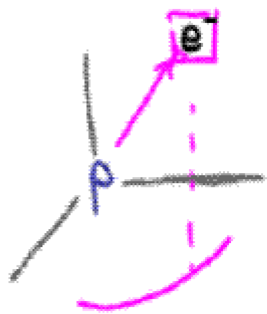
Physics 100 – October 17, 2007

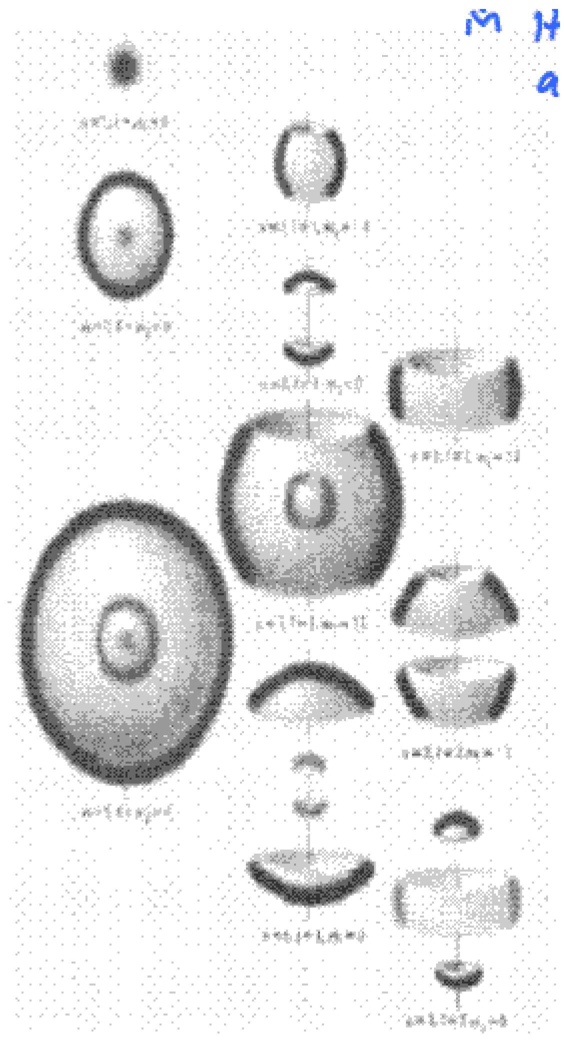
- Exams graded ... but data still needs to be recorded
- Will put in box outside my office for you to pick up (B+L 203 E)
- Will post solutions, grade distribution online
- Please look over your papers + solns carefully
- regrade policy on web
- Presentation groups

  - 7 Asteroids/extinctions
  - 6 GPS
  - 7 Nuclear Terrorism
  - 8 Nuclear Bombs
  - 6 Life + Times of X
  - 5 Cosmic Microwave Bckgnd
  - 5 Music

- Next week — class in your jammies

Quantum Mechanical treatment of H atom
(Schrödinger's equation) (single e^-)





only particular STATES of existance for electron allowed

STATES vary by energy + shape

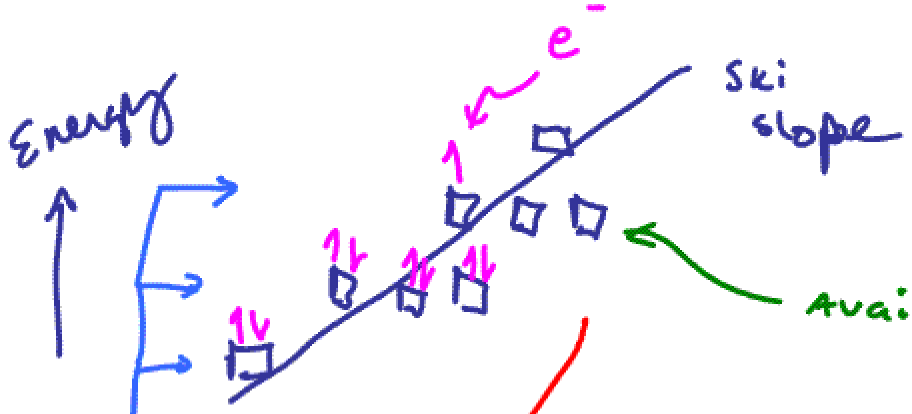
For multielectron atoms — Electrons fill lowest available energy state, then next higher available state, etc

chemical characteristics of atom determined by how electrons populate the available quantum states

For example — "ionization energy"

energy to remove e⁻ from atom

higher up — larger radius
~ easier to remove



Available quantum states
ski condos

The way electrons populate the STATES / condos determined by the fact they are "fermions" (spin ½)

Periodic structure in how e^- populate
Available houses
⇒ periodic structure in
Atomic characteristics

As Z = # protons increases → # electrons increase
→ determines type of atom/element

