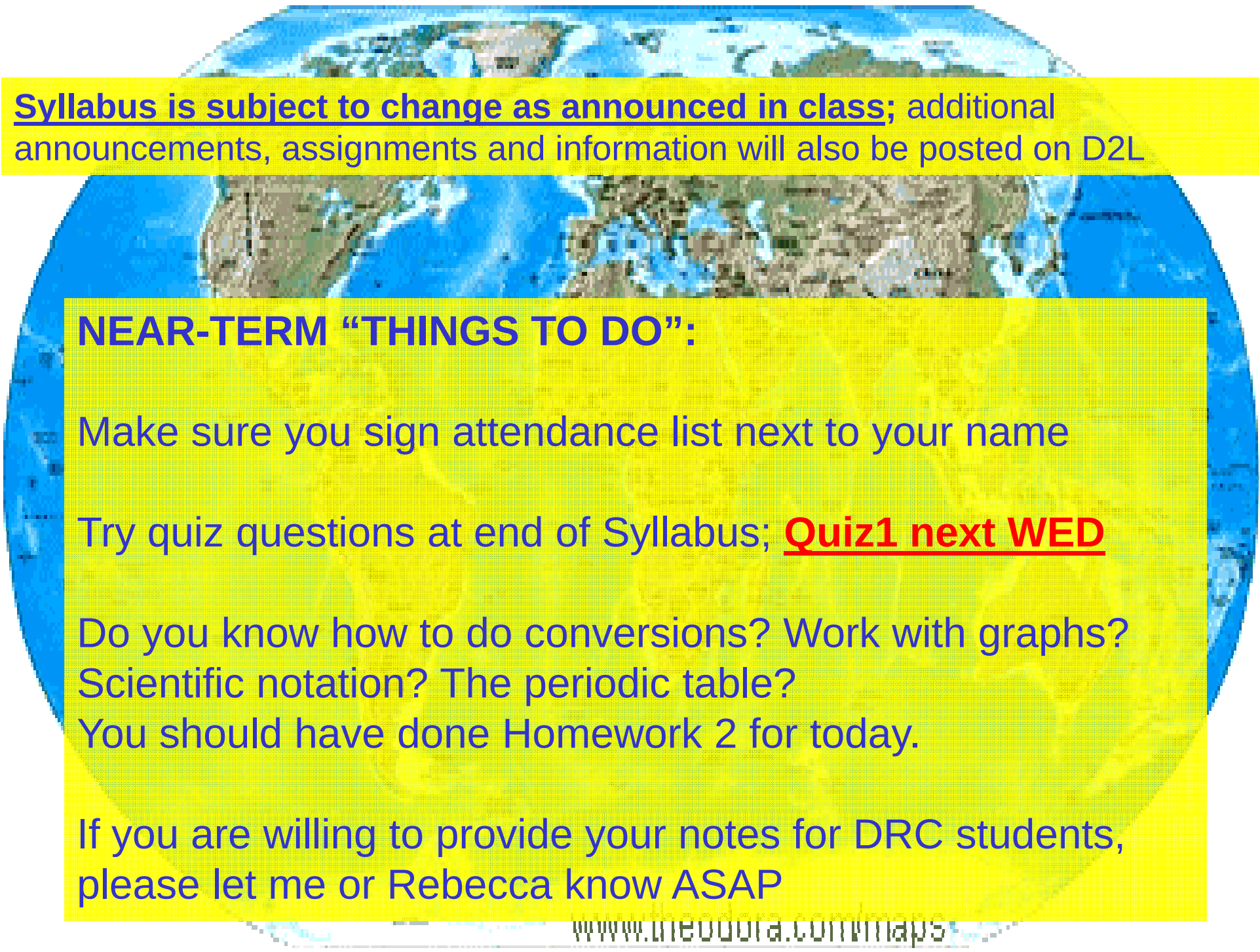


NATS-101 (Sections 51, 52H) Introduction to Global Change



Fourteen billion years after the big bang.



Syllabus is subject to change as announced in class; additional announcements, assignments and information will also be posted on D2L

NEAR-TERM “THINGS TO DO”:

