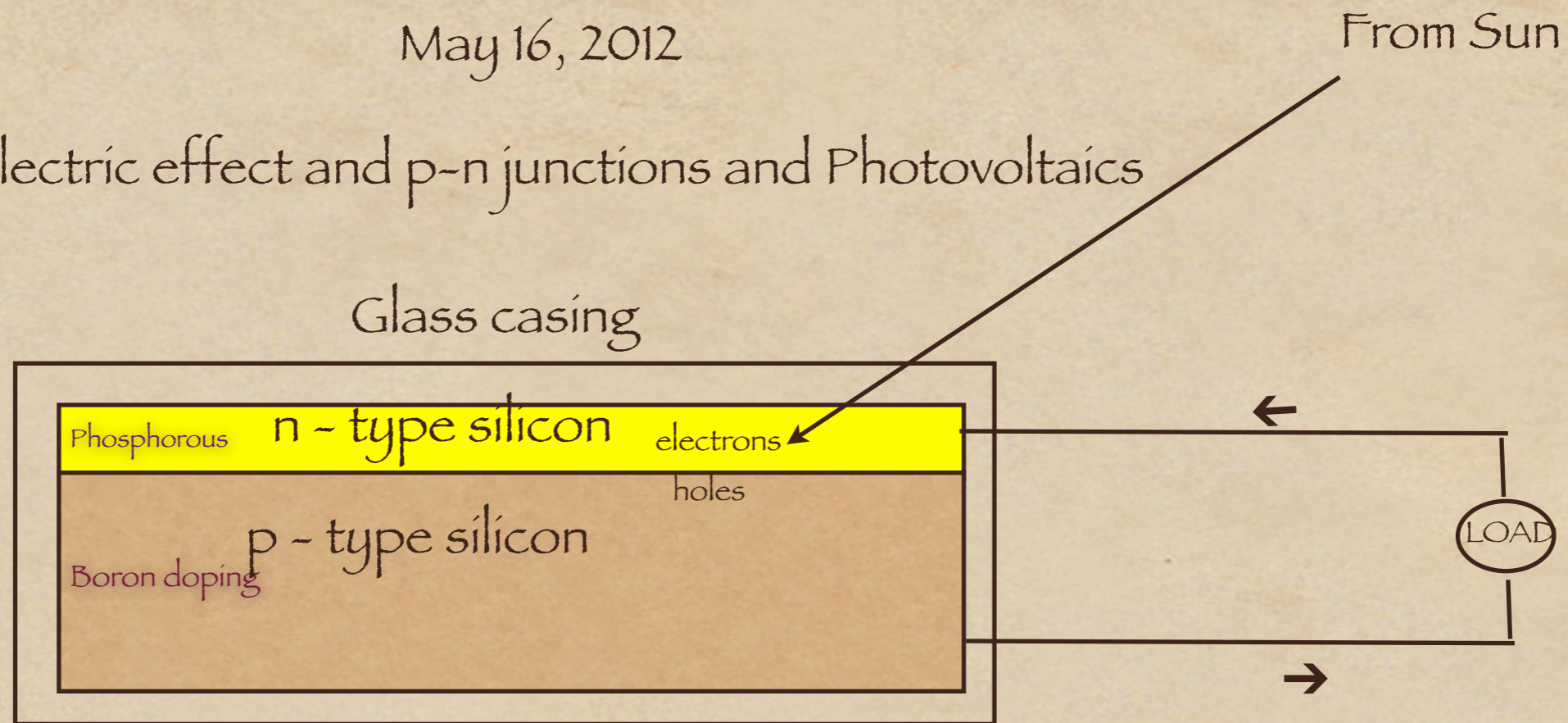


Lecture 19
May 16, 2012

Photoelectric effect and p-n junctions and Photovoltaics

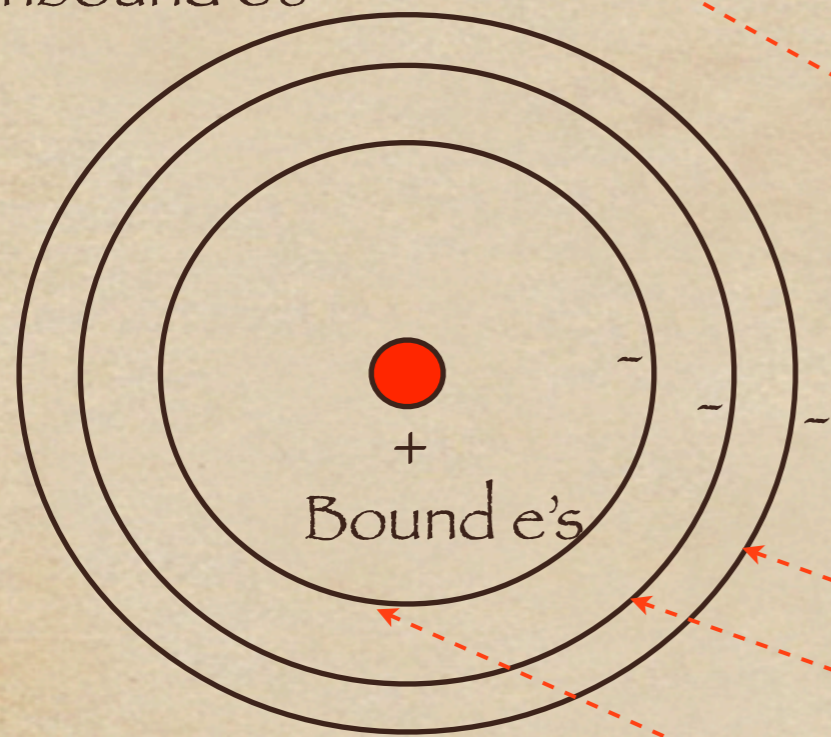


<http://www.pbs.org/wgbh/nova/solar/insi-nf.html>

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Atoms and energy levels

Unbound e's



Classical electronic orbits

Energy increasing upwards



Highly excited states
(Unbound state)

2nd Excited state: (Bound
State)

1st Excited state: (Bound
State)

Ground state: (Bound State)

Modern picture of an atom.

