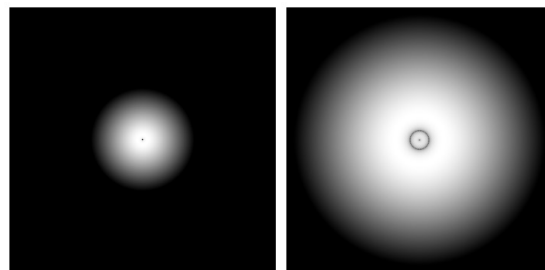


## What we know about electron waves so far



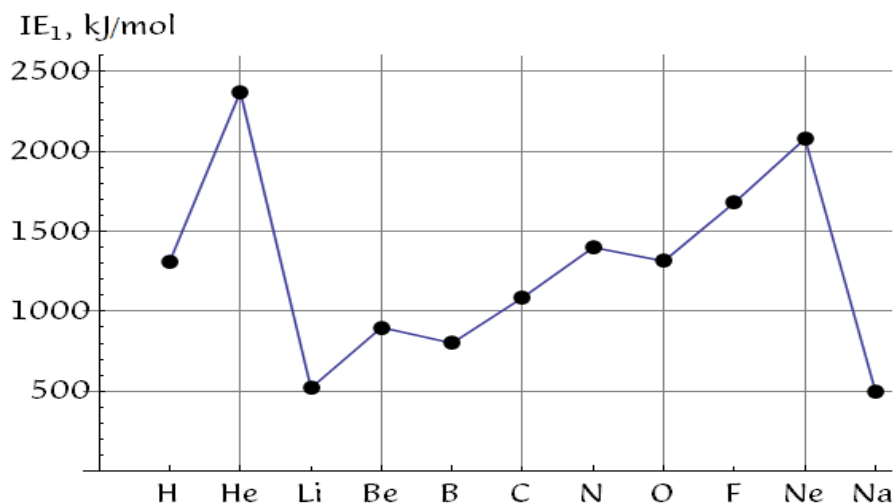
H 1s

H 2s

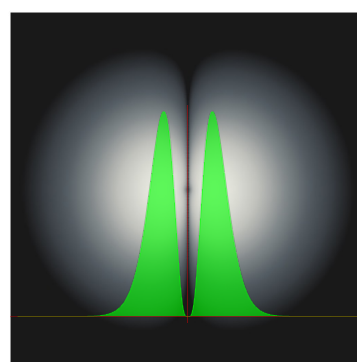
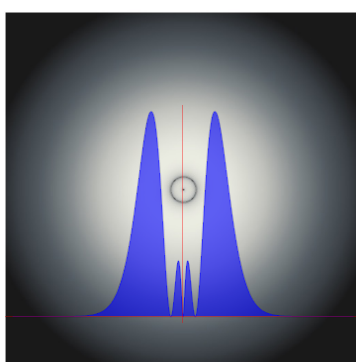
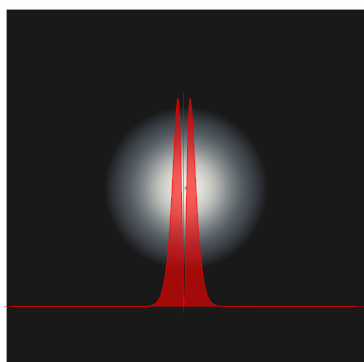
H 1s

He<sup>+</sup> 1s

## First ionization energy of first two periods

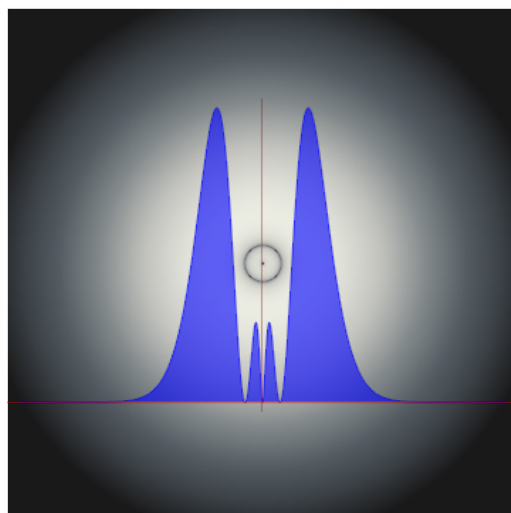


## Two of lithium's electrons are 1s



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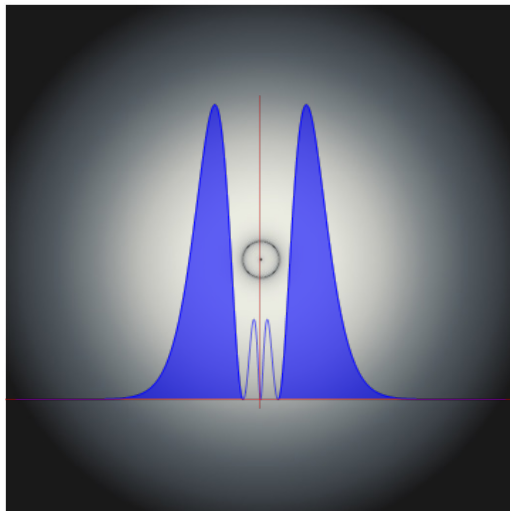
## 2s portion of Li $1s^2 2s$ electron cloud



