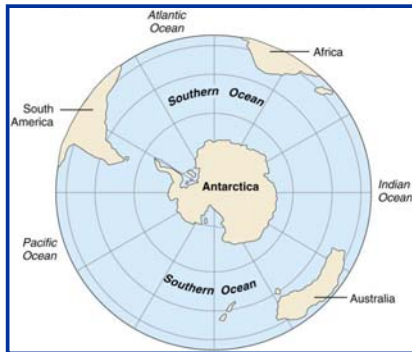
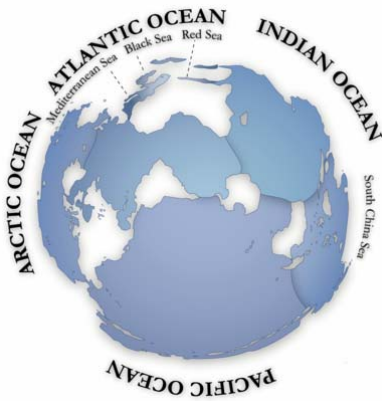
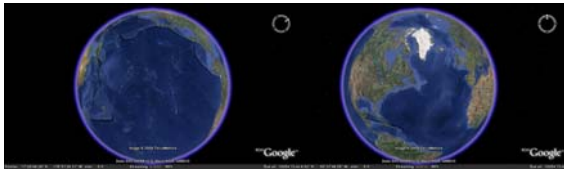
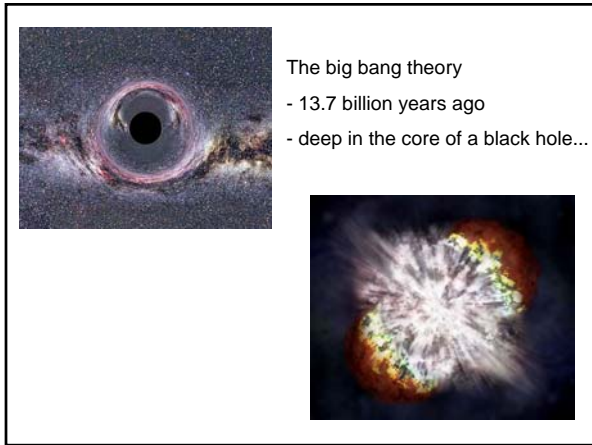
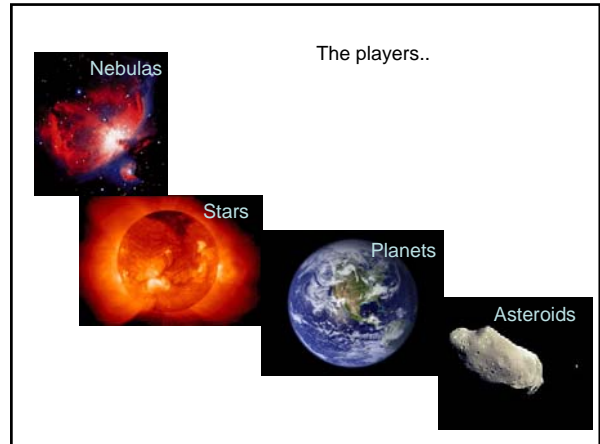
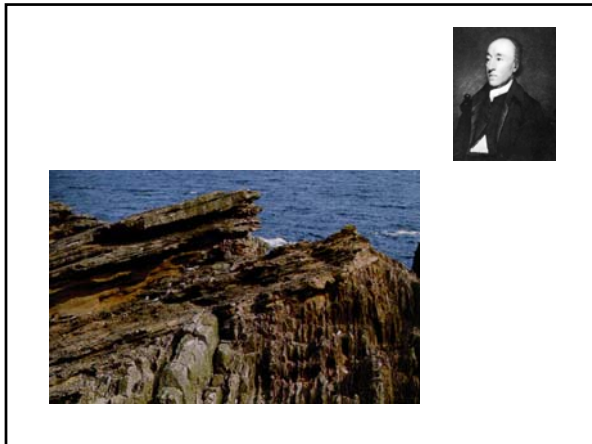