Periodic Table of the elements

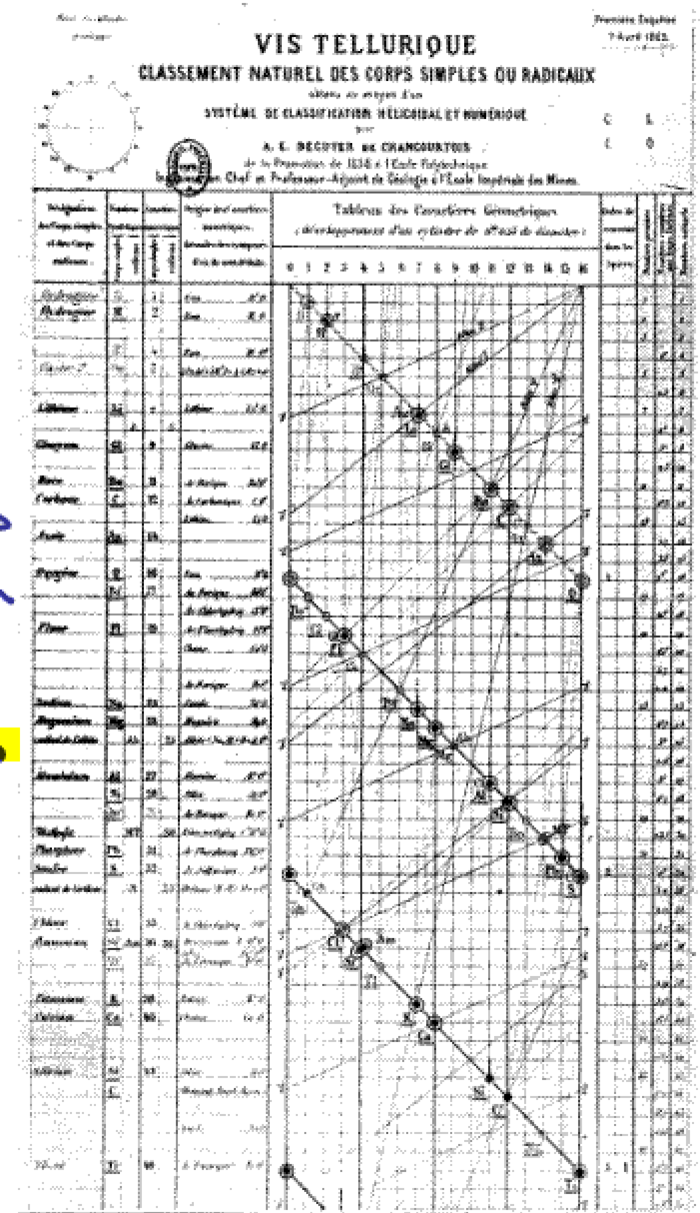
John Newlands - English analytical chemist (1837-1898) ... Arranged table of elements by ATOMIC MASSES

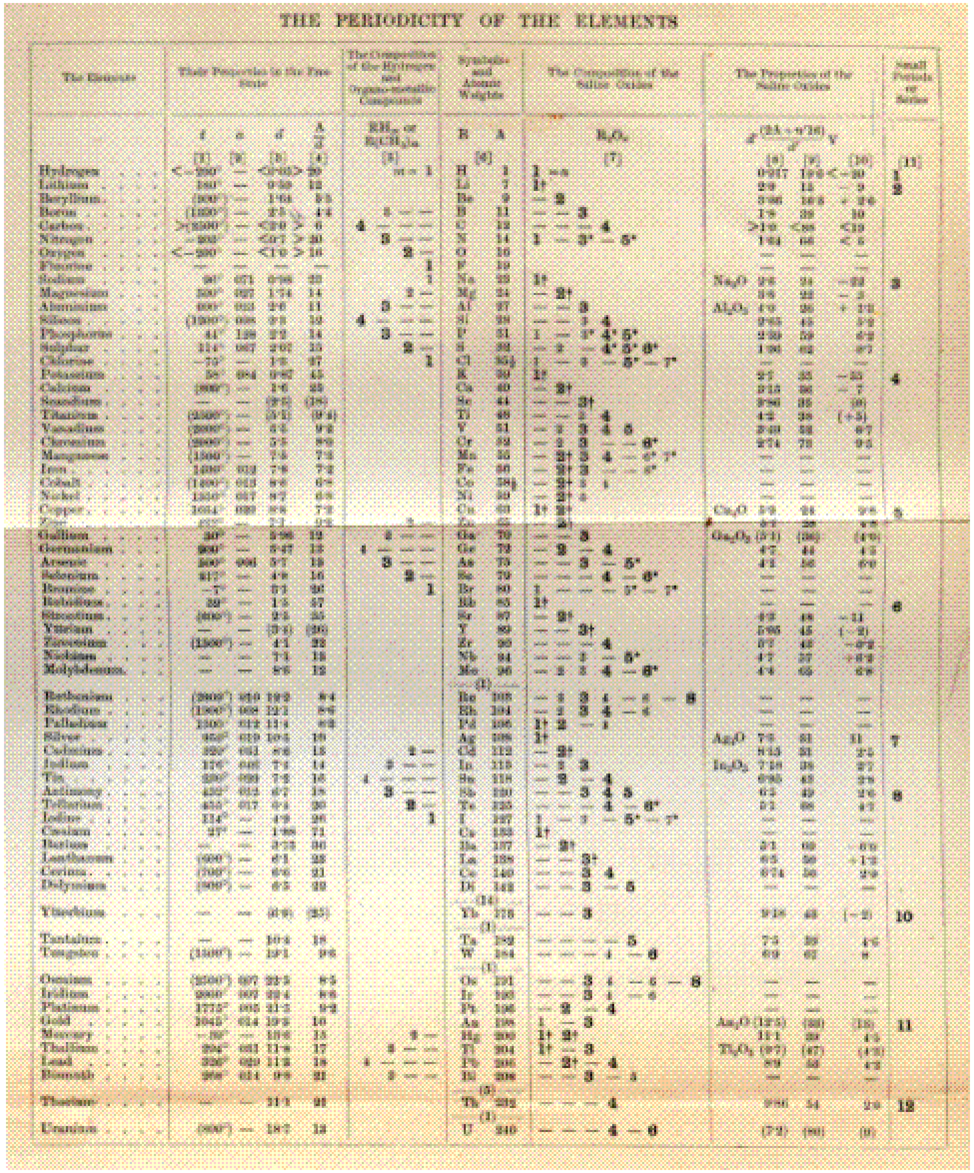
Antoine Lavoisier
France (1743-1794)

"Father of Modern chemistry"
quantitative Analysis

guillotined during French Revolution

Alexandre-Emile Béguyer de Chancourtios
France (1820-1886)




THE PERIODICITY OF THE ELEMENTS

Dmitri Mendeleev
Russian (1834–1907)

when elements arranged by mass – see a certain periodicity in their chemical properties.