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

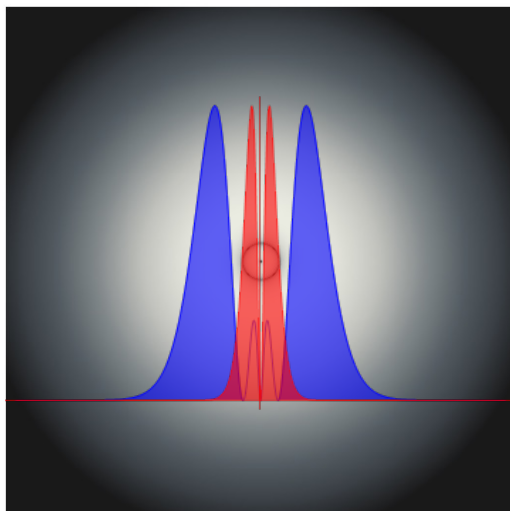


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## 2s outer loop is shielded by $1s^2$ cloud

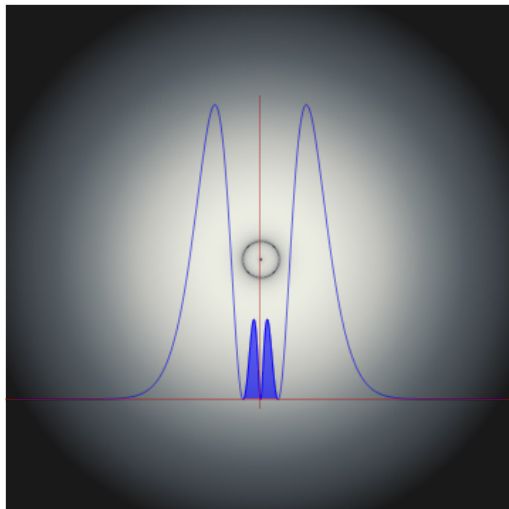


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2s **inner loop** of Li  $1s^2 2s$  electron cloud

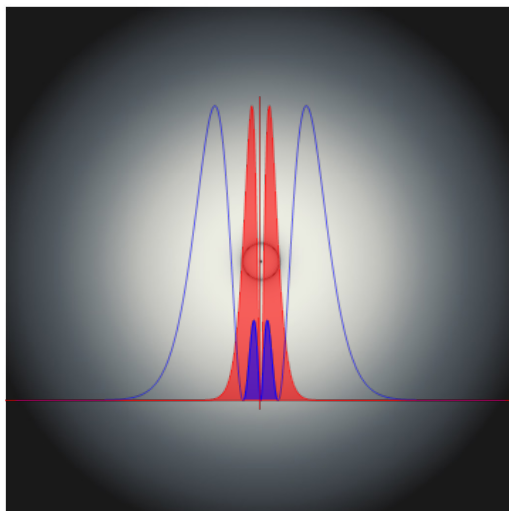


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2s **inner loop** is **not shielded** by  $1s^2$  cloud

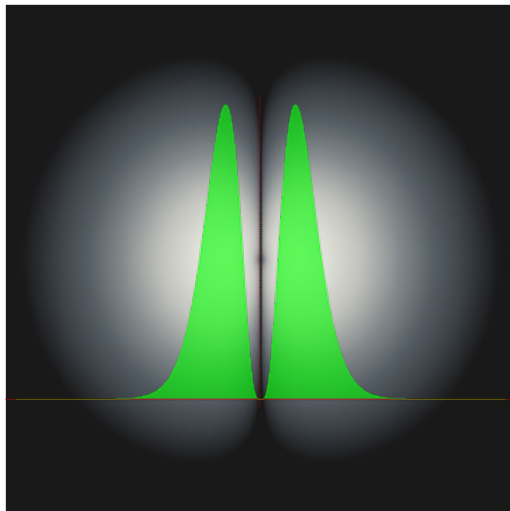


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## 2p portion of Li $1s^2 2p$ electron cloud

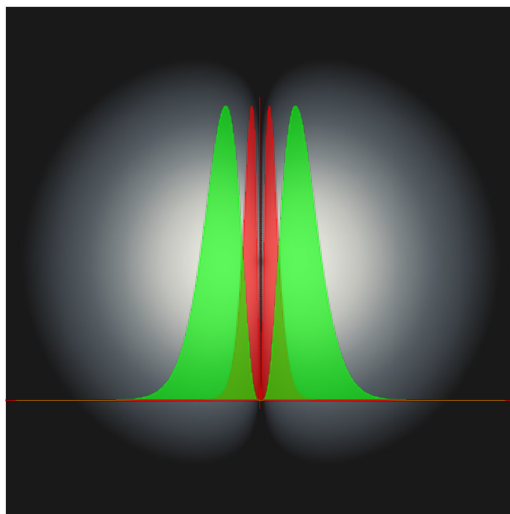


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CH101 - Multi-electron atoms handout

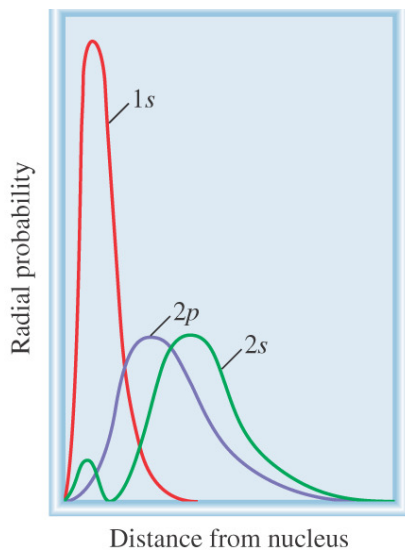
## 2p is shielded by $1s^2$ cloud



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## Shielding of 2p



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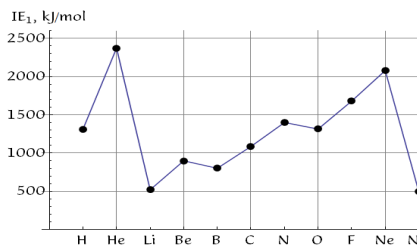
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## First ionization energy, $I_1$

### 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  $Z_{\text{eff}}$  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!

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

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

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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  $Z_{\text{eff}}$  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