Oceanography:
An introduction to the world's ocean
Lecture 1 – Ocean origins



Oceanus
The blue planet
Gaia

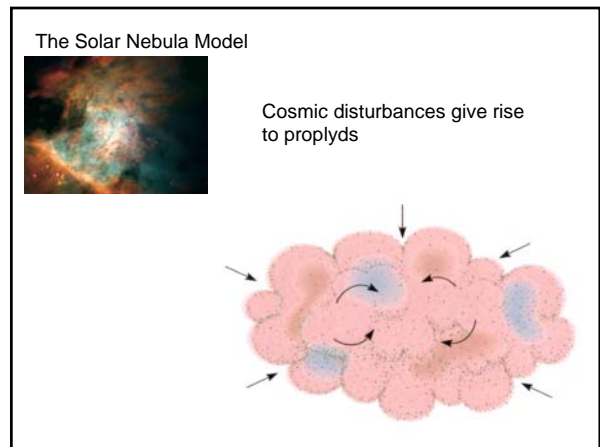
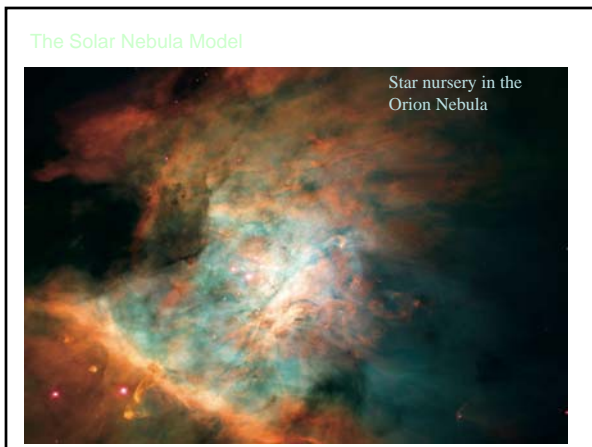