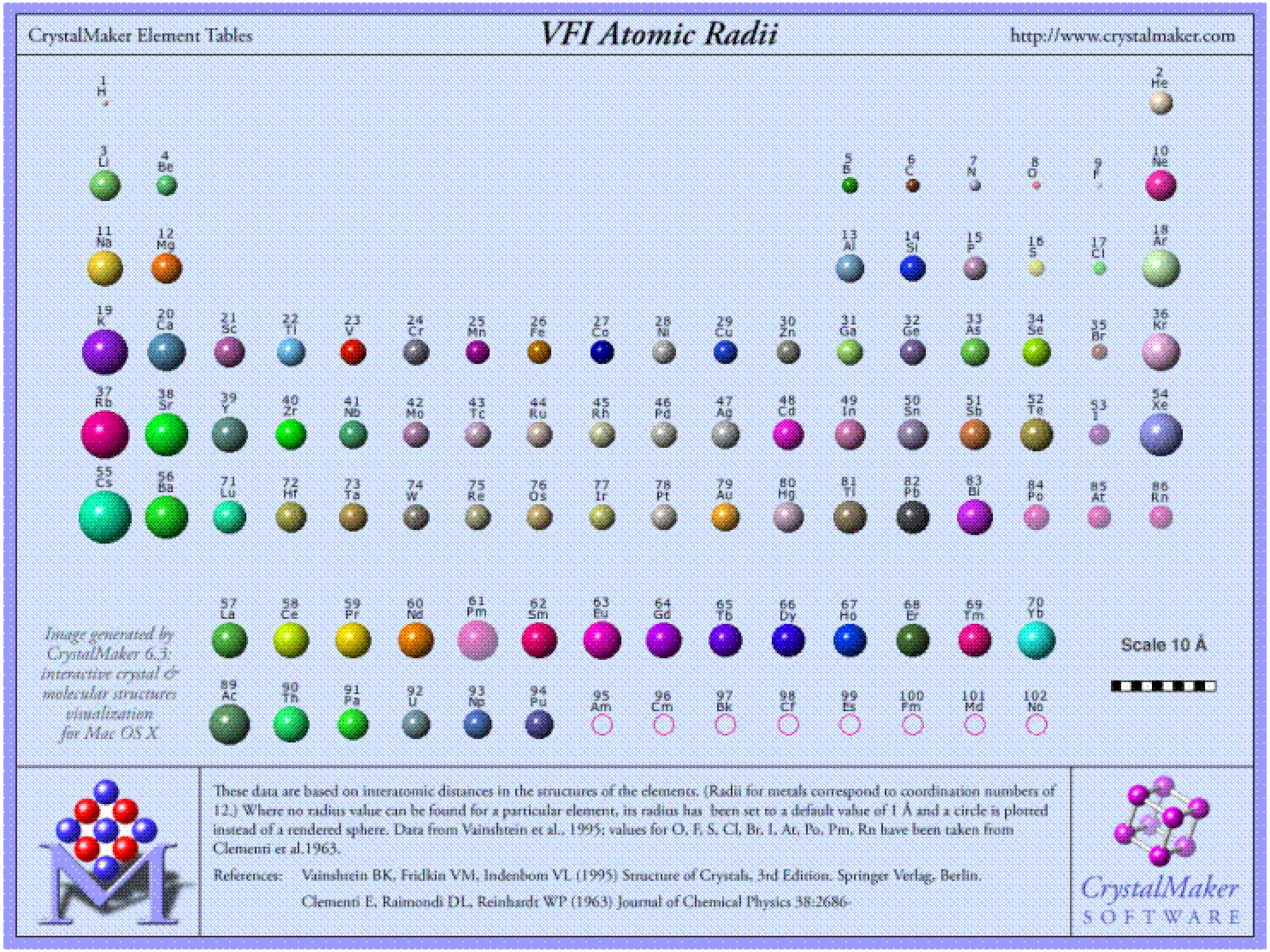
Los Alamos National Laboratory Chemistry Division

Periodic Table of the Elements

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	11B	12B	3A	4A	5A	6A	7A	8A
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
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
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
55 Cs	56 Ba	57 La*	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
87 Fr	88 Ra	89 Ac~	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Uub		114 Uuq		116 Uuh		118 Uuo

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
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

element names in blue are liquids at room temperature
element names in red are gases at room temperature
element names in black are solids at room temperature

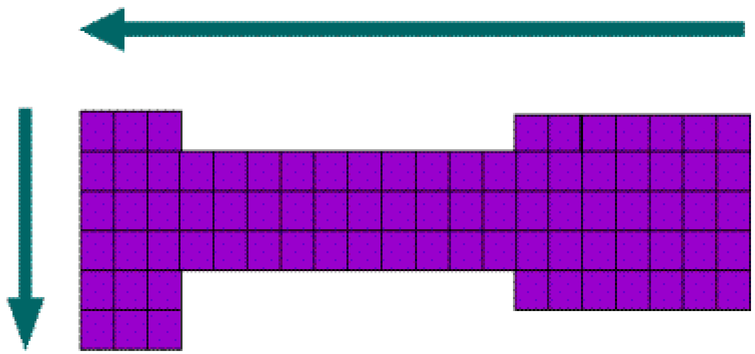


CrystalMaker Element Tables
VFI Atomic Radii
http://www.crystalmaker.com
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 Ar
19 K
20 Ca
21 Sc
22 Ti
23 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
39 Y
40 Zr
41 Nb
42 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
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
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
Scale 10 Å
Image generated by CrystalMaker 6.3: interactive crystal & molecular structures visualization for Mac OS X
These data are based on interatomic distances in the structures of the elements. (Radii for metals correspond to coordination numbers of 12.) Where no radius value can be found for a particular element, its radius has been set to a default value of 1 Å and a circle is plotted instead of a rendered sphere. Data from Vainshtein et al., 1995; values for O, F, S, Cl, Br, I, At, Po, Pm, Rn have been taken from Clementi et al.1963.
References: Vainshtein BK, Fridkin VM, Indenbom VL (1995) Structure of Crystals, 3rd Edition. Springer Verlag, Berlin.
Clementi E, Raimondi DL, Reinhardt WP (1963) Journal of Chemical Physics 38:2686-
CrystalMaker SOFTWARE

