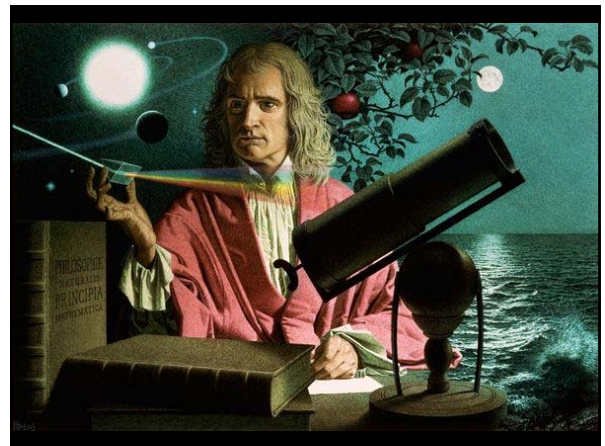


Astrobiology & Life in the Universe

Some Background Science

Dr. R. L. Hudson (Spring, 2018)



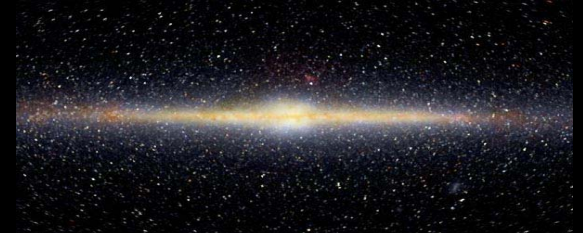
The Milky Way

Hazy band of stars

Galileo, ca. 1610





The Milky Way Galaxy




NASA Infrared Image 125,000 LY across

The Milky Way Galaxy



Artist: Jon Lomberg

The Milky Way Galaxy



About 200 billion stars

$$\frac{a^3}{p^2} = \frac{G}{4\pi^2} (m_1 + m_2)$$

The Milky Way Galaxy – Clouds of Gas and Dust



Artist: Jon Lomberg



The Milky Way Galaxy ... Looking Further



How do we know?

Edwin Hubble

Hubble Space Telescope



1889 - 1953



1990 - ?

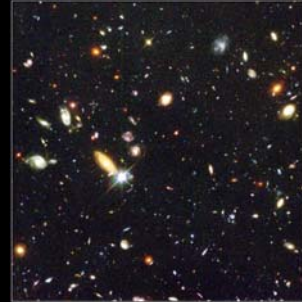
Hubble Contribution #1 External Galaxies



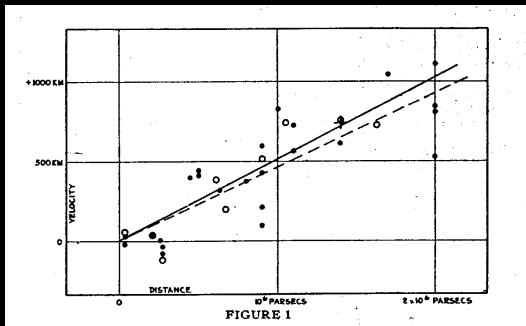
Hubble Contribution #2 Classes of Galaxies



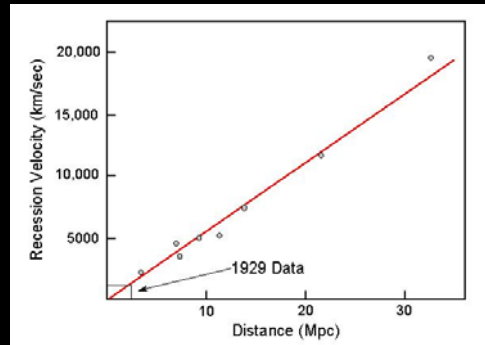
Hubble Contribution #3 Galactic Motion



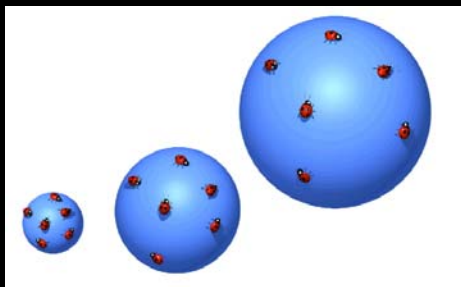
The Hubble Diagram (1929)



The Hubble Diagram (1931)