Make sure you sign attendance list next to your name

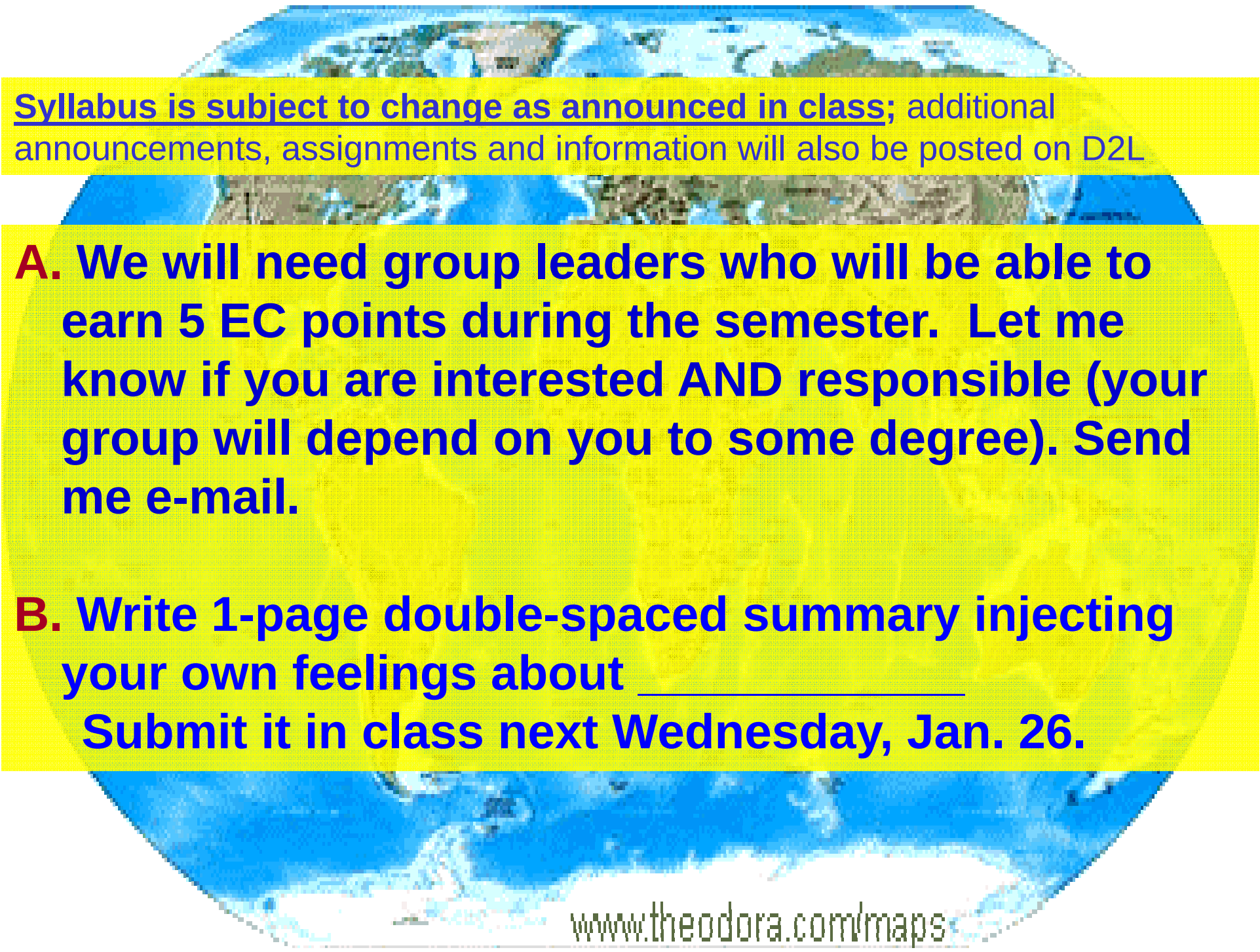
Try quiz questions at end of Syllabus; **Quiz1 next WED**

Do you know how to do conversions? Work with graphs?

Scientific notation? The periodic table?

You should have done Homework 2 for today.

If you are willing to provide your notes for DRC students, please let me or Rebecca know ASAP



Syllabus is subject to change as announced in class; additional announcements, assignments and information will also be posted on D2L

A. We will need group leaders who will be able to earn 5 EC points during the semester. Let me know if you are interested **AND** responsible (your group will depend on you to some degree). Send me e-mail.

B. Write 1-page double-spaced summary injecting your own feelings about _____
Submit it in class next **Wednesday, Jan. 26.**

A circular map of the world, centered on the Atlantic Ocean. The continents of North America, South America, Europe, Africa, Asia, and Australia are visible. The map is rendered in a classic style with blue oceans and green/brown landmasses. A semi-transparent rectangular box is overlaid on the center of the map, containing the text.

August-
Old ways
Energy
Locavore

ATOMS & SPEED

(homework to be worked but not turned in)

Diameter= 0.5 to 2.5×10^{-8} cm (in **scientific notation**, which is “economical”)

Scientific notation

$$1 \times 10^{-8} \text{ cm}$$

=

General (expanded) notation

How many inches is 1×10^{-8} cm? (1in = 2.54cm; 0.394in = 1cm)

Mass proton= 1.672×10^{-24} g
electron= 9.108×10^{-28} g

“Mole”= 6.02×10^{23} atoms of an element (or molecules of a compound).