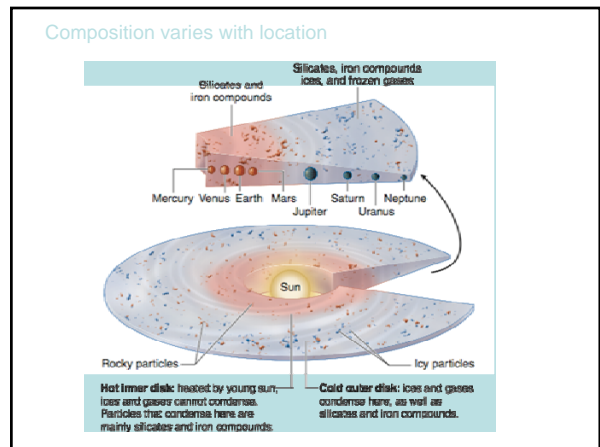
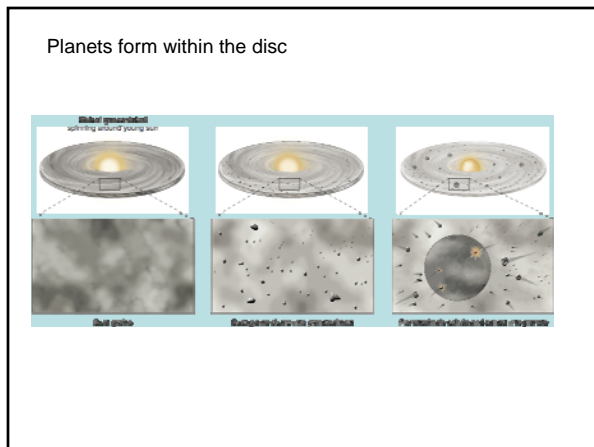
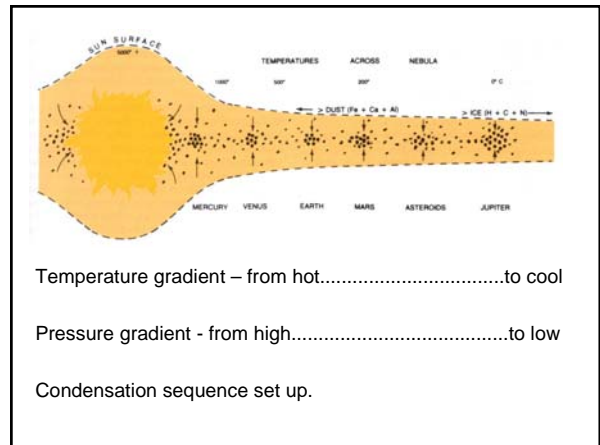
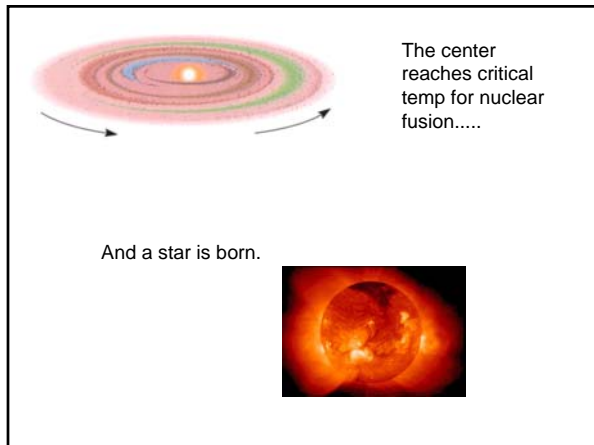
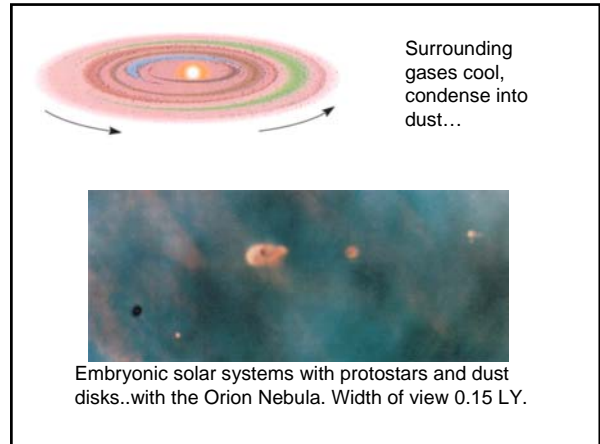
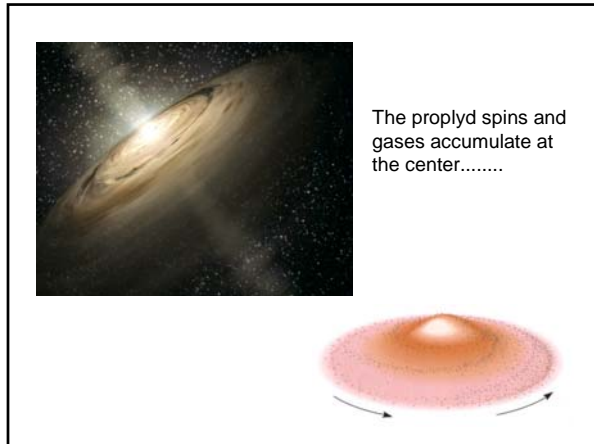


The Friedman – LeMaitre Theory.....