The Expanding Universe



http://www.nap.edu/html/oneuniverse/images/motion_2.jpg



Stellar Diversity



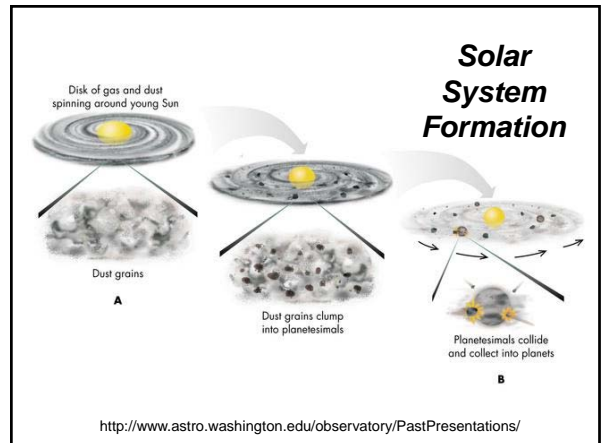
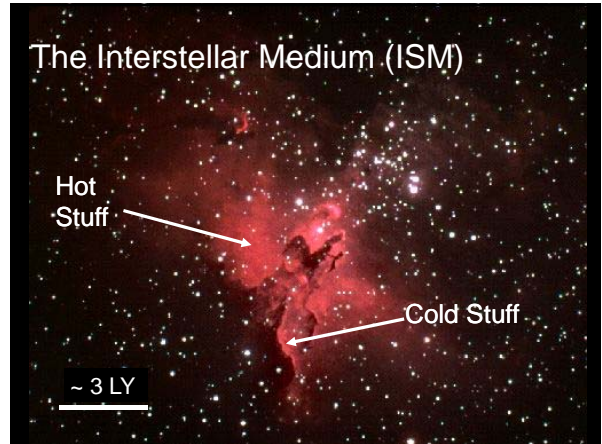
What unifies all of this?

The Interstellar Medium (ISM)

Hot Stuff

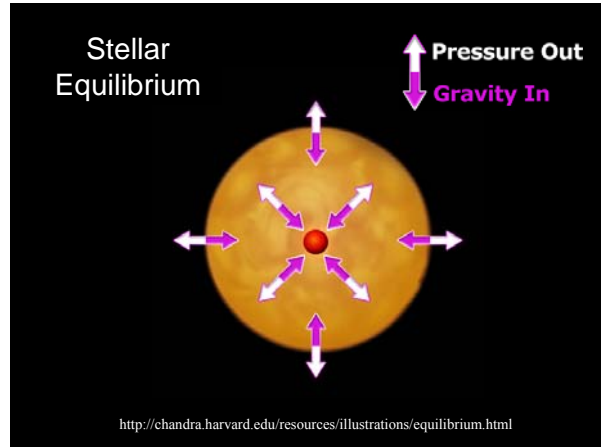
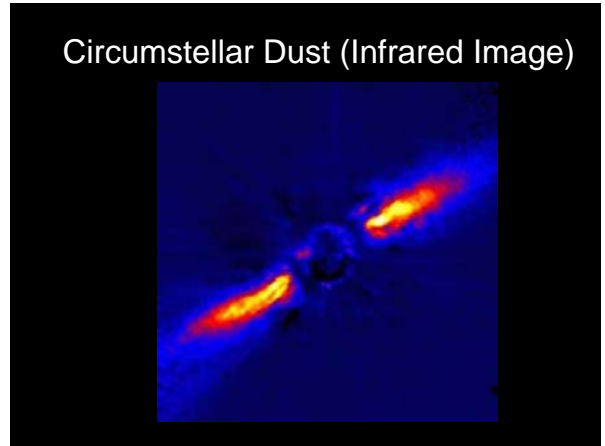
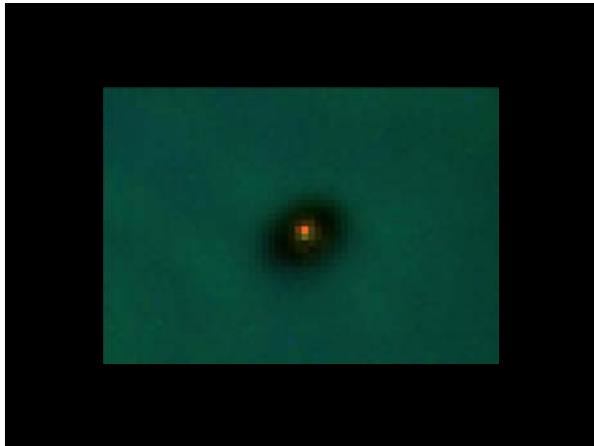
Cold Stuff

