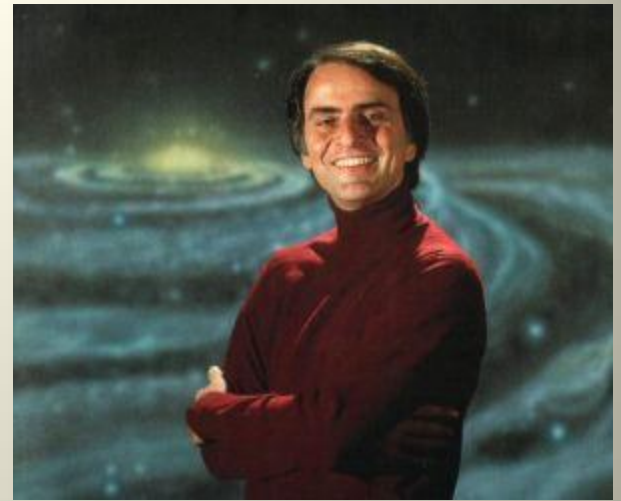


Welcome to Class 3: Stars, Galaxies and the Universe

Remember: sit only in the first 10
rows of the room

Are we really made of 'Star Stuff'? What the heck does that mean, anyway?



Only 4% of the Universe is made of matter astronomers understand. What evidence is there for this?

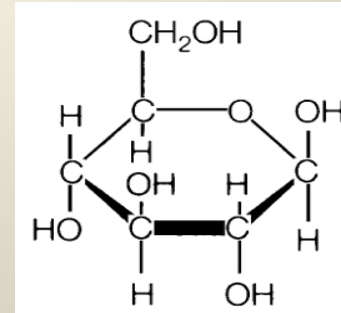
Remember: sit in the first 10 rows
of the room only

Join groups, discuss then individually answer with your PRS: Astronomy tells us

1. The age of the universe is infinite
2. The elements of life are seen only on Earth.
3. The observable universe is finite
4. The physical laws have changed with time.

1. Which elements are important for life?

H, C, N, O, Mg, Si, Fe, etc..
The list is pretty long.



Glucose

1A										2A						3A				4A		5A		6A		7A		8A															
1 H 1.00794											4 Be 9.012182					5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797					1 H 1.00794	2 He 4.002602																
3 Li 6.941											12 Mg 24.3050					13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948					3 K 39.0983	4 Ca 40.078	21 Sc 44.955910	22 Ti 47.887	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29					55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.2217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po (209)	85 At (210)	86 Rn (222)				
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)					114 (289)	(287)			116 (289)			118 (293)																				

58 Ce 140.116	59 Pr 140.90765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04	71 Lu 174.967
90 Th 232.0381	91 Pa 231.03688	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

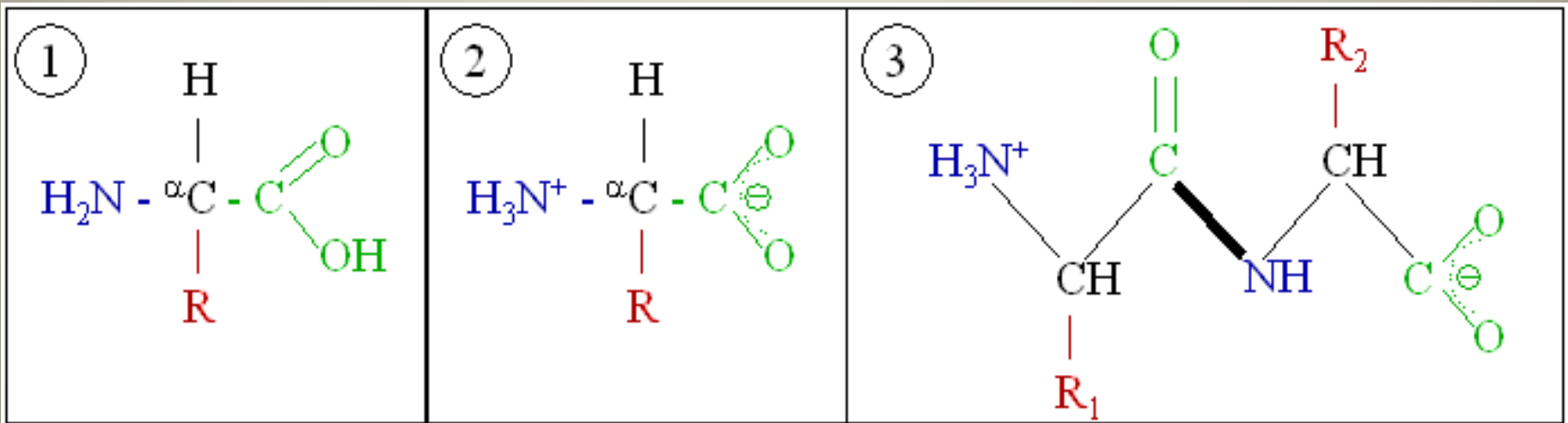
2. Where did (most of) the elements of life come from?



