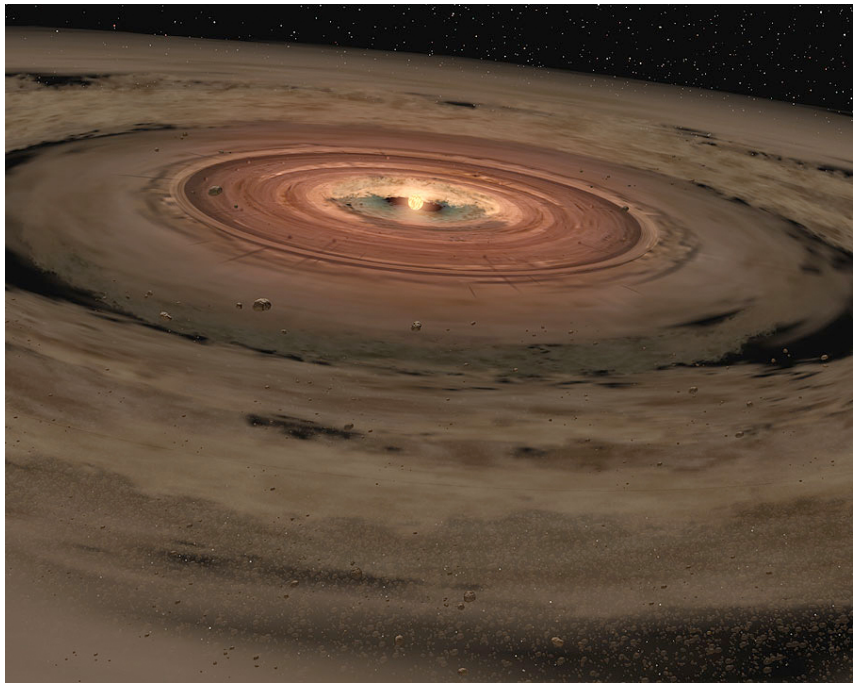
Introductory Astronomy

Week 3: Solar System(s)

Clip 4: Terrestrial Planet Formation