The atomic weight of an element (expressed in grams) will contain a mole of atoms

Element

Li

Ru

Mass of 1 mole

1 mole of Ru is how many ounces? (1 oz = 28.35 g; 1 g = 0.0353 oz)

Speed of Light (in vacuum)

General

186,000 mi/s

=

Scientific

=

3×10^{10} cm/s

Back to our “Epic story”

PERIODIC TABLE OF THE ELEMENTS

Table of Radioactive Isotopes

Naturally occurring radioactive isotopes are indicated by a blue mass number. Half lives are in parentheses where s, m, h, d and y stand for seconds, minutes, hours, days and years respectively. The symbols describing the mode of decay and resulting radiation are defined as follows:

α alpha particle β^- beta particle β^+ positron γ gamma ray ϵ internal electron conversion

VIIIA

2 4.0026

He

1.00794

1

1.00794

1

1.00794

1

1.00794

1

1.00794

1

1.00794

1

1.00794

1

1.00794

1

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1.00794

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1.00794

1

1.00794

1

1.00794

GROUP
IA

1 1.00797

H

1.00797

1

1.00797

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1

1.00797

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1.00797

1

1.00797

GROUP
IIA

2 4.0026

He

1.00794

1

1.00794

1

1.00794

1

1.00794

1

1.00794

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1

1.00794

1

1.00794

1

1.00794

As 227(22y)a

Ag 110(24d)a

111(7.5d)a

Am 241(458y)a

242(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

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243(16.0h)a

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243(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

243(16.0h)a

Cd 113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

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113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