-> Stars

3. Are these elements seen just on Earth or elsewhere?

-> Everywhere! And more than mere elements are seen in space..



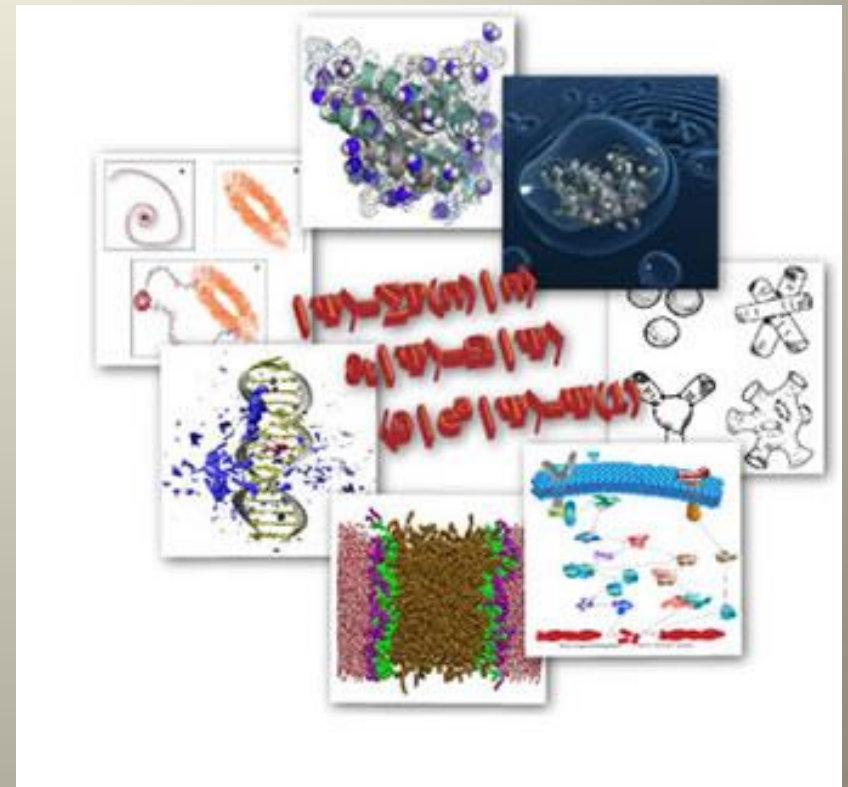
Amino Acids are the building blocks of life (make up proteins/enzymes). They are found naturally in space!

4. What governs the formation of atoms, molecules and matter in general?

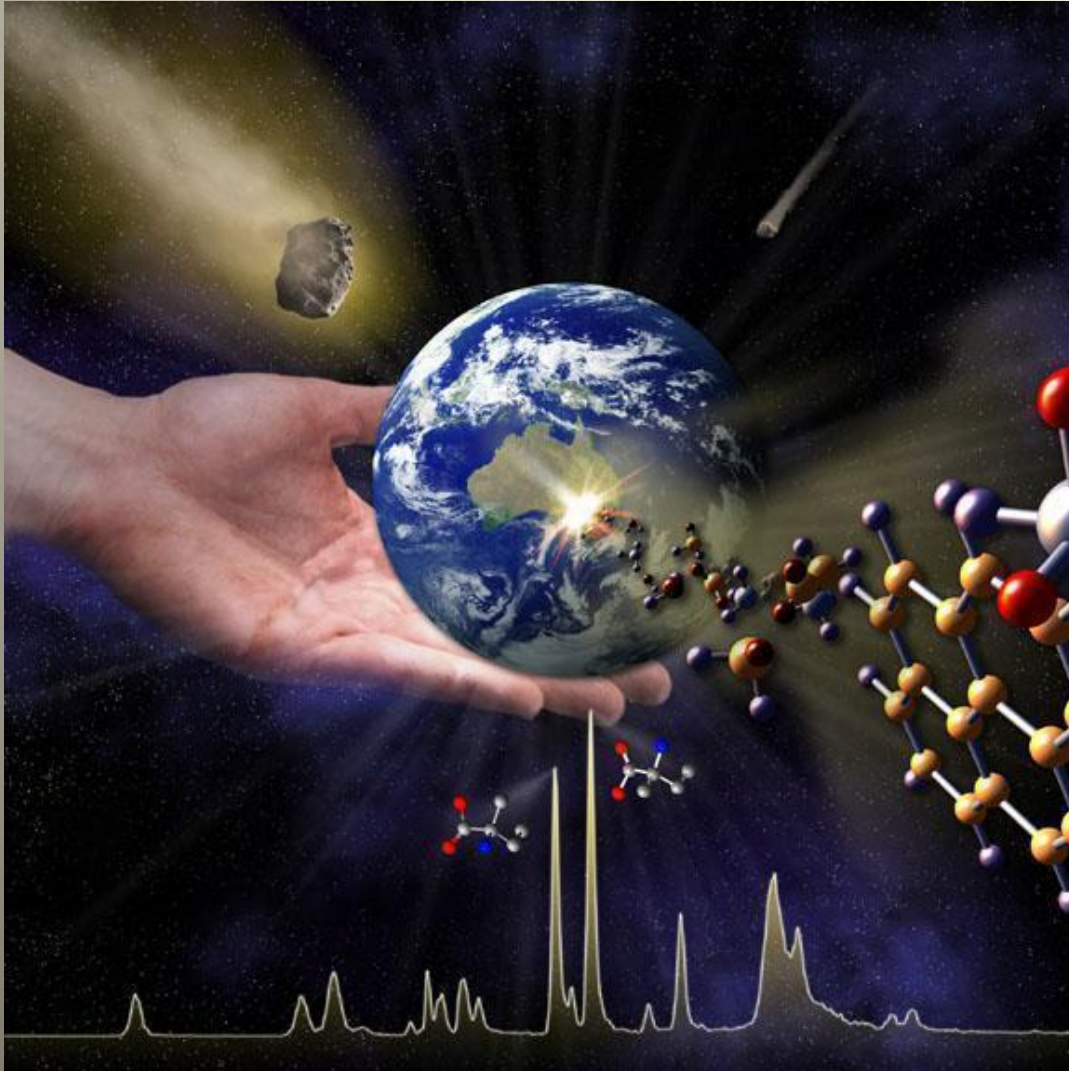
-> The known laws of physics.

5. Are the physical laws unique on Earth or do they exist elsewhere?

-> The known laws of physics must be in effect everywhere since we see the molecules of life through out the universe.



6. How do astronomers know this?



-> The same way chemists identify elements and molecules in the lab, Astronomers see the same spectral characteristics when studying distant light in the universe.

Put the following in order of LARGEST
scale to the smallest scale:

1. Local Group, Galaxy,
Universe, Solar System
2. Universe, Local Group,
Galaxy, Solar System.
3. Universe, Galaxy, Local
Group, Solar System.
4. Galaxy, Universe, Local
Group, Solar System.

What is the radius of the Solar System (light travel time to Pluto)

1. Light seconds
2. Light minutes
3. Light hours
4. Light years
5. 10s of light years

What is the diameter of the Milky Way Galaxy (light travel time)

1. 10 light years
2. 100 light years
3. 1,000 light years
4. 10,000 light years
5. 100,000 light years

What is the diameter of the Local Group of galaxies

1. 100,000 light years
2. Millions of light years
3. 10s of million light years
4. 100 million light years

What is the radius of the Observable Universe (light travel time)

1. 100 million light years
2. Billion light years
3. 10 billion light years
4. 100 billion light years

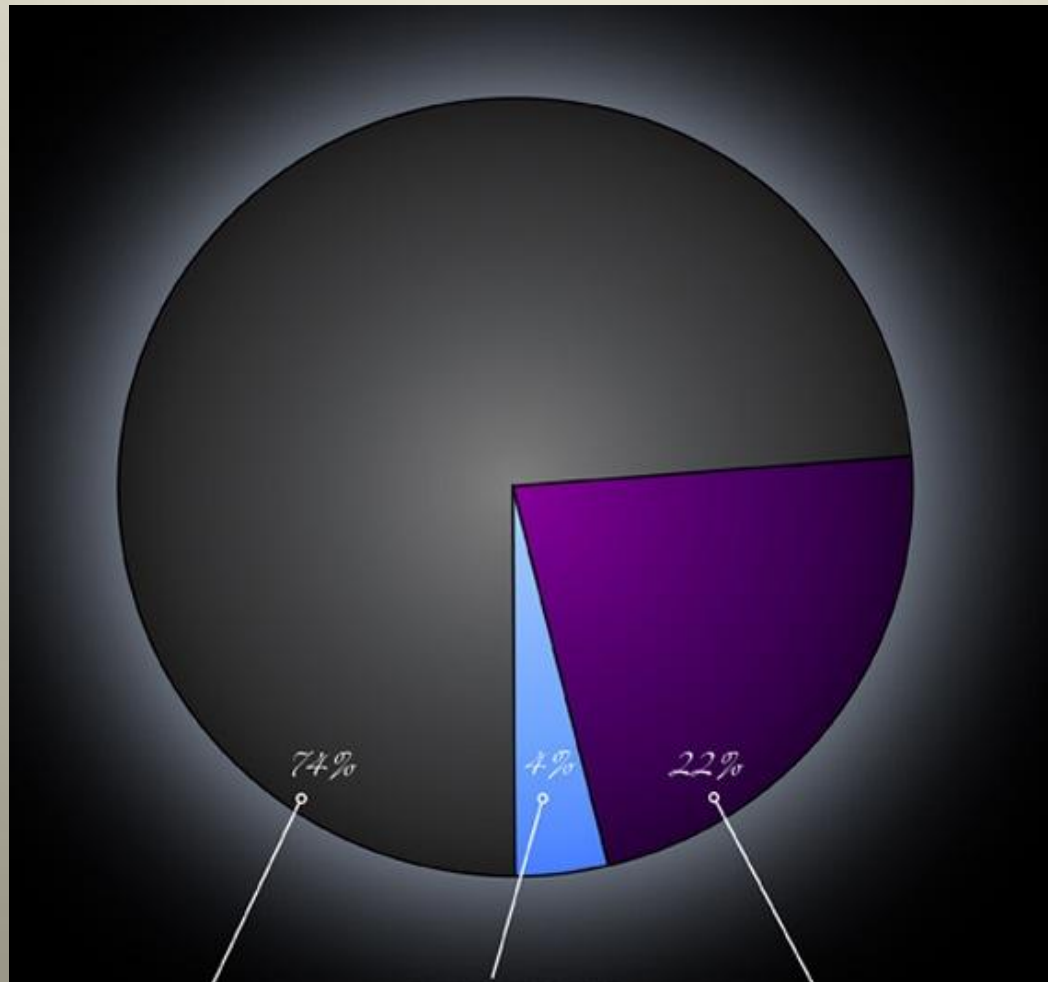
In your **group**, write down other properties of our Universe (age, radius, mass, etc)

- It has a finite age: 13.72 billion years.

This was first estimated by Edwin Hubble in 1925 when he discovered the universe was expanding (he just counted back to when it must have 'left').

- It has a finite observable radius: 13.72 billion light years
- It has a finite observable mass: About 10^{55} kg (this is about 100 billion galaxies like the Milky Way)
- Why do we qualify these with 'observable'?

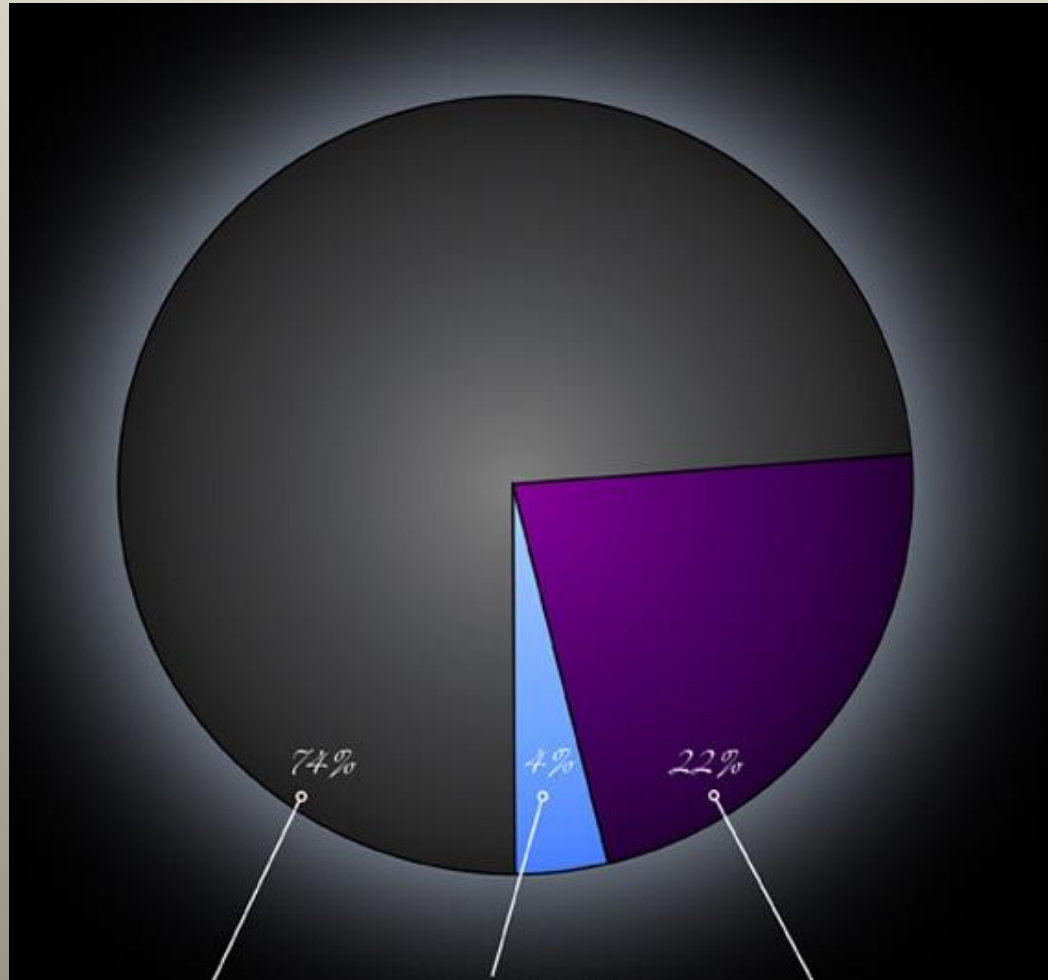
What is our Universe made up of?



What is the Universe made of, in order of highest percentage..

1. Dark Energy, Dark Matter, Normal Matter
2. Dark Matter, Normal Matter, Dark Energy
3. Dark Energy, Normal Matter, Dark Matter

What is our Universe made up of?



Dark Energy

Normal Matter

Dark Matter

Spread out in the room.

Put all your materials on the floor
and place your PRS clicker on the
table in front of you.

Take care that others can not
view your selection

1. Which of the elements came from the Big Bang and not from stars?

1. Hydrogen

2. Silicon

3. Carbon

4. Oxygen

5. Iron

2. What is the diameter of our Milky Way Galaxy?

1. 100 light years
2. 1000 light years
3. 10,000 light years
4. 100,000 light years
5. Million light years

3. How many galaxies does our observable universe contain?

1. 100 billion
2. 1 trillion
3. 10 trillion
4. 100 trillion

To do list for next class

- Refer to the class syllabus
- Read assigned pages in textbook and review study questions on objectives list
- Register and bring PRS transmitter to class
- Bring textbook to class (not mandatory)