~ 3 LY



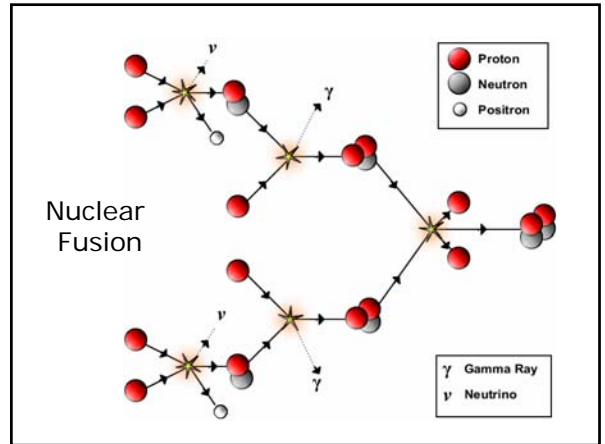
Solar System Formation





Periodic Table of the Elements

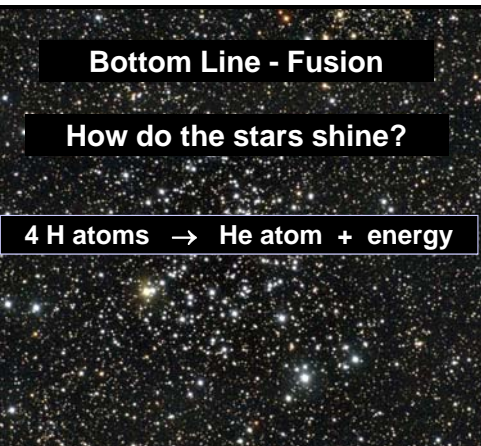
1	IA																IIA																III A										IV A										V A										VI A										VII A										VIII A										O										He																																																																																																																																								
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6	Cs																Ba																*La										Hf										Ta										W										Re										Os										Ir										Pt										Au										Hg										Tl										Pb										Bi										Po										At										Rn																																																								
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* Lanthanide Series																Ce																Pr																Nd																Pm																Sm																Eu																Gd																Tb																Dy																Ho																Er																Tm																Yb																Lu															
+ Actinide Series																Th																Pa																U																Np																Pu																Am																Cm																Bk																Cf																Es																Fm																Md																No																Lr															



Bottom Line - Fusion

How do the stars shine?

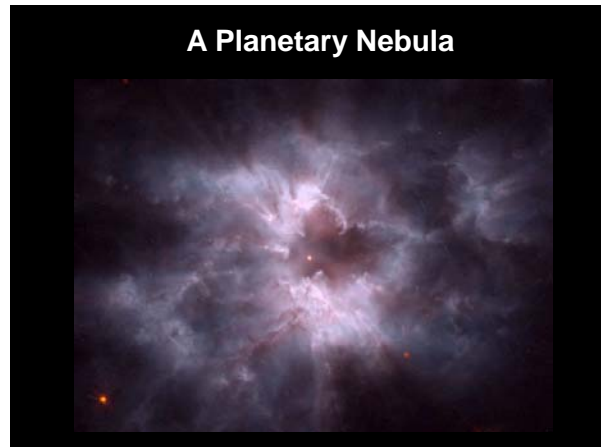
4 H atoms → He atom + energy



Periodic Table of the Elements

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* Lanthanide Series
+ Actinide Series



Yes, there are exceptions ...

... but they are rare

Yes, there are exceptions ...

Supernova 1987A



Where is the supernova?



Where is the supernova?



Where is the supernova?



Now where is the supernova?



And now where is the supernova?



Right here!

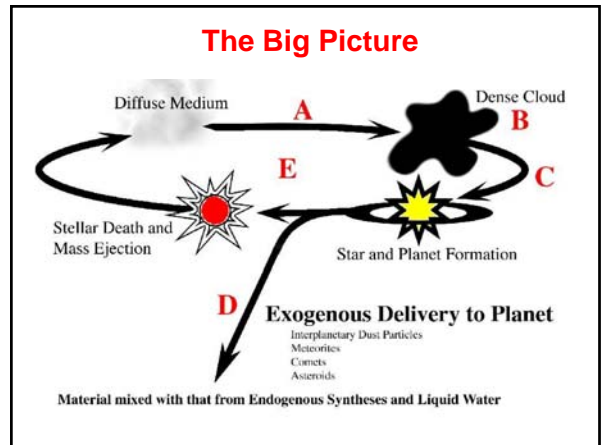


A Supernova Remnant



Periodic Table of the Elements

1	IA	H																	0	He			
2	IIA	Li	Be											IIIA	B	IVA	C	VA	N	O	F	VIIA	Ne
3	IIIB	Na	Mg											IIIB	Al	IVB	Si	VB	P	S	Cl	VIIA	Ar
4	IVB	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	IIIB	Ga	IVB	Ge	VA	As	Se	Br	Kr	
5	VB	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	IIIB	In	IVB	Sn	VA	Sb	Te	I	Xe	
6	VIB	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	IIIB	Tl	IVB	Pb	VA	Bi	Po	At	Rn	
7	VIIA	Fr	Ra	+Ac	Rf	Ha	Sg	Ns	Hs	Mt	110	111	112	113									
* Lanthanide Series		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu								
+ Actinide Series		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr								



Sources of Material

Most of the images used here are either original, from our class's textbook, or in the public domain. The supernova image was from the Anglo-Australian Observatory and several other images are from the Astronomy Picture of the Day Web site. The "Big Picture" drawing is from Jason Dworkin of NASA. I will be glad to add any credits missed.