Figures from –

http://www.shodor.org/chemviz/ionization/students/background.html

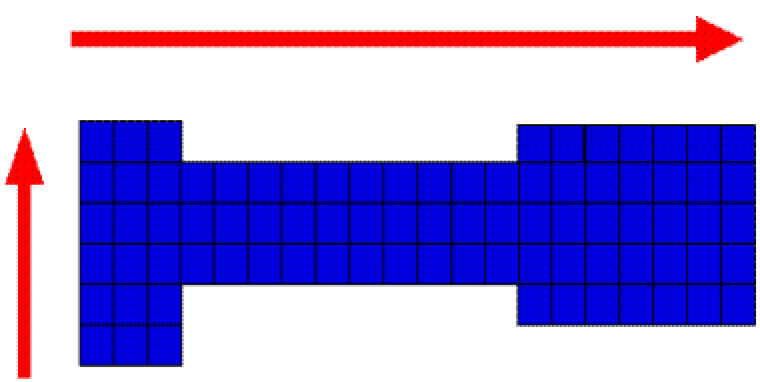
Atomic Size Increases With Arrows

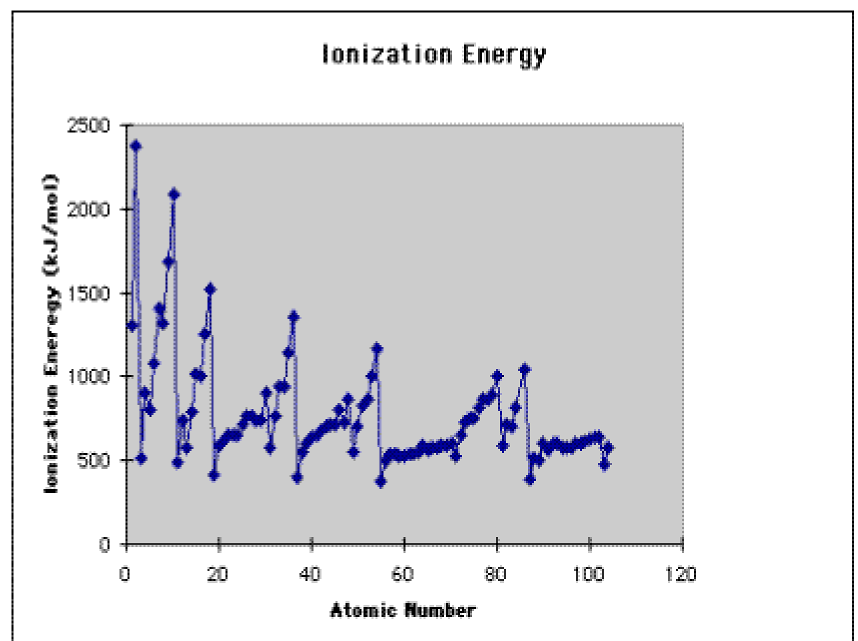


ionization Energy

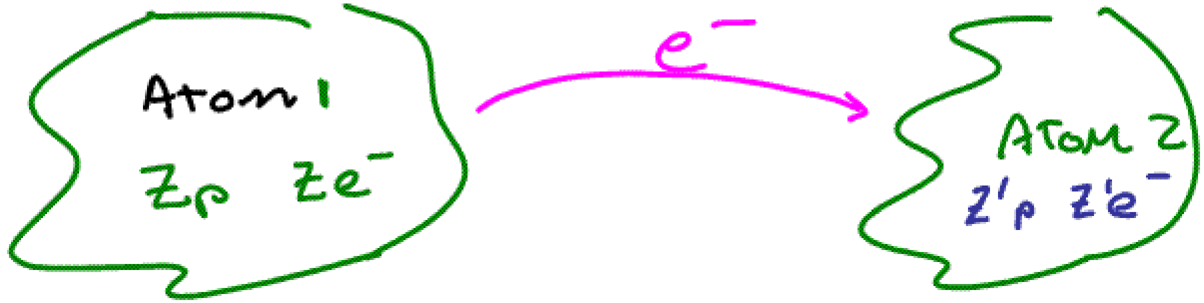