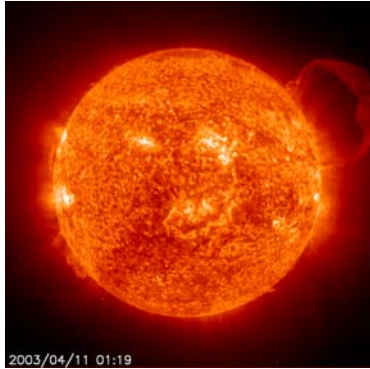
Supporting evidence:

1. Steven Hawkins agrees – space & singularities...
2. Hubble's Law – Galaxies continue to move further away
3. Penzias and Wilson 1965 – Cosmic background radiation pervades the universe
4. Existence and prevalence of hydrogen and helium

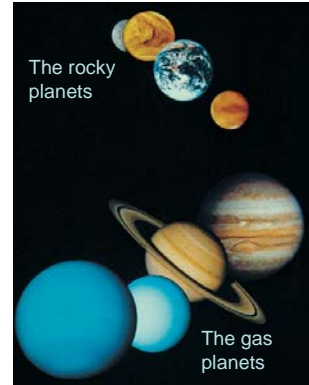




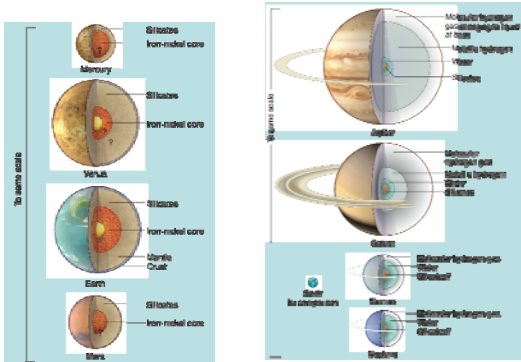
At the center of the disc is the star – in our case the Sun...



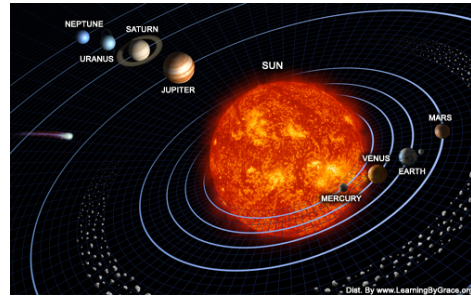
The planets can be categorized by composition



Size and core composition of planets reflect these classifications



Leads us to our modern solar system...



25 Million years of meteorite bombardment follow...
Best know meteorite - Orpheus

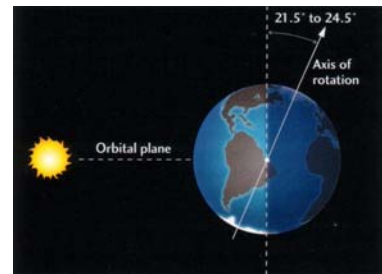


The jelly donut model....

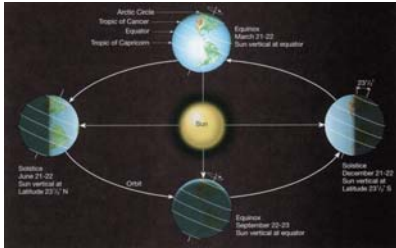


The Moon influences tides, and a range of other cycles on earth...

The impact of Orpheus causes the earth to tilt 21.5-24.5° from the vertical to its orbital plane.



Which in turn gives rise to...
seasonal weather changes

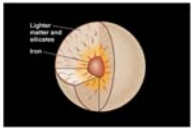


Formation of the Earth – as the blue planet

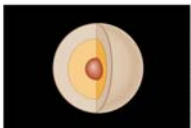


From planetesimals to planet...

Theory No 1:
Homogenous Accretion Model



Step 1 : Accretion - the homogenous blob stage



Step 2: Density stratification -

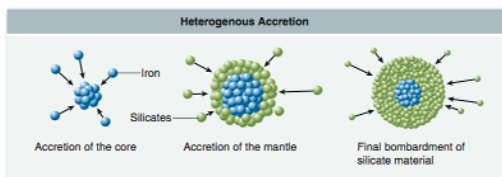
Step 3: Cooling of outer layers

the cookies and cream model

Outgassing – Volcanic eruptions release water into the atmosphere...



