This artist’s impression shows the formation of a gas giant planet in the ring of dust around the young star HD 100546. This system is also suspected to contain another large planet orbiting closer to the star. The newly-discovered object lies about 70 times further from its star than the Earth does from the Sun. This protoplanet is surrounded by a thick cloud of material so that, seen from this position, its star is almost invisible and red in color because of scattering of light from the dust. Credit: ESO/L. Calçada
Protoplanetary disks or **proplyds** are everywhere all around us, actually being more common than even the most hard-core science fiction fan would have ever dreamt, not in their wildest dreams.

This implies that planets themselves, which are much more difficult to spot than these showy disks, are extremely common as well, including earth-like ones too probably, but due to size even more difficult to spot.
We think that this is how our very own solar system most likely looked, \(~4.6\) billion years ago.

A common theme: later spiral/lenticular galaxies, and bottom-up galaxy formation model.

In the modern default model, young stars (protostars) are the ones that form planets, so they come early on.

When dating our own solar system at the very least, this is definitely true (Sun, Earth, other planets, all the same age roughly, to within few millions of years: that’s “nothing”)

Can also see in observation of stellar planetary systems forming right now as speak...

* Later on: “T Tauri” protostars...
Accretion Model, and Gas Collapse Model: 2 different ways of viewing possible planetary system formations

Either way, all planets start out their lives as just clouds of gas (just as the stars do)

- Some become gas giants, remaining all gas or nearly so, like the 4 we have in our own system: Jupiter, et al.
- Others, depending on the exact temperatures and pressure conditions, and the exact details and degree of the collapse, can become (small) rocky worlds (solid – liquid is a bit trickier)
Speaking of Liquid...
More Reasons Why Disks

- Why a disk? The reason is same as reason that Saturn's rings form a disk.
  - Particles which are NOT in regular, circular, equatorial orbits will collide and will either break up or be forced to conform to a regular orbit.
  - Collision processes can act both to confine material to a thin disk (what we now call the ecliptic) as well as cause the orbits of the surviving objects to be regular circles/ellipses that are spaced apart, so that there are no further collisions (major, often).

- Note all planets orbit the Sun in same direction, the direction Sun rotates!

http://lasp.colorado.edu/~bagenal/1010/SESSIONS/11.Formation.html
Individual Planets

- A & S article: magnetism plays role too, not just gravity
- Helps address question of how the clumpiness randomly started on its own
- Be aware electricity and magnetism MUCH stronger than gravity, which compensates: BIG things
- Just like sun and stars, a planet can have rich internal structures concentrically
- Crust, mantle, cores: not just earthly concepts!

http://lasp.colorado.edu/~bagenal/1010/SESSIONS/11.Formation.html
This lecture already looks a heck of a lot different than a same one would have even just 15-20 years ago (new!)
Homework

- Quiz #7
- I will extend 2 tries, but average
- Due 11:59 PM tomorrow, Tuesday February 7th
- On moon, eclipses, related

All discussion of the ultimate nature of things must necessarily be barren unless we have some extraneous standards against which to compare them.

— Sir James Jeans
In The Mysterious Universe (1930), 114.