energy to remove an electron

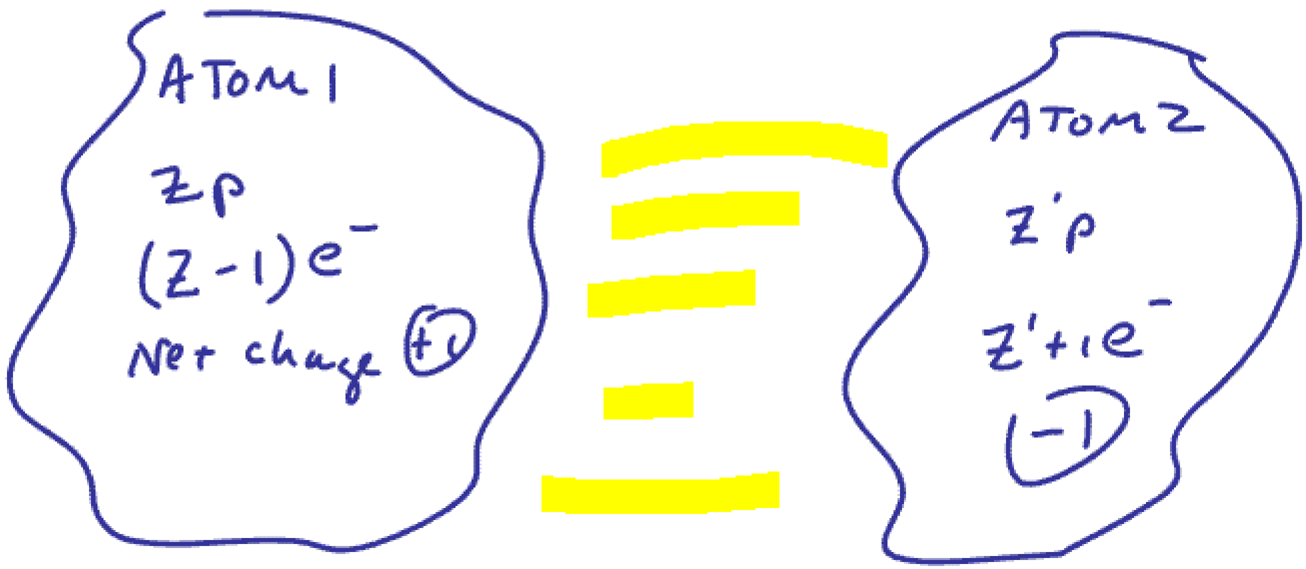
Ionization Energy Increases With Arrows





Chemistry





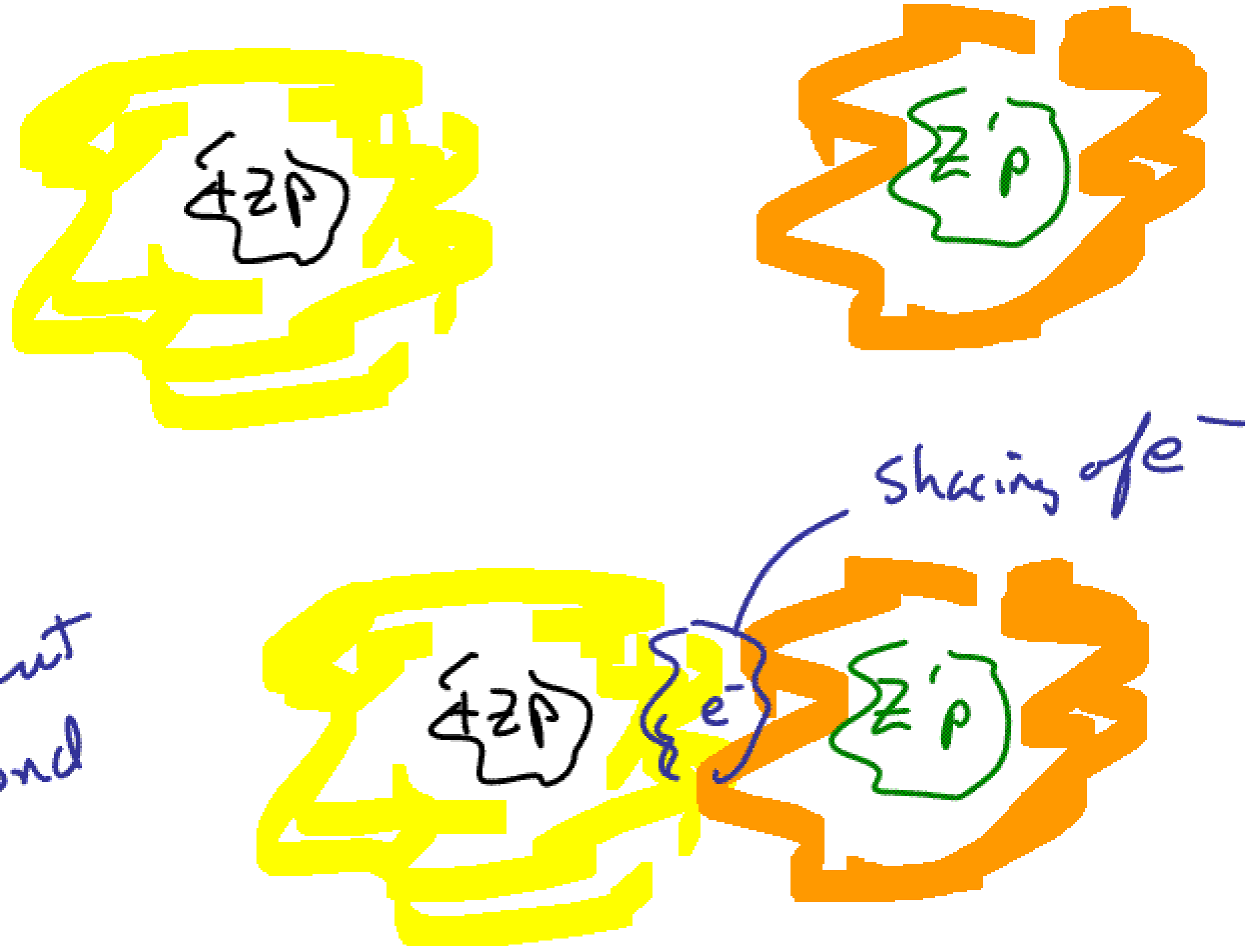
ionic Bond

Attraction

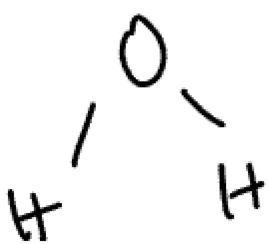
Coulomb

$Na^+ Cl^-$

Sodium chloride (SALT)