113(4.8h)a

Fe 55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

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55(2.6y)a

55(2.6y)a

55(2.6y)a

55(2.6y)a

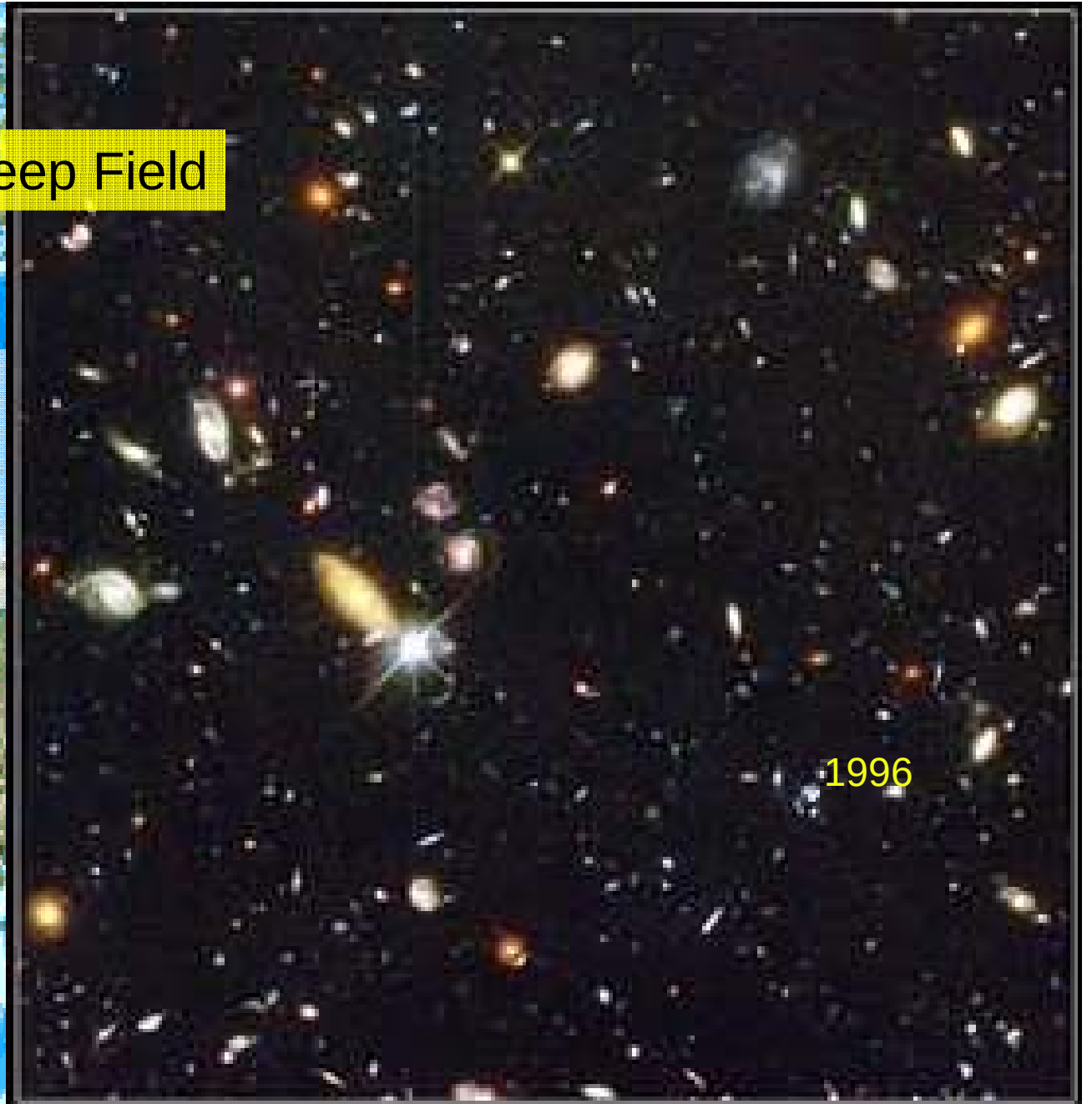
55(2.6y)a

55(2.6y)a

55(2.6y)a

Hubbell Deep Field

Viewing a dark speck of sky, the area equivalent to a square 1mm^2 in area held 1 m from your eyes