Theory no 2 : Heterogeneous accretion model – Step wise process



This theory provides two possible routes for the arrival of water

1. Outgassing

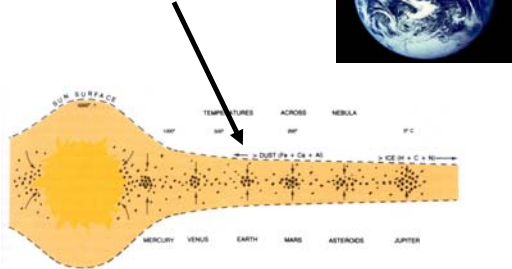


2. Deposition



Where did earth's water come from ?

The habitable zone



Did earth's water come from cosmic gases?

No...probably not.....

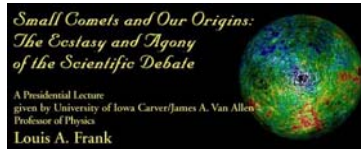


Certainly water forms when stars are born

However, cosmic explosions strip this water out - as evidenced in "rocky planets"

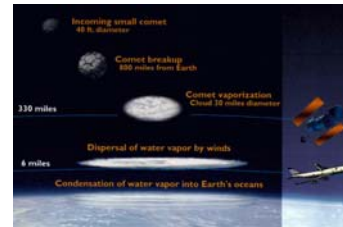
Did earth's water arrive on comets and meteorites?

Louis A. Frank (1999)



Did earth's water arrive on comets and meteorites?

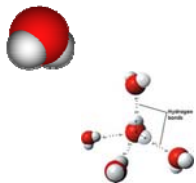
Incoming comets bring water into our upper atmosphere



Lots...of incoming comets.....
20 / min –
Typical size
20 – 40 tons

Did earth's water arrive on comets and meteorites?

So, No, probably not comets...



However, ratios of heavy to regular water are different in water within comets...



Where did / does earth's water come from ?

Ans : The wet magma ocean hypothesis.



- Hybrid version of preceding theories

-Earth formed from planetesimals, with some sequencing

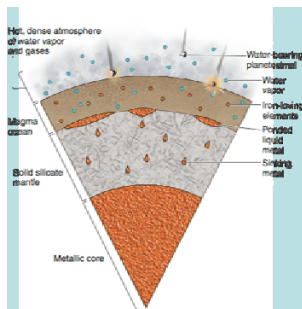
-A thick atmosphere kept earth warm, outer layers molten.

-Meteorites and comets dissolved into this molten magma and then were later released during out-gassing

-So, our water did originate in outer space.....

Where did / does earth's water come from ?

Ans : The wet magma ocean hypothesis.



As Earth continued to cool, the thick atmosphere condensed and water fell to earth as hot rain...leading to our primordial ocean.

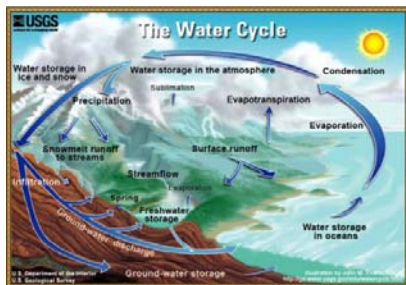
Warm

Acidic

But, it was liquid water on the surface of our planet



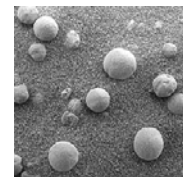
Today, our water cycle is a relatively closed system, replenished only on a geological time scale



Water on Mars ?



Spacecraft Opportunity



Hematite blueberries

Looking beyond....



Gliese 581b

Earth's twin...in case we need it.....