Covalent Bond



water

Quantum Mechanics + Uncertainity

$$\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + V\psi(x) = E\psi(x)$$

1927 Copenhagen Interpretation of QM

Bohr
Heisenberg
Born

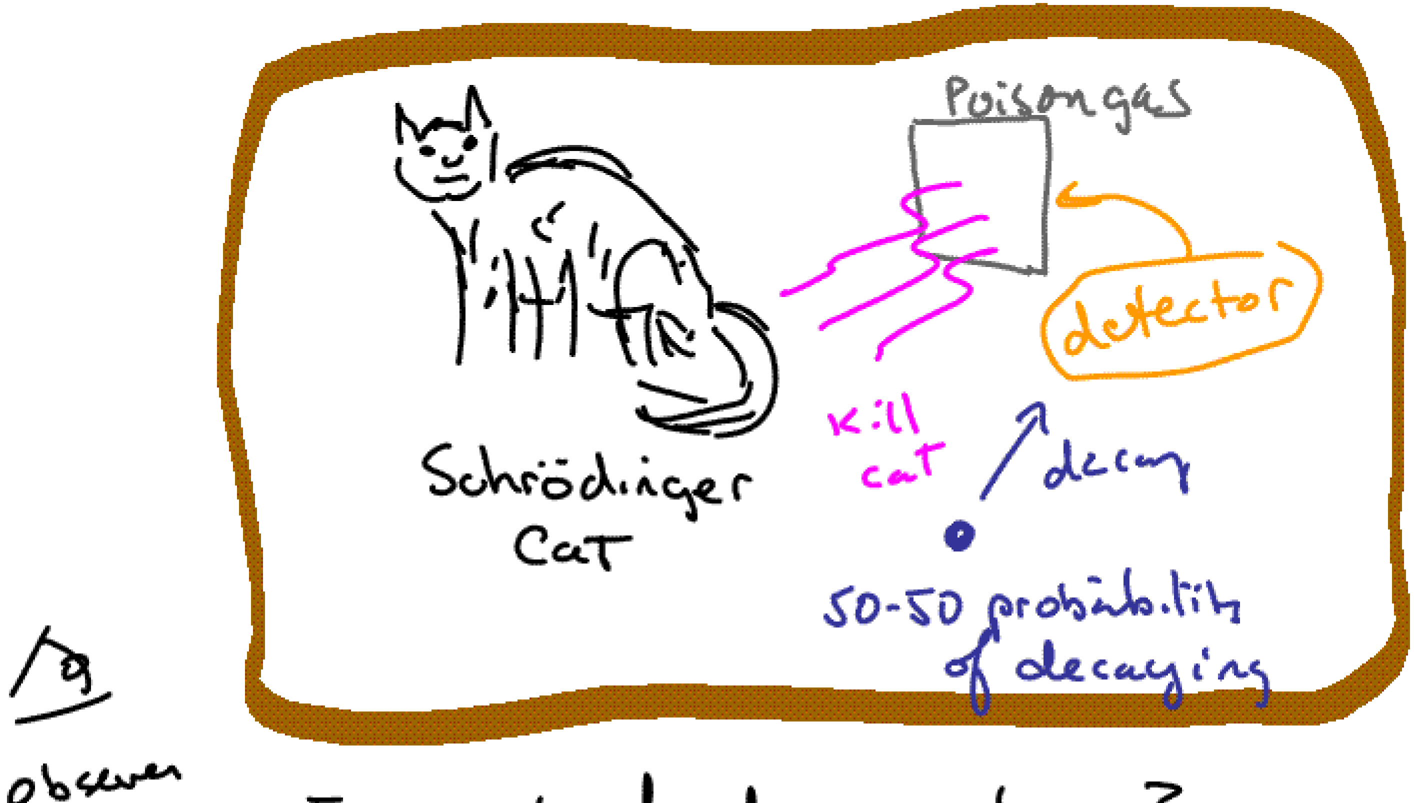
$\psi(x)$ not well defined → tool for calculation

