Physics & Astronomy presents:

Alia Wofford
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"Breaking the Ice: The Dynamics Behind Snowball Earth's Meltdown"

April 10th at noon in OLIN 268
Pizza will be served

You can also join Alia at 4pm in OLIN 264 for diamond painting!
Attendees will make a space-themed coaster or other diamond art to keep

The 3-D Schrödinger Equation

$$-\frac{\hbar^2}{2mr^2}\left[\frac{\partial}{\partial r}\left(r^2\frac{\partial\psi}{\partial r}\right)+\frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial\psi}{\partial\theta}\right)+\frac{1}{\sin^2\theta}\frac{\partial^2\psi}{\partial\phi^2}\right]+U\psi=E\psi$$

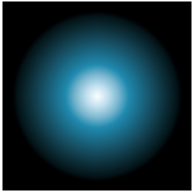
For hydrogen: $U = \dfrac{kq_1q_2}{r} = -\dfrac{ke^2}{r}$ (remember Unit 1!)

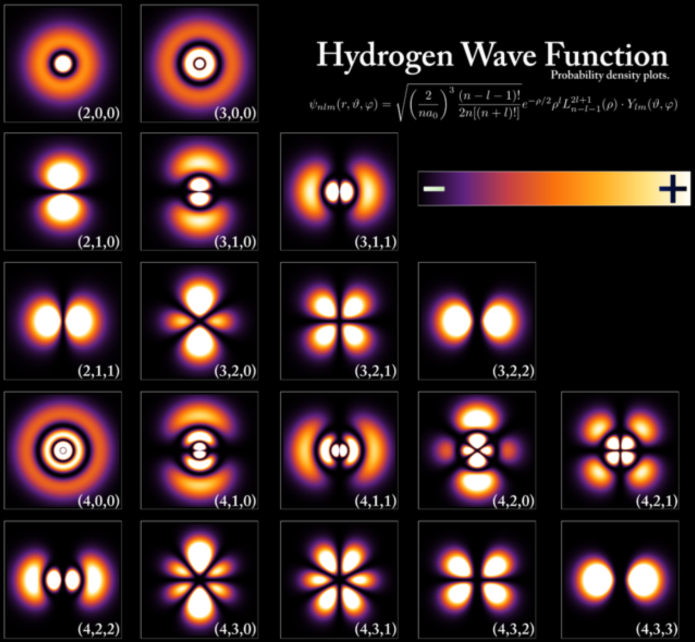
	n	ℓ	m_ℓ	$\psi_{n\ell m_\ell}(r,\theta,\phi)$
1s	1	0	0	$\frac{1}{\sqrt{\pi a_0^3}}\, e^{-r/a_0}$
2s	2	0	0	$\frac{1}{4\sqrt{2\pi a_0^3}}\left[2-\frac{r}{a_0}\right] e^{-r/2a_0}$
2p	2	1	0	$\frac{1}{4\sqrt{2\pi a_0^3}}\,\frac{r}{a_0}\, e^{-r/2a_0}\,\cos\theta$
2p	2	1	±1	$\frac{1}{8\sqrt{\pi a_0^3}}\,\frac{r}{a_0}\, e^{-r/2a_0}\,\sin\theta\, e^{\pm i\phi}$

$a_0 = \dfrac{\hbar^2}{me^2} = 0.0529\,\text{nm}$

Probability density is $|\psi|^2$

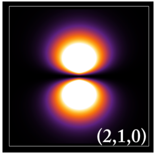
For 1s orbital:




Hydrogen Wave Function
Probability density plots.
$\psi_{nlm}(r,\vartheta,\varphi) = \sqrt{\left(\frac{2}{na_0}\right)^3 \frac{(n-l-1)!}{2n[(n+l)!]}}\, e^{-\rho/2}\rho^l L^{2l+1}_{n-l-1}(\rho)\cdot Y_{lm}(\vartheta,\varphi)$
−
+
(2,0,0)
(3,0,0)
(2,1,0)
(3,1,0)
(3,1,1)
(2,1,1)
(3,2,0)
(3,2,1)
(3,2,2)
(4,0,0)
(4,1,0)
(4,1,1)
(4,2,0)
(4,2,1)
(4,2,2)
(4,3,0)
(4,3,1)
(4,3,2)
(4,3,3)

Lecture 19 — Concept Test 1

The probability density for the 2p state is shown at right. What does this mean about the electron orbiting the nucleus?



1. The electron orbits the nucleus in a circular orbit
2. The electron orbits the nucleus in an elliptical orbit
3. The electron precesses as it orbits the nucleus
4. The electron's orbit is unstable and changes each time it circles around the nucleus
5. You can't think of the electron as orbiting in any classical sense

Lecture 19 — Concept Test 2

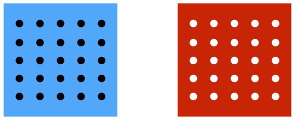
How many possible quantum states can an electron in the hydrogen atom with $n = 2$ have?

1. 2
2. 4
3. 6
4. 8
5. 10
6. 12

Group→ ↓Period	1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																		2 He
2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	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
5	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
6	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
7	87 Fr	88 Ra	89 Ac	**	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
				*	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	
				**	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	

Lecture 19 — Concept Test 3

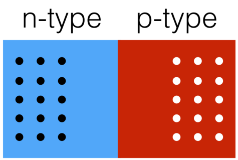
You have two isolated doped semi-conductors (not in contact with one another). Which of the following is true?



1. The p-type has a net positive charge and the n-type has a net negative charge
2. The n-type has a net positive charge and the p-type has a net negative charge
3. Both the p-type and n-type are uncharged

Lecture 19 — Concept Test 4

We now bring the two semiconductors into contact, creating a depletion zone near the boundary between them. Which of the following is true?



1. The p-type has a net positive charge and the n-type has a net negative charge

2. The n-type has a net positive charge and the p-type has a net negative charge

3. Both the p-type and n-type are uncharged