Chapter 06 Part 2
Making the Planetary “Donuts”

Where did the solar system come from?

Galactic Recycling
- Elements that formed planets were made in stars and then recycled through interstellar space.

Evidence from Other Gas Clouds
- We can see stars forming in other interstellar gas clouds, lending support to the nebular theory.

It All Begins With “Star-stuff”
- Our Solar System is a relative newcomer in this universe.
- Our current theory is that it formed about 4.6 billion years ago from matter spewed from exploding stars.
- Carl Sagan called us the product of this “star-stuff” since we are condensed leftover from these novas.

Step #1: Condense the Matter
- It begins with a solar nebula, a cloud of gases and dust from the novas.
- Slowly, these gases and dust particles condensed as gravity attracted them.
- Most of these gases were hydrogen and helium gas leftover from the novas.
Step #2: Make a Proto-Sun

- Once the gas has begun to condense, a focal point forms for all the dust and gases.
- This focal point becomes the “proto-sun” and quickly begins to collapse and form the beginning of fusion.
- At left, this can be seen as the red dot. Notice how it clears a path out of the grayish dust and finally becomes a sun.

Step #3: Make a Disk

- As the sun begins to condense and attract more matter, it becomes dense enough to form itself into a spinning ball.
- As its mass increases, the new sun’s gravity attracts the gas cloud and flattens it into a revolving disk.
- You can see this happening in “a” and “b” at left.

Conservation of Angular Momentum

- The rotation speed of the cloud from which our solar system formed must have increased as the cloud contracted.

Flattening

- Collisions between particles in the cloud caused it to flatten into a disk.

Disks Around Other Stars

- Observations of disks around other stars support the nebular hypothesis.

Step #4: Begin Stellar Fusion

- As the sun begins to condense, it becomes denser and the hydrogen gases are compressed to the point that they begin to fuse.
- This nuclear “fusion” gives off energy and light and we now have a “star”.
- This is shown in pictures “c” and “d” at left.
Step #5: Make Proto-planets
- As the sun begins fusion, its heat warms the remaining gas and dust and its gravitational attraction begins to form clumps of matter.
- These “proto-planets” revolve around the new sun, which saves them from becoming star-fuel.
- This is seen in “e” and “f”.

Step #6: Condense Your Planets!
- As the proto-planets begin revolving, their eccentric orbits bring them near to each other.
- These “close-calls” lead to collisions and absorptions as bigger planets are hit repeatedly.
- Slowly, the biggest planets begin clearing lanes in their orbits and eventually become the only one left standing in their orbit.

Why are there two major types of planets?

Step #7: Find a Home for Stragglers
- Not every proto-planet will be absorbed into bigger planets.
- Some will be leftover (like crumbs after all the cookies are eaten) - like this asteroid.
- These “minor planets” will find their own orbits and may eventually be pulled into a larger planet.
- We see this with our Solar System’s asteroid belt (between Mars and Jupiter).

Where did asteroids and comets come from?

Step #8: Step Back as They Impact
- Over the course of time, many of these minor planets have collided with the Earth and Moon.
- Their impact may have formed the Moon, killed off the dinosaurs, and kept Bruce Willis’ career alive until the “Sixth Sense”.
- We see these as comets and meteor showers.
Asteroids and Comets
- Leftovers from the accretion process
- Rocky asteroids inside frost line
- Icy comets outside frost line

Heavy Bombardment
- Leftover planetesimal s bombarded other objects in the late stages of solar system formation.

Origin of Earth’s Water
- Water may have come to Earth by way of icy planetesimal s from the outer solar system.

How do we explain the existence of our Moon and other exceptions to the rules?

Captured Moons
- The unusual moons of some planets may be captured planetesimals.

Giant Impact
- Giant impact stripped matter from Earth's crust. Stripped matter began to orbit then accreted into the Moon.
Giant impacts might also explain the different rotation axes of some planets.