↳ ≡ Wave function

$\psi^2(x)$ is well defined

measure of the probability of finding the particle at position x

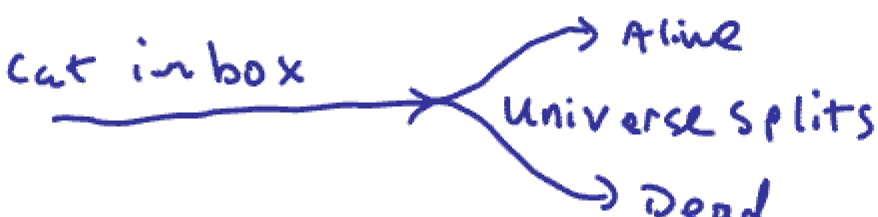
Probabilistic

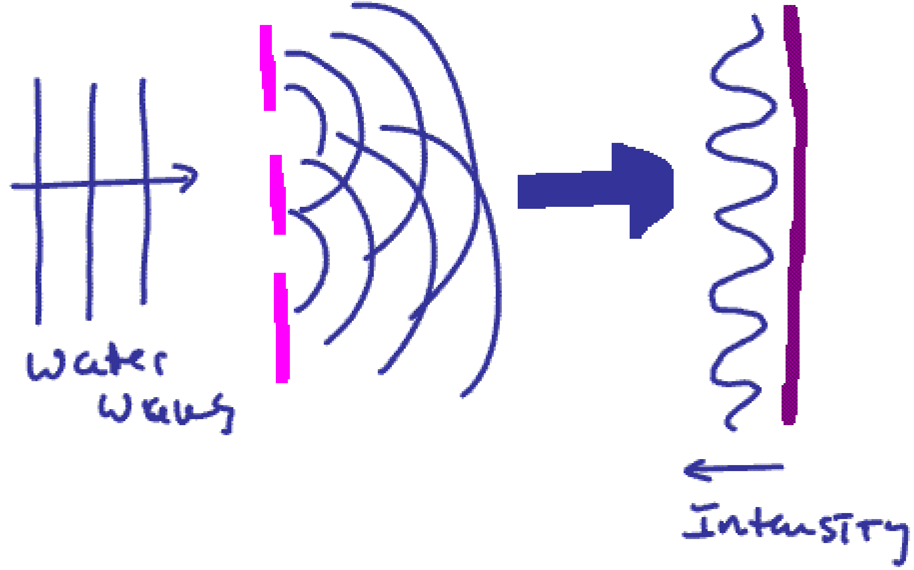


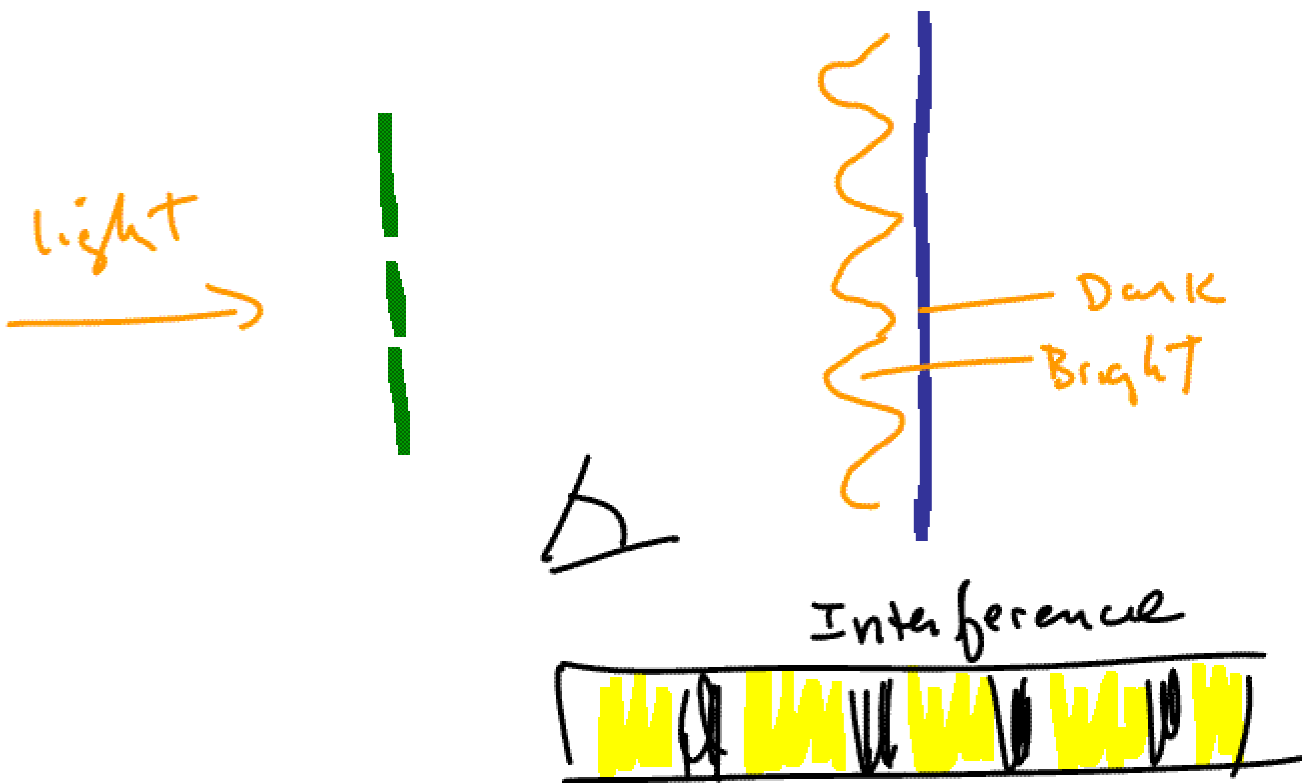
Is cat dead or alive?

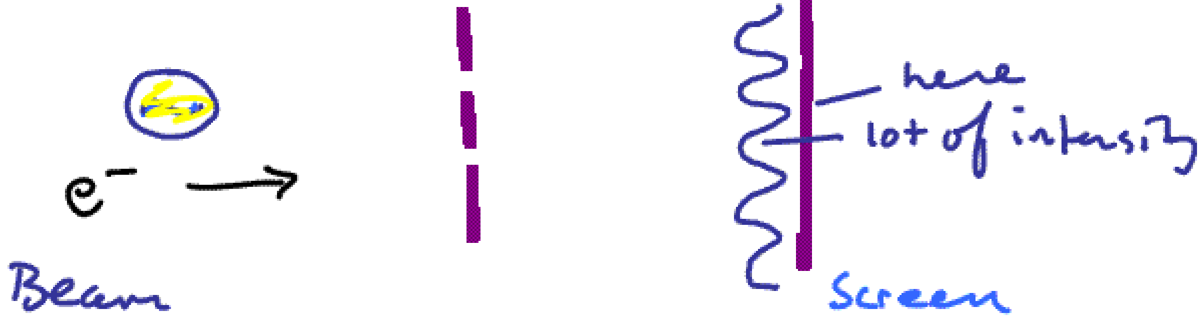
Copenhagen $\quad Cat = \frac{1}{2}\left(|Dead\rangle + |Alive\rangle \right)$