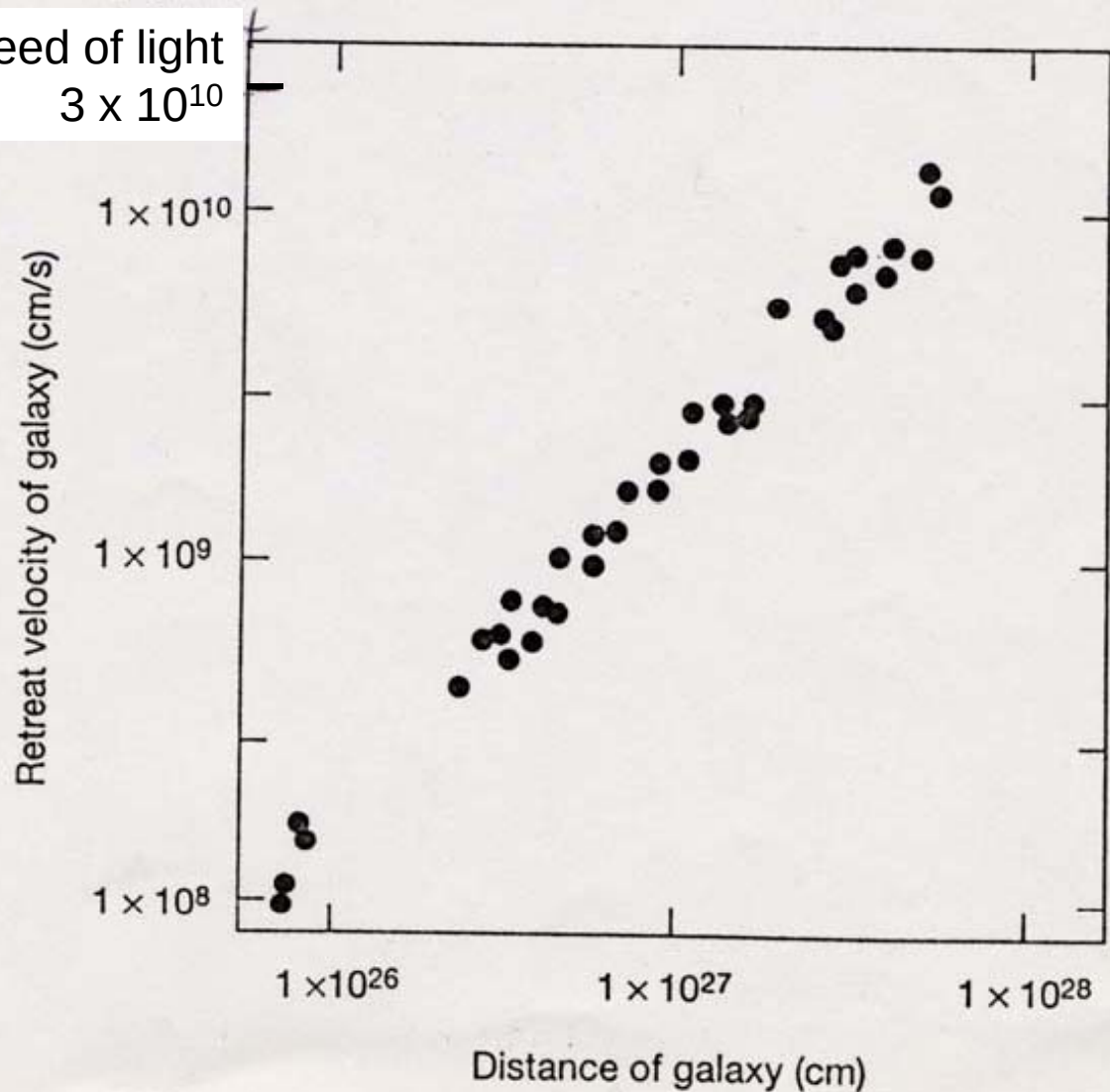


1996

Advanced Camera Survey 2003

Figure 6.1 Relationship between the distance to a galaxy or group of galaxies and the velocity at which the galaxies are moving away from ours. Notice that the data are plotted on a logarithmic scale. (After Broecker, 1985.)