Bohr's old quantum theory as described in many books.

Excitation energies at resonance : $e_1 - e_2 = h \nu$

get related to specific wave lengths.

Atomic or molecular excitations dominate quantum efficiency of absorption (CO₂ problem)

Basic concept of metal and nonmetal-> semiconductor

Periodic Table of Elements

1 1 H																	2 2 He
3 2 Li	4 2 Be											5 2 B	6 2 C	7 2 N	8 2 O	9 2 F	10 2 Ne
11 3 Na	12 3 Mg	III B	IV B	V B	VIB	VII B	VII			IB	IB	13 3 Al	14 3 Si	15 3 P	16 3 S	17 3 Cl	18 3 Ar
19 4 K	20 4 Ca	21 4 Sc	22 4 Ti	23 4 V	24 4 Cr	25 4 Mn	26 4 Fe	27 4 Co	28 4 Ni	29 4 Cu	30 4 Zn	31 4 Ga	32 4 Ge	33 4 As	34 4 Se	35 4 Br	36 4 Kr
37 5 Rb	38 5 Sr	39 5 Y	40 5 Zr	41 5 Nb	42 5 Mo	43 5 Tc	44 5 Ru	45 5 Rh	46 5 Pd	47 5 Ag	48 5 Cd	49 5 In	50 5 Sn	51 5 Sb	52 5 Te	53 5 I	54 5 Xe
55 6 Cs	56 6 Ba	57 6 *La	72 6 Hf	73 6 Ta	74 6 W	75 6 Re	76 6 Os	77 6 Ir	78 6 Pt	79 6 Au	80 6 Hg	81 6 Tl	82 6 Pb	83 6 Bi	84 6 Po	85 6 At	86 6 Rn
87 7 Fr	88 7 Ra	89 7 +Ac	104 7 Rf	105 7 Ha	106 7 106	107 7 107	108 7 108	109 7 109	110 7 110								

* Lanthanide Series

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	71 Lu
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+ Actinide Series

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	103 Lr
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Legend - click to find out more...

H - gas

Li - solid

Br - liquid

Tc - synthetic



Non-Metals



Transition Metals



Rare Earth Metals



Halogens



Alkali Metals



Alkali Earth Metals



Other Metals

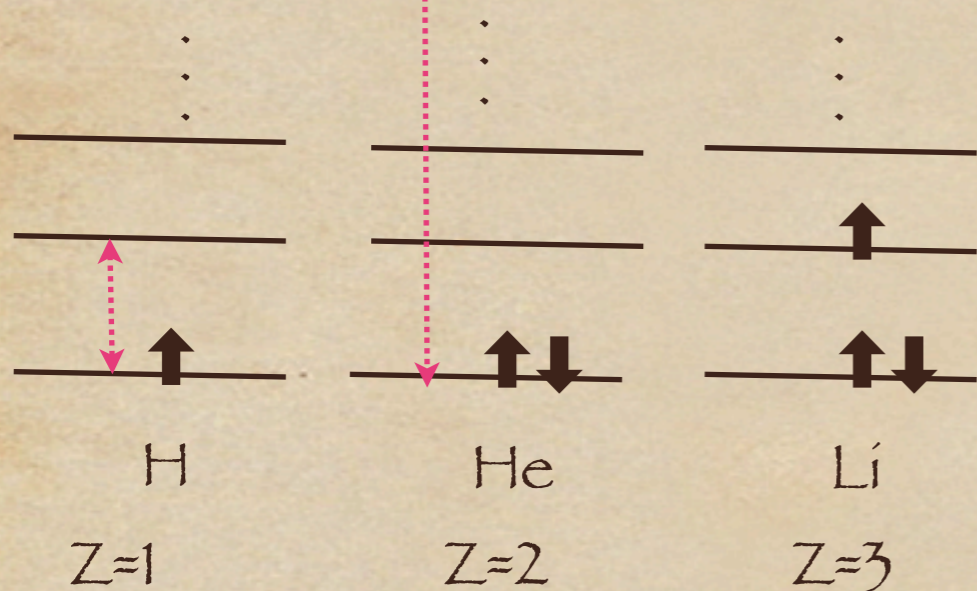


Inert Elements

- A bound state has an electron in “perpetual captivity” of an ion.
- Different bound states usually have different energies. However a given energy level can and does accommodate a fixed number of electrons. (2 for s, 6 for p, 10 for d etc).
- The number of bound states is usually infinity
- An unbound state corresponds to electrons that are free and not bound to an ion

Visualizing a few typical atoms :

————— Vacuum level (Free states begin here)



$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J} = 8.066 \times 10^5 \text{ m}^{-1}$$

$$\Delta \varepsilon = h \nu = h c / \lambda$$

$$13.6 \text{ eV} \sim 10^7 \text{ m}^{-1} \rightarrow 1000 \text{ \AA}^0$$

Optical transitions:

Both ways (absorption or emission)

Energy increasing



n=4 N=32

n=3 N=18

n=2 N=8

n=1 N=2

atomic levels

n= Principal Q N

N= number of e's accommodated

Band 4

N=32

Band 3

N=18

Band 2

N=5

Band 1

N=2

Metal

Solid= array of atoms

Band 4

N=32

Band 3

N=18

Fermi level

Band 2

N=8

Band 1

N=2

Semiconductor

e.g. Si

Fermi Level= Energy of top most occupied energy level.