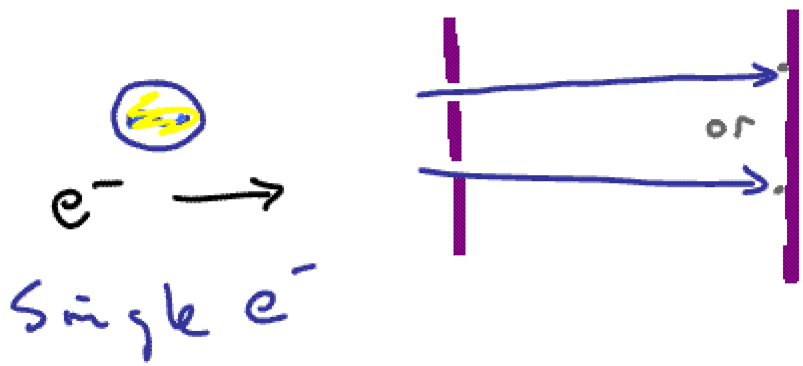
Many worlds view of quantum Mechanics

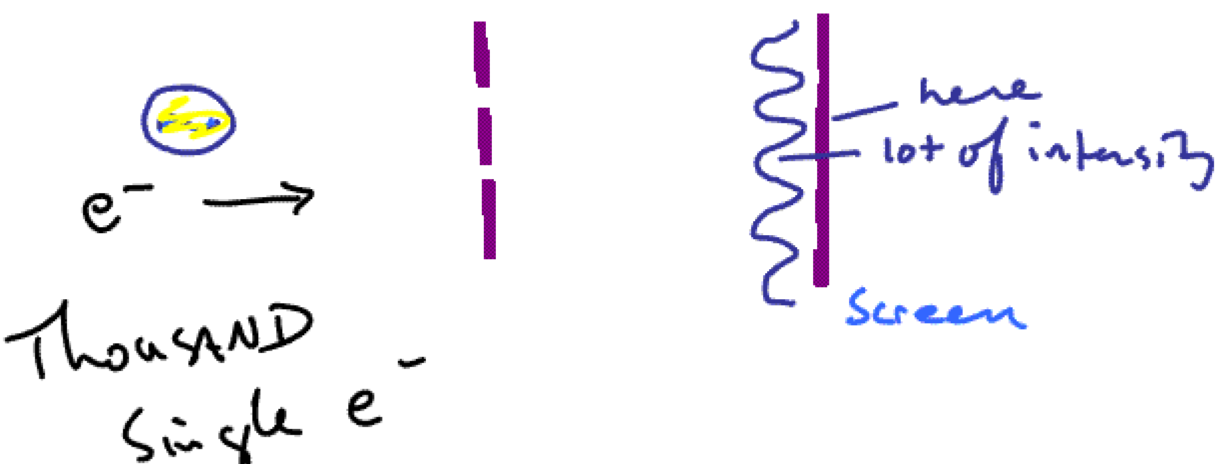


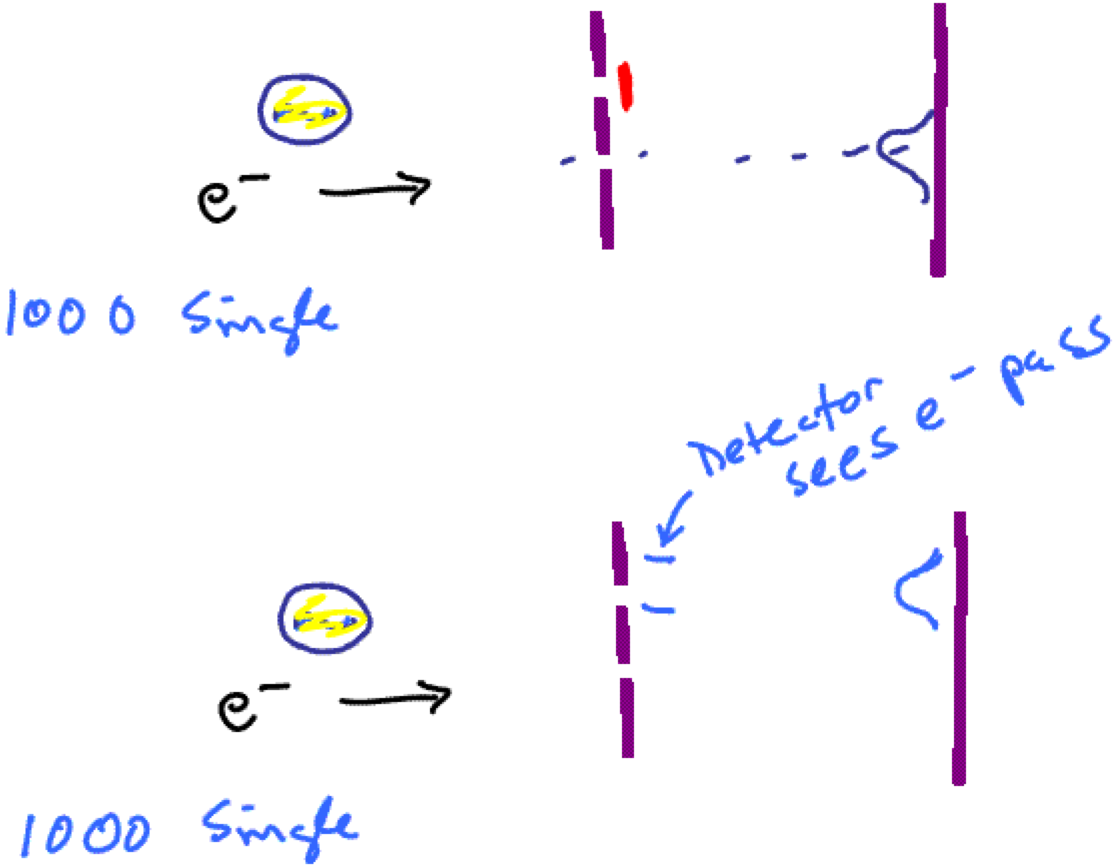

water waves
Intensity


light
Dark
Bright
Interference


e⁻
Beam
here
lot of intensity
Screen


e⁻
or
Single e⁻


e⁻
here
lot of intensity
Screen
THOUSAND
Single e⁻



Observation "collapses" wavefunction + interference pattern disappears