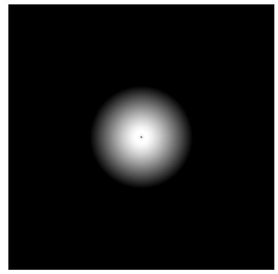
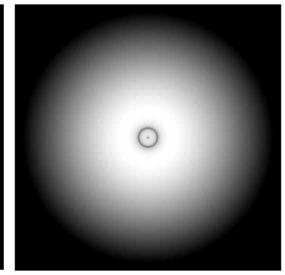
CH101 - Multi-electron atoms handout

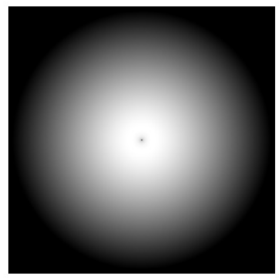
What we know about electron waves so far



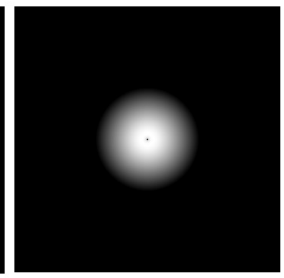
H $1s$



H $2s$



H $1s$



He^{+} $1s$

1

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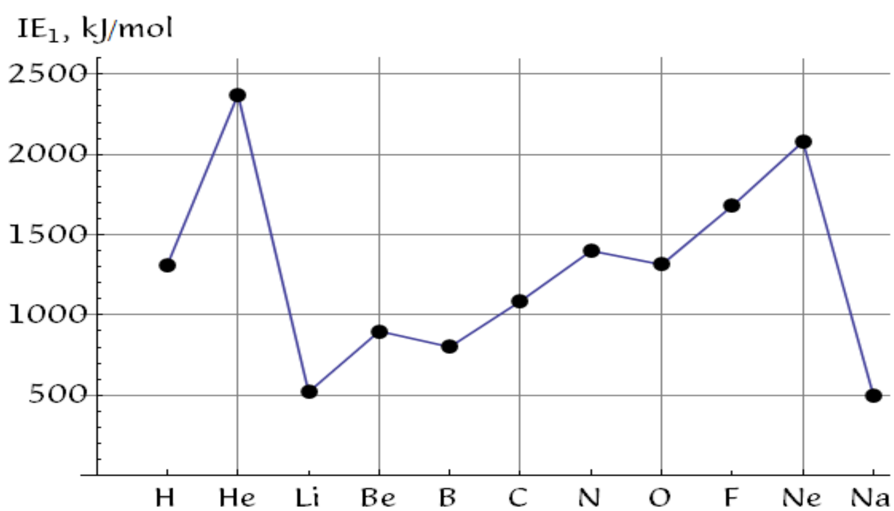
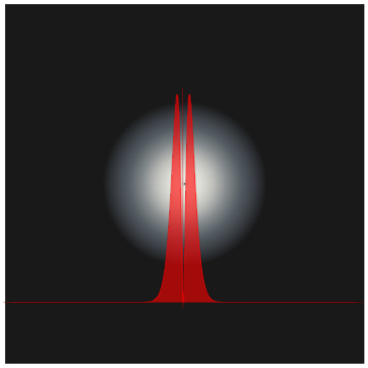
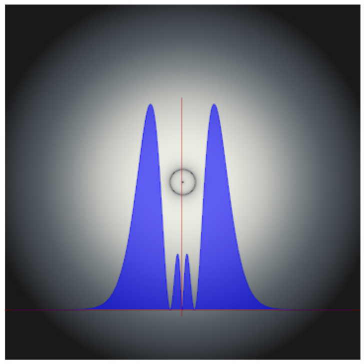
First ionization energy of first two periods

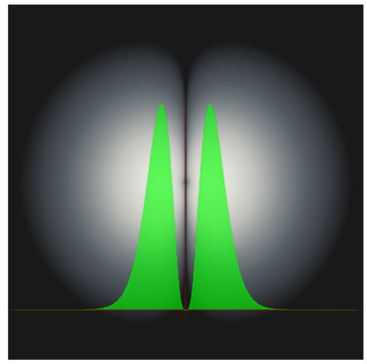


2

Two of lithium's electrons are 1s







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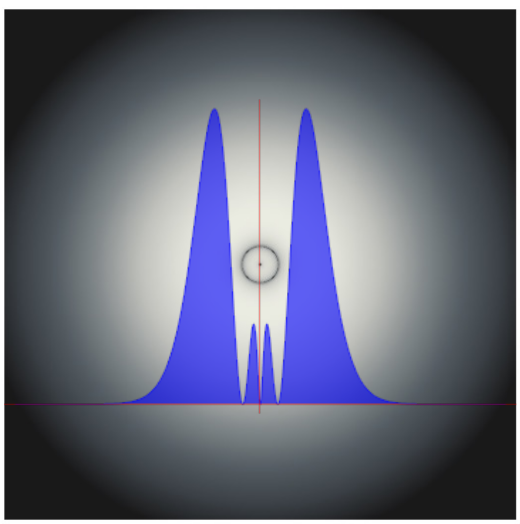
3

2s portion of Li $1s^2 2s$ electron cloud



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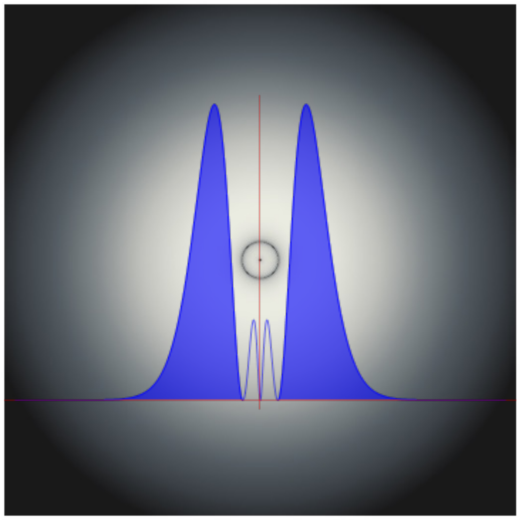
4

2s **outer loop** of Li $1s^2 2s$ electron cloud



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5

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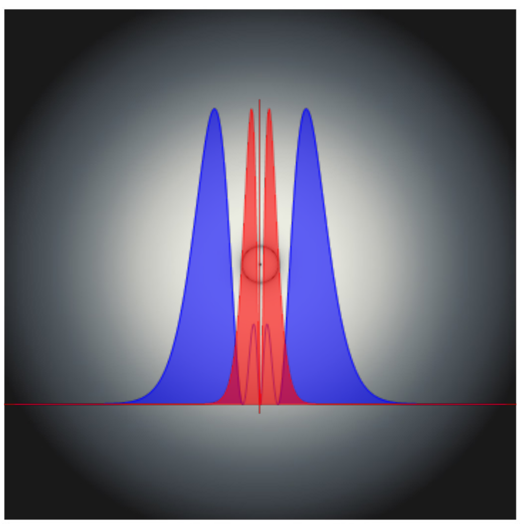
2s **outer loop is shielded** by $1s^2$ cloud



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6

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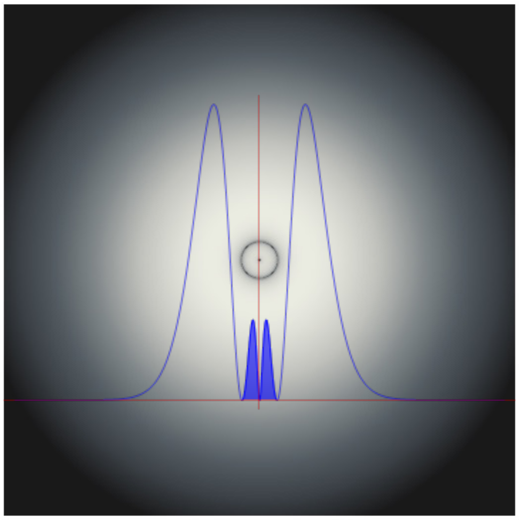
2s inner loop of Li $1s^2 2s$ electron cloud



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7

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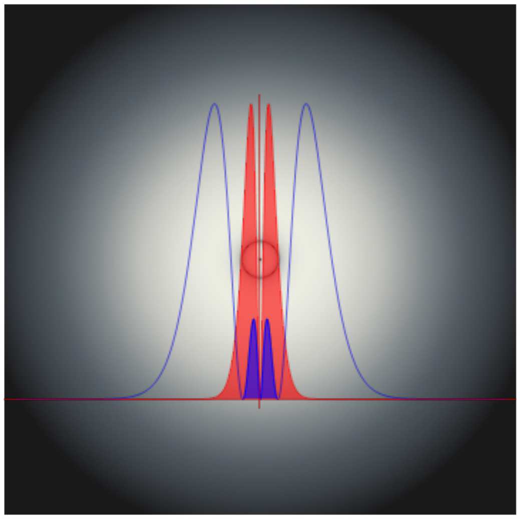
2s inner loop is not shielded by $1s^2$ cloud



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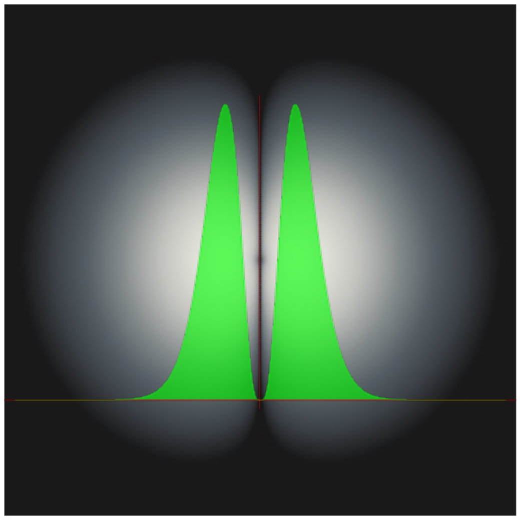
8

2p portion of Li $1s^22p$ electron cloud



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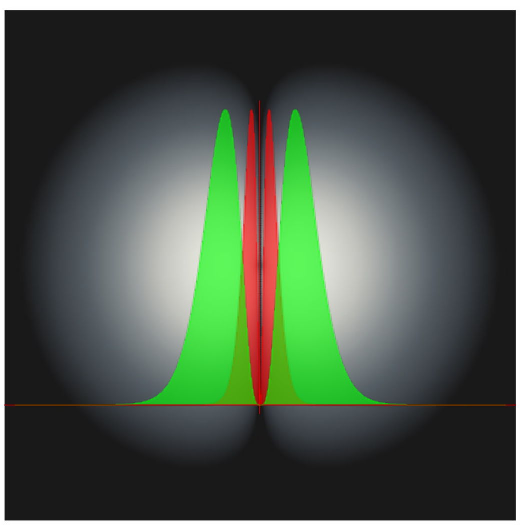
9

2p is shielded by $1s^2$ cloud



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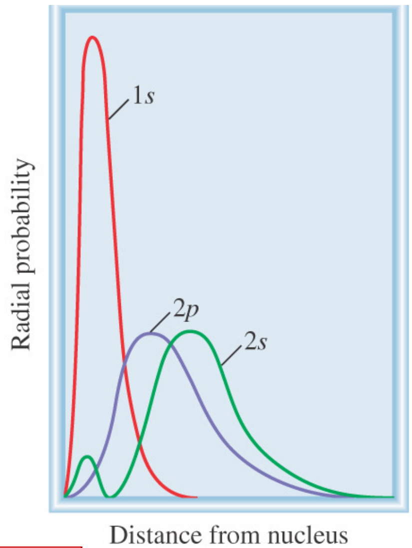
10

Shielding of 2p



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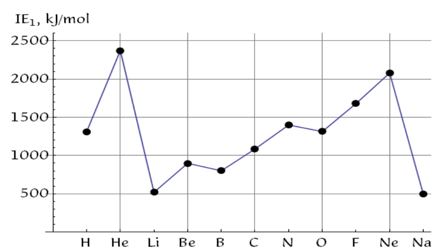
11

First ionization energy, I_1



Big take-away messages:

- **Biggest effect** is number of loops (*n*)
- Then we look at the nuclear charge
  In general, increasing *Z* leads to larger Z_{eff} and higher ionization energy

Small things:

- First new shielding (i.e., new subshell) decreases IE
- First electron/electron repulsion decreases IE

TRENDS: (a) Size and (b) Ionization energy→ ALL FOLLOW ABOVE RULES!

$E_n = -(2.18\text{ aJ})\, Z_{eff}^2/n^2$

radius = 52.9 pm n^2/Z_{eff}^2

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Periodic Trends summary

Valence electrons are the ones with the largest value of "*n*" (number of loops) → easiest to ionize and largest in size

Trends:

(1) Down family → increase *n*, so decrease in ionization energy
(also explains why alkali metals are the lowest ionization energy)

(2) Across period → increase Z leads to increase Z_{eff} and so increase in ionization energy (explains why the noble gases are the highest ionization energies)

(3) Small "blips" across period → shielding and e^-/e^- repulsion

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13