speed of light
 3×10^{10}

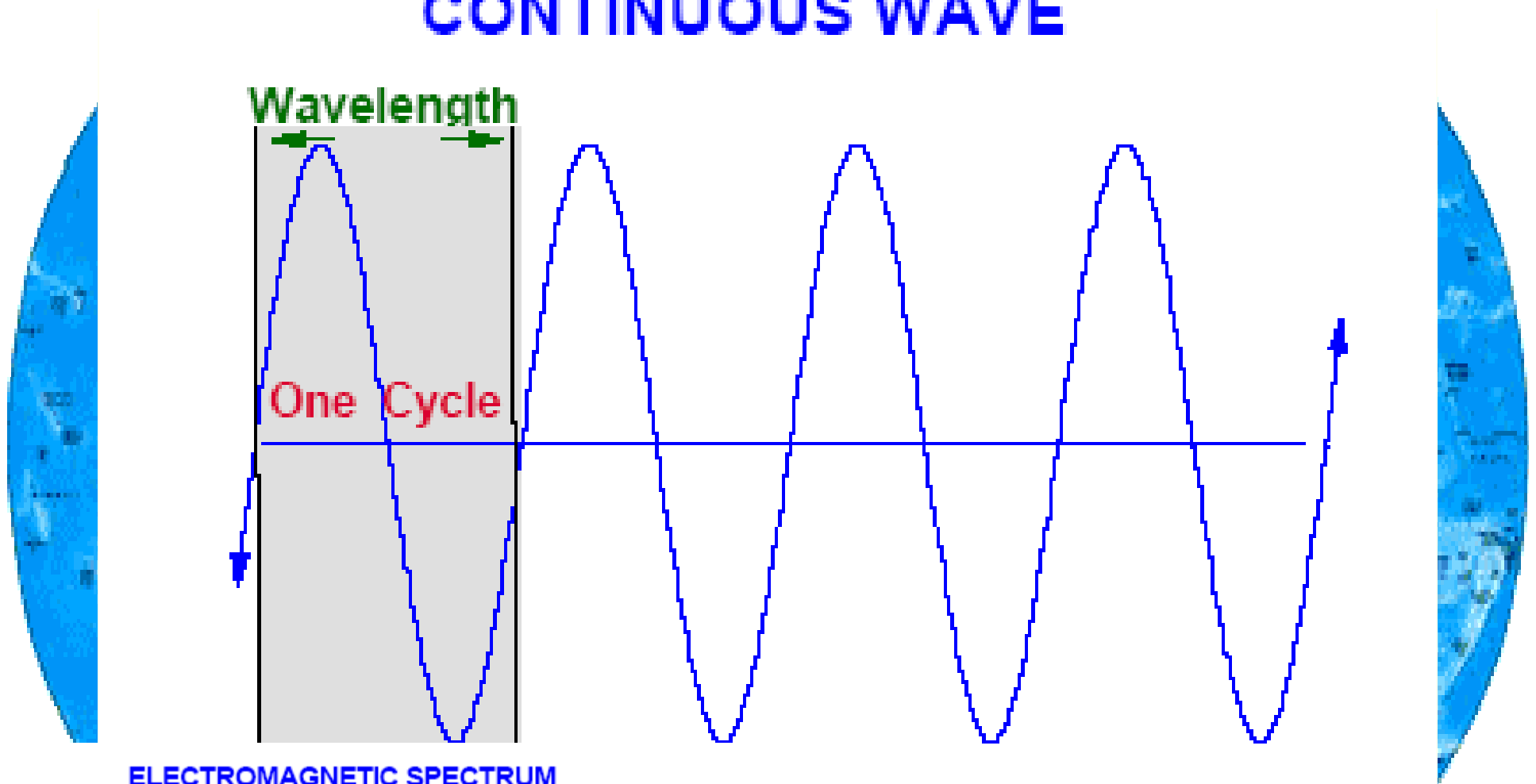


60 mph = 3×10^3 cm/s

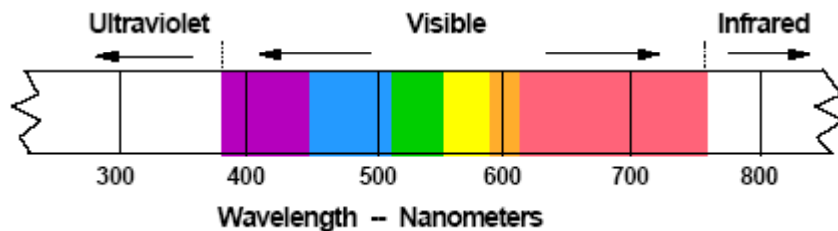
This is evidence of an event called the “Big Bang”, but how do we know they are moving so fast away from us?

ANSWER: from color shift (“Red Shift”) caused by “Doppler Effect”

CONTINUOUS WAVE



ELECTROMAGNETIC SPECTRUM



http://uvb.nrel.colostate.edu/UVB/publications/uvb_primer.pdf

PERIODIC TABLE OF THE ELEMENTS

Table of Radioactive Isotopes

Naturally occurring radioactive isotopes are indicated by a blue mass number. Half lives are in parentheses where s, m, h, d and y stand for seconds, minutes, hours, days and years respectively. The symbols describing the mode of decay and resulting radiation are defined as follows:

α alpha particle β^- beta minus β^+ positron γ gamma ray ϵ internal electron capture ϵ^- L-electron capture ϵ^+ positronium annihilation

GROUP
IA

1 1.00797
H
Hydrogen

IIA

2 4.0026
He
Helium

As 227(22yr)
Ag 110(24hr)
110(54hr)
Am 241(459yr)
242(16.0hr)
243(8000yr)

Cd 113(4.6hr)
Ce 141(32.6d)
143(29.1d)
144(285d)
Cl 246(35hr)
248(300yr)

Fe 55(2.4yr)
59(44.5d)
Fm 255(20hr)
Ge 72(14.1hr)
Me 99(67hr)

La 140(40.2hr)
176(10¹⁰yr)
177(6.8d)
Md 256(90m)
257(22m)

Pu 242(3.8 x 10⁵yr)
243(4.35hr)
244(8.00yr)
245(10.6hr)
246(35.8d)

Sr 90(28.9yr)
89(51.4d)
85(64.4d)
Tb 160(73d)
161(5.9yr)

Te 127(7.3hr)
129(6.6hr)
130(6.6hr)
131(2.6yr)
132(7.8d)

Yb 174(1.3 x 10¹¹yr)
176(1.2 x 10¹¹yr)
177(4.18 x 10¹⁰yr)
178(1.1 x 10¹¹yr)
179(3.4 x 10¹¹yr)

Lu 175(9.7 x 10¹⁰yr)
176(3.78 x 10¹⁰yr)
177(4.74 x 10¹⁰yr)
178(1.25 x 10¹¹yr)
179(8.48 x 10¹⁰yr)

Ac 227(21.8yr)
228(6.13hr)
229(13.7d)
230(71.3yr)
231(43.2yr)

Th 232(1.4 x 10¹⁰yr)
234(24.1d)
234m(4.81hr)
235(7.04 x 10⁸yr)
236(2.31 x 10⁷yr)

