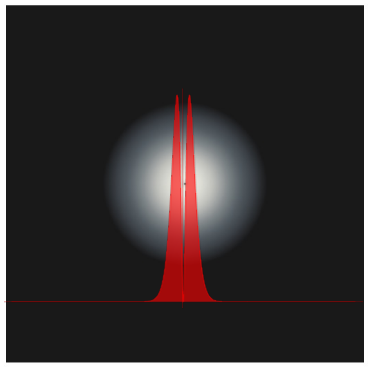
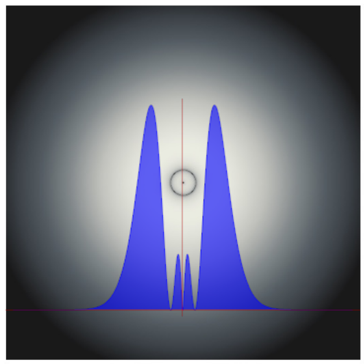
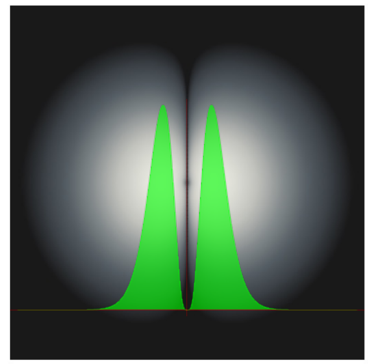
Shielding and multi-electron atoms

Two of lithium's electrons are 1s

<u>Goal:</u> Estimate the effective nuclear charge (Z_{eff}) experienced by the Li atom 2s and 2p orbitals. Use images on the following slides to guide you.







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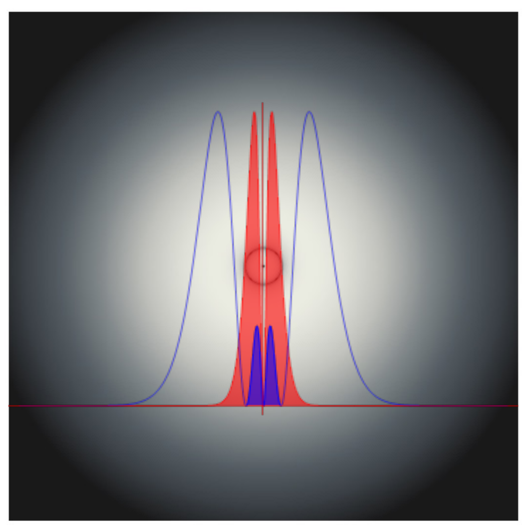
1

Shielding and multi-electron atoms

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

The outer loop of 2s is about 10% of the electron wave.



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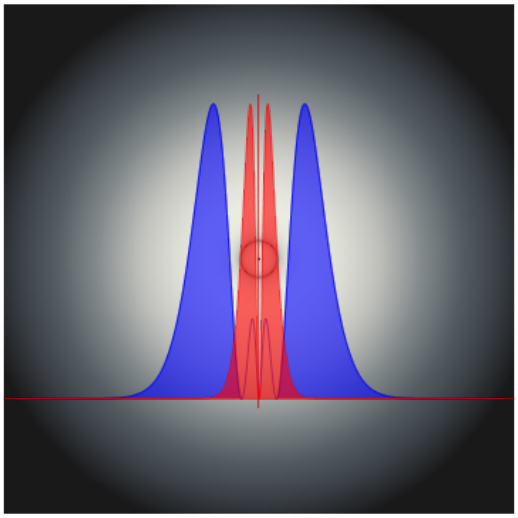
2

Shielding and multi-electron atoms

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

The outer loop of 2s is about 90% of the electron wave.



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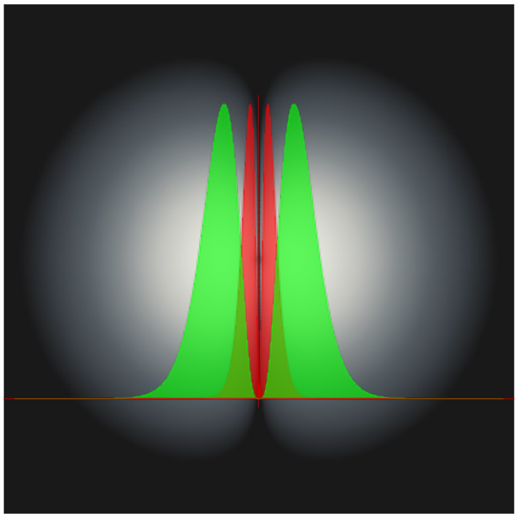
3

Shielding and multi-electron atoms

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



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Shielding of 2s and 2p in Li

- **Draw** an energy level diagram showing the relative energies of lithium's 2s and 2p orbitals. How does this explain the ground-state electron configuration of lithium?

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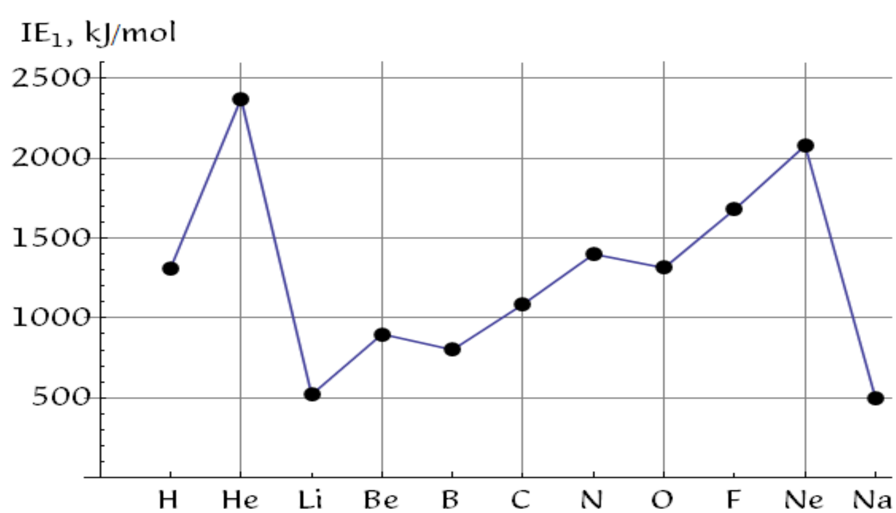
First ionization energy of first two periods



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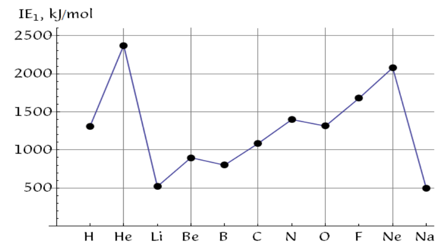
Shielding and multi-electron atoms

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 = $52.9\text{ pm } n^2/Z_{eff}^2$

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Shielding and multi-electron atoms

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 decrease 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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