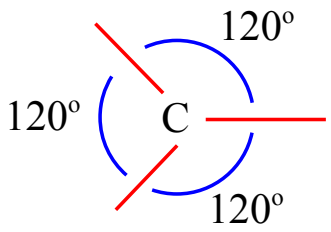
Image by MIT OpenCourseWare.

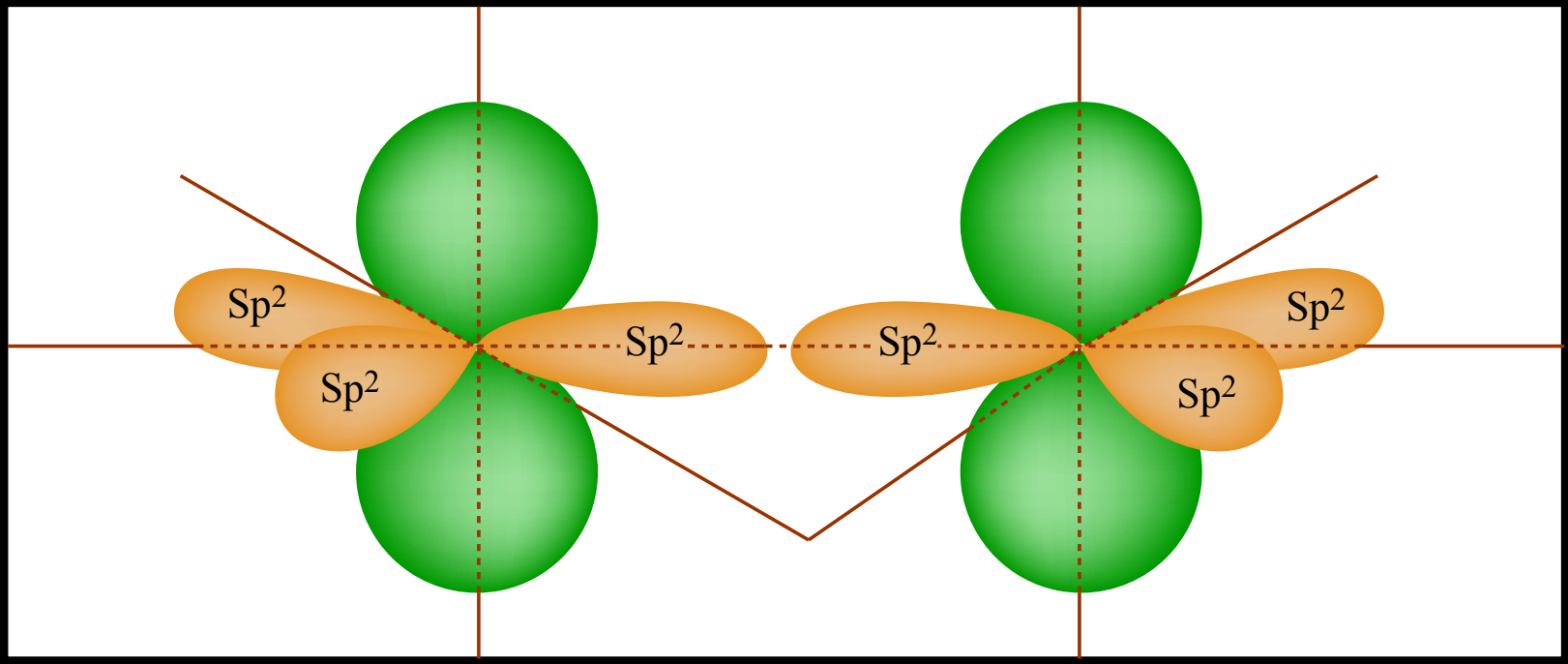
paramagnetism in liquid oxygen

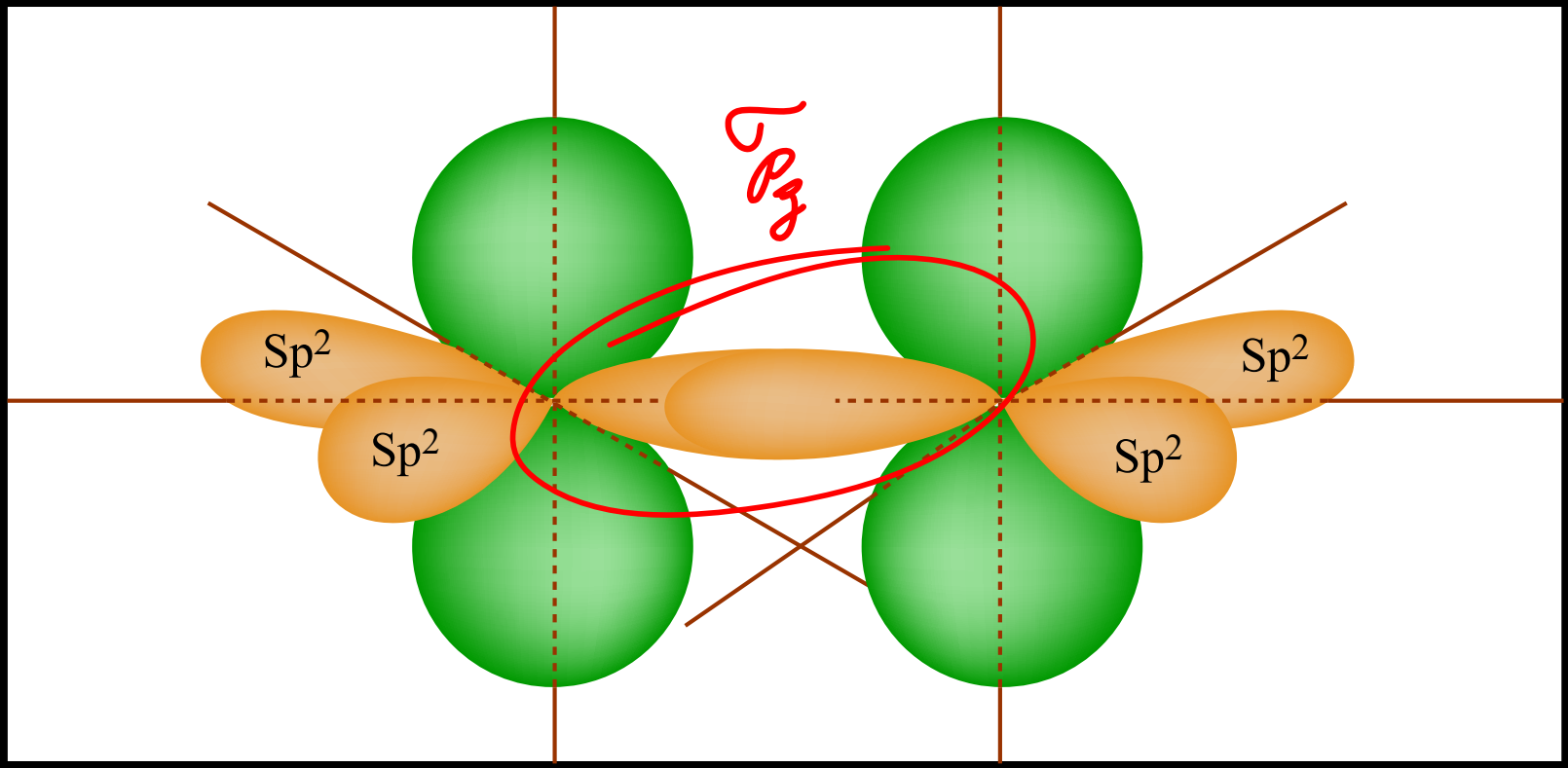


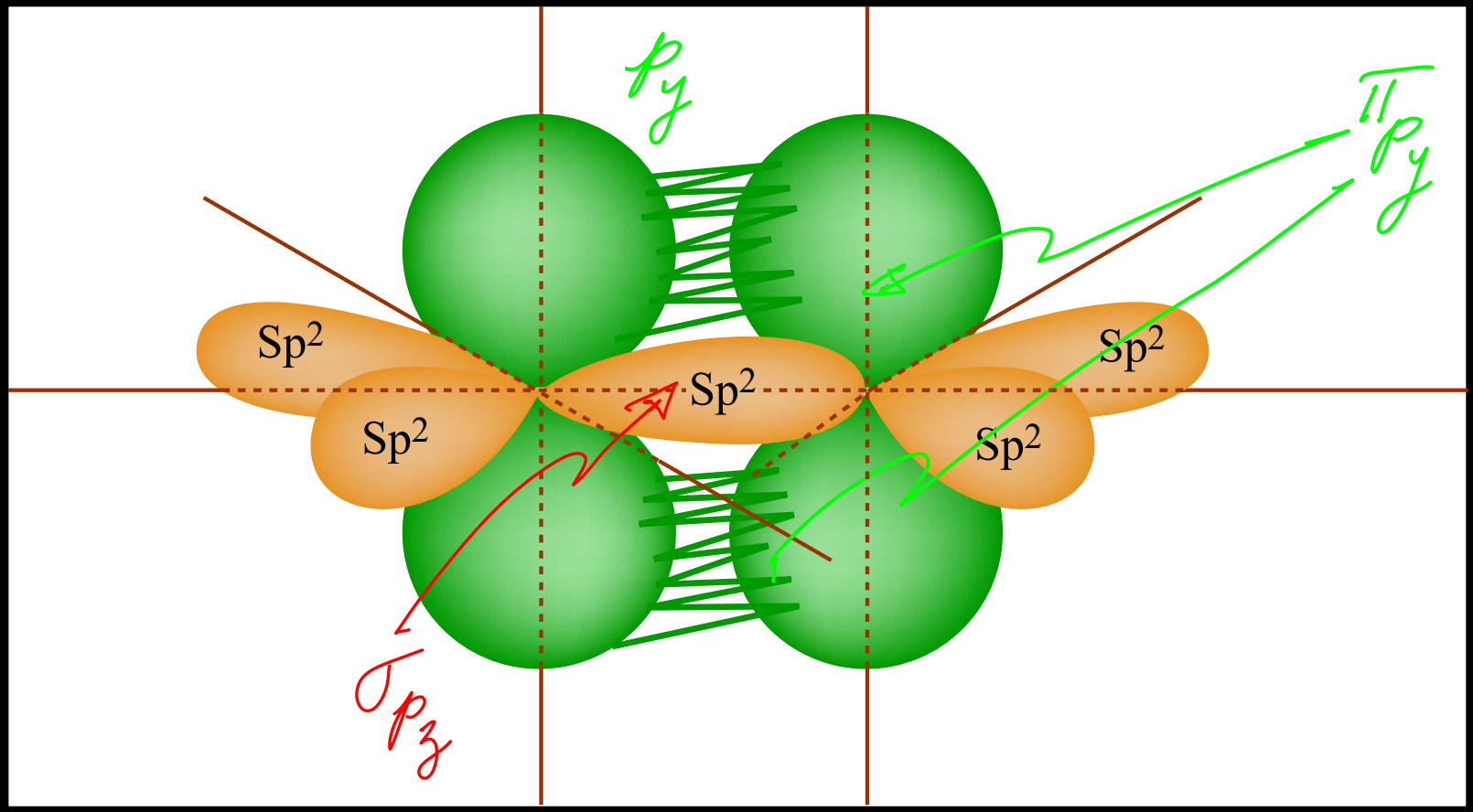


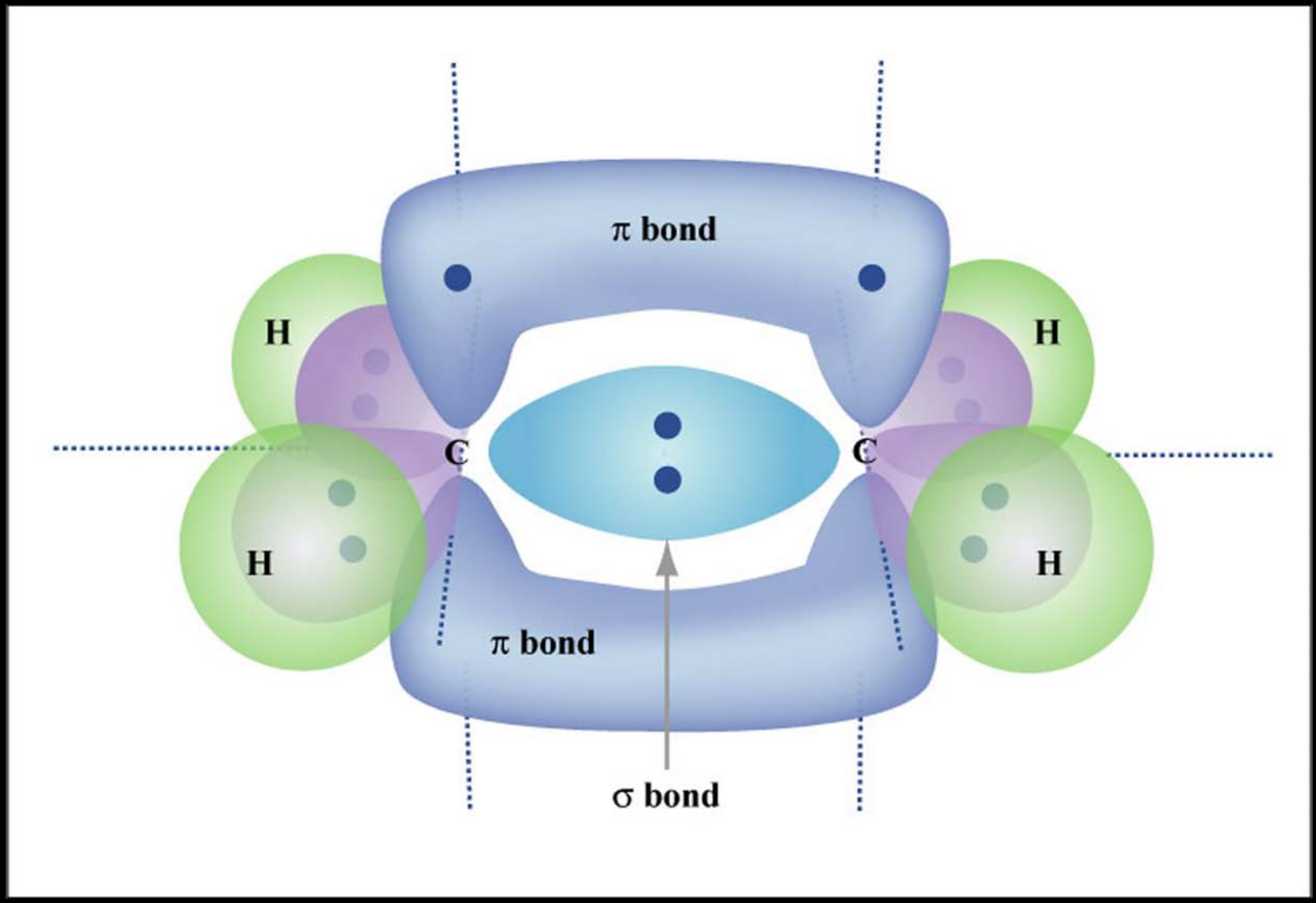
Top View











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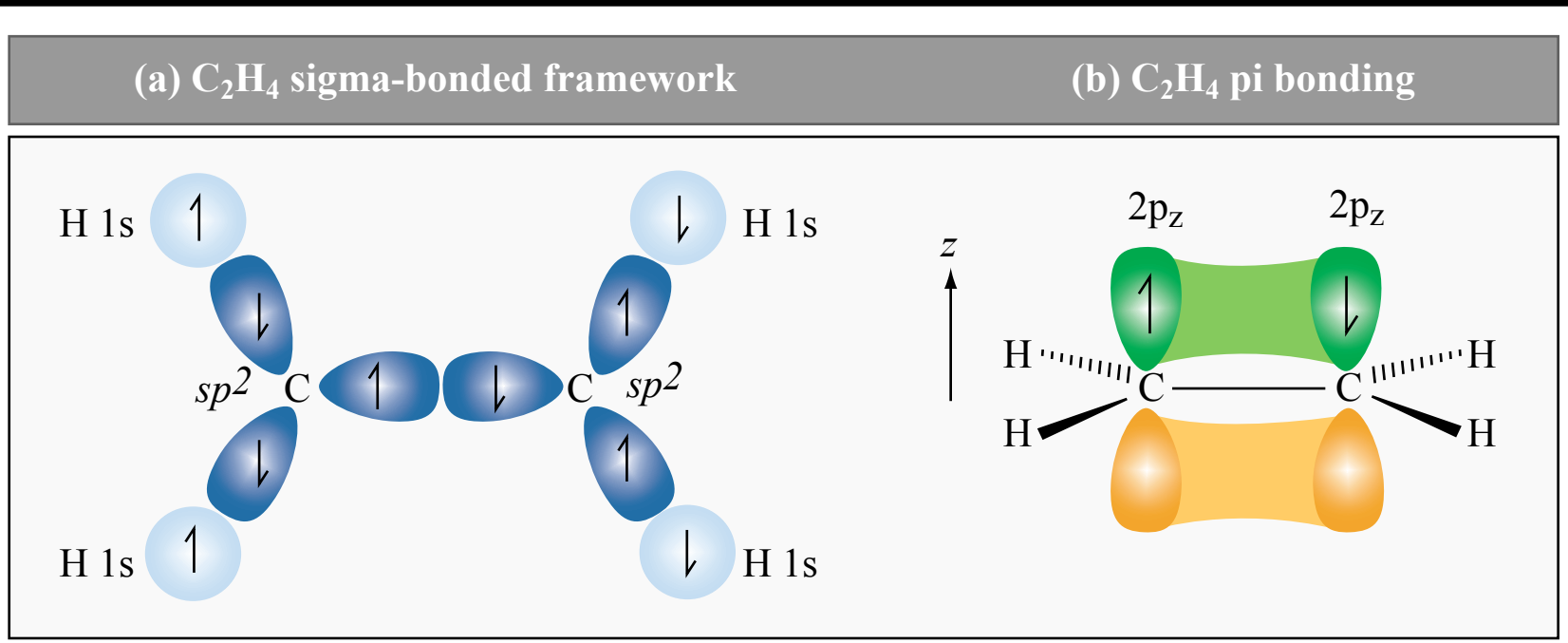

Image by MIT OpenCourseWare.

Extremes in electronegativity

NaI: $\Delta\chi = 1.73$

CsAu: $\Delta\chi = 1.75$

Cs and Au, both metals, melt to form metallic liquids, *but*…

when the concentration nears 50%

(equal numbers of donors & acceptors)

💣 electron transfer occurs 💣 !

$$Cs \rightarrow Cs^{+} + e$$

$$Au + e \rightarrow Au^{-}$$

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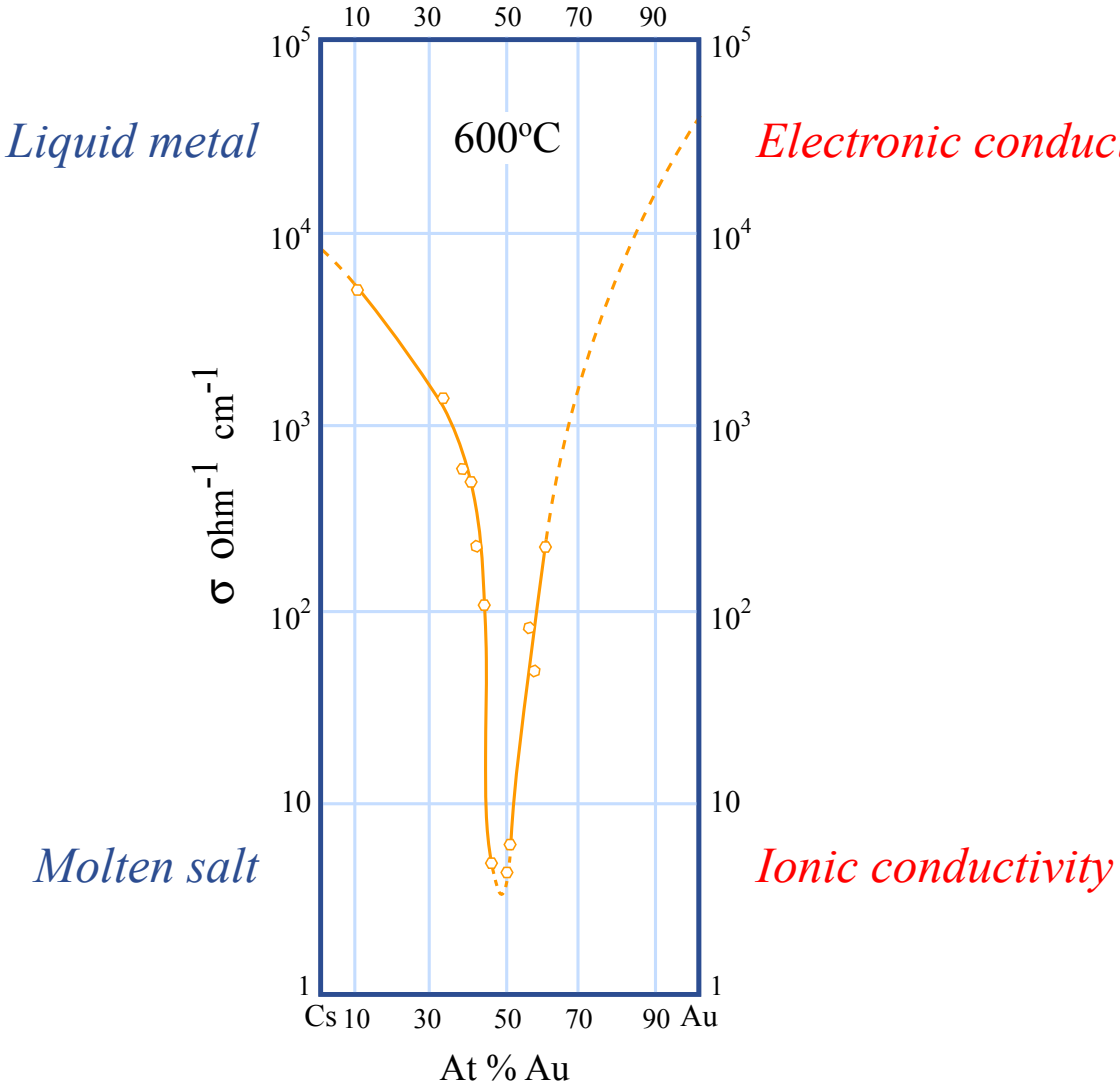
metallic melt turns into molten salt!!

☞ clear, colorless liquid

☞ big drop in electrical conductivity

☞ shift from electronic to ionic conduction

Specific electrical conductivity of liquid Cs – Au alloys as a function of concentration (Hoshino *et al.* 1975)



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Arcery!

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3.091SC Introduction to Solid State Chemistry

Fall 2009