IIIA

3 6.939
Li
Lithium

IVA

4 9.0122
Be
Beryllium

VA

5 10.811
B
Boron

VIA

6 12.01115
C
Carbon

VIIA

7 14.0067
N
Nitrogen

VIIIA

8 15.9994
O
Oxygen

VIIIA

9 18.9984
F
Fluorine

VIIIA

10 20.18
Ne
Neon

VIIIA

11 22.9898
Na
Sodium

VIIIA

12 24.312
Mg
Magnesium

VIIIA

13 26.9815
Al
Aluminum

VIIIA

14 28.086
Si
Silicon

VIIIA

15 30.9738
P
Phosphorus

VIIIA

16 32.06
S
Sulfur

VIIIA

17 35.453
Cl
Chlorine

VIIIA

18 39.948
Ar
Argon

VIIIA

19 39.102
K
Potassium

VIIIA

20 39.098
Ca
Calcium

VIIIA

21 44.956
Sc
Scandium

VIIIA

22 47.88
Ti
Titanium

VIIIA

23 50.942
V
Vanadium

VIIIA

24 51.996
Cr
Chromium

VIIIA

25 54.938
Mn
Manganese

VIIIA

26 55.845
Fe
Iron

VIIIA

27 58.933
Co
Cobalt

VIIIA

28 58.933
Ni
Nickel

VIIIA

29 63.546
Cu
Copper

VIIIA

30 65.38
Zn
Zinc

VIIIA

31 69.723
Ga
Gallium

VIIIA

32 72.64
Ge
Germanium

VIIIA

33 74.922
As
Arsenic

VIIIA

34 78.96
Se
Selenium

VIIIA

35 79.904
Br
Bromine

VIIIA

36 83.904
Kr
Krypton

VIIIA

37 85.47
Rb
Rubidium

VIIIA

38 87.62
Sr
Strontium

VIIIA

39 88.905
Y
Yttrium

VIIIA

40 91.224
Zr
Zirconium

VIIIA

41 92.906
Nb
Niobium

VIIIA

42 95.94
Mo
Molybdenum

VIIIA

43 98.906
Tc
Technetium

VIIIA

44 101.07
Ru
Ruthenium

VIIIA

45 102.905
Rh
Rhodium

VIIIA

46 106.4
Pd
Palladium

VIIIA

47 107.87
Ag
Silver

VIIIA

48 112.40
Cd
Cadmium

VIIIA

49 114.82
In
Indium

VIIIA

50 118.69
Sn
Tin

VIIIA

51 121.73
Sb
Antimony

VIIIA

52 127.60
Te
Tellurium

VIIIA

53 126.904
I
Iodine

VIIIA

54 131.30
Xe
Xenon

VIIIA

55 132.905
Cs
Cesium

VIIIA

56 137.34
Ba
Barium

VIIIA

57 138.91
La
Lanthanum

VIIIA

58 140.907
Ce
Cerium

VIIIA

59 140.907
Pr
Praseodymium

VIIIA

60 144.24
Nd
Neodymium

VIIIA

61 147.07
Pm
Promethium

VIIIA

62 150.36
Sm
Samarium

VIIIA

63 151.96
Eu
Europium

VIIIA

64 157.25
Gd
Gadolinium

VIIIA

65 158.92
Tb
Terbium

VIIIA

66 162.50
Dy
Dysprosium

VIIIA

67 164.930
Ho
Holmium

VIIIA

68 167.26
Er
Erbium

VIIIA

69 168.934
Tm
Thulium

VIIIA

70 173.04
Yb
Ytterbium

VIIIA

71 174.9
Lu
Lutetium

VIIIA

72 178.49
Hf
Hafnium

VIIIA

73 180.948
Ta
Tantalum

VIIIA

74 183.85
W
Tungsten

VIIIA

75 186.21
Re
Rhenium

VIIIA

76 186.904
Os
Osmium

VIIIA

77 192.22
Ir
Iridium

VIIIA

78 195.08
Pt
Platinum

VIIIA

79 196.967
Au
Gold

VIIIA

80 200.59
Hg
Mercury

VIIIA

81 204.37
Tl
Thallium

VIIIA

82 207.19
Pb
Lead

VIIIA

83 208.980
Bi
Bismuth

VIIIA

84 209
Po
Polonium

VIIIA

85 210
At
Astatine

VIIIA

86 222
Rn
Radon

VIIIA

87 223
Fr
Francium

VIIIA

88 226
Ra
Radium

VIIIA

89 227
Ac
Actinium

VIIIA

90 232.038
Th
Thorium

VIIIA

91 231
Pa
Protactinium

VIIIA

92 238.029
U
Uranium

VIIIA

93 237
Np
Neptunium

VIIIA

94 244
Pu
Plutonium

VIIIA

95 243
Am
Americium

VIIIA

96 247
Cm
Curium

VIIIA

97 247
Bk
Berkelium

VIIIA

98 251
Cf
Californium

VIIIA

99 257
Es
Einsteinium

VIIIA

100 261
Fm
Fermium

VIIIA

101 262
Md
Mendelevium

VIIIA

102 265
No
Nobelium

VIIIA

103 269
Lr
Lawrencium

VIIIA

104 271
Uu
Ununquadium

VIIIA

105 272
Uub
Unbibium

VIIIA

106 273
Uut
Untrium

VIIIA

107 274
Uuq
Unquadrium

VIIIA

108 275
Uuh
Unhexium

VIIIA

109 276
Uus
Unseptium

VIIIA

110 277
Uuo
Unoctium

VIIIA

111 278
Uuh
Unenneum

VIIIA

112 279
Uuo
Unbinilium

VIIIA

113 280
Uuh
Untrium

FUSION

Elements from (He), Li to Fe produced by fusion

For example,

4 H atoms (${}^1_1\text{H}$) combine to produce 1 He atom (${}^4_2\text{He}$)
($6.696 \times 10^{-24}\text{g}$) ($6.648 \times 10^{-24}\text{g}$)

Where did the “lost” mass go?

Converted to energy $E = mc^2$

(nuclear energy $\gg$ chemical energy)

nuclear

1g H converted to He would heat swimming pool (50m x 15m x 2.5m) to boiling

chemical

1g H combusted to H_2O wouldn't release enough heat for you to perceptibly notice a change in swimming pool temperature

PERIODIC TABLE

Table of Radioactive Isotopes

GROUP IA

1	1.00797
1	H
-352.7	
-239.2	
0.071	

IIA

3	6.939
3	Li
1330	
180.5	
0.53	

4	9.0122
4	Be
3770	
1277	
1.83	

11	22.9898
11	Na
892	
97.8	
0.97	

12	24.312
12	Mg
1107	
650	
1.74	

19	39.102
19	K
760	
63.7	
0.86	

20	40.08
20	Ca
1440	
838	
1.55	

21	44.956
21	Sc
2730	
1539	
3.0	

22	88.906
22	Ti
3360	
1668	
4.51	

37	85.47
37	Rb
688	
38.9	
1.33	

38	87.62
38	Sr
1380	
768	
2.6	

39	88.905
39	Y
2927	
1509	
4.47	

40	88.906
40	Zr
3380	
1832	
6.49	

55	132.905
55	Cs
690	
28.7	
1.90	

56	137.34
56	Ba
1640	
77.4	
3.3	

57	138.91
57	La
3470	
920	
6.17	

58	138.91
58	Ce
3470	
920	
6.17	

87	(223)
87	Fr
(27)	
—	

88	(226)
88	Ra
700	
3.0	

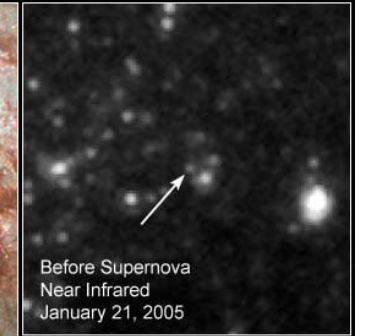
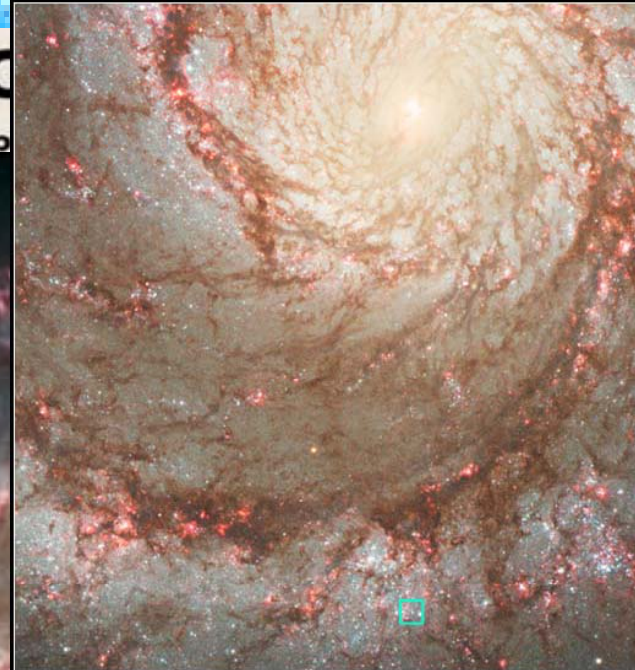
89	(227)
89	Ac
1030	
—	

90	(232)
90	Th
1000	
—	

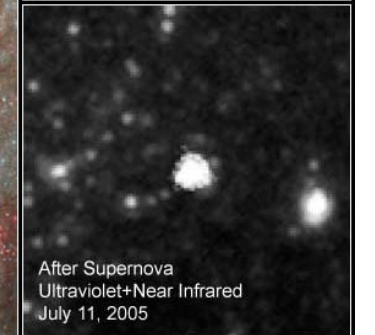
ATOMIC NUMBER	ATOMIC WEIGHT (2)	OXIDATION STATES (Bold most stable)
30	65.37	
30	Zn	
65.37		
906		
419.3		
7.14		
(g/ml) (3)		
NAME		

Supernova 2005cs in M51

Hubble Space Telescope • ACS



Before Supernova
Near Infrared
January 21, 2005



After Supernova
Ultraviolet+Near Infrared
July 11, 2005

NASA, ESA, W. Li and A. Filippenko (University of California, Berkeley),
S. Beckwith (STScI), and The Hubble Heritage Team (STScI/AURA)

STScI-PRC05-21

Whirlpool galaxy M51



OK, what was the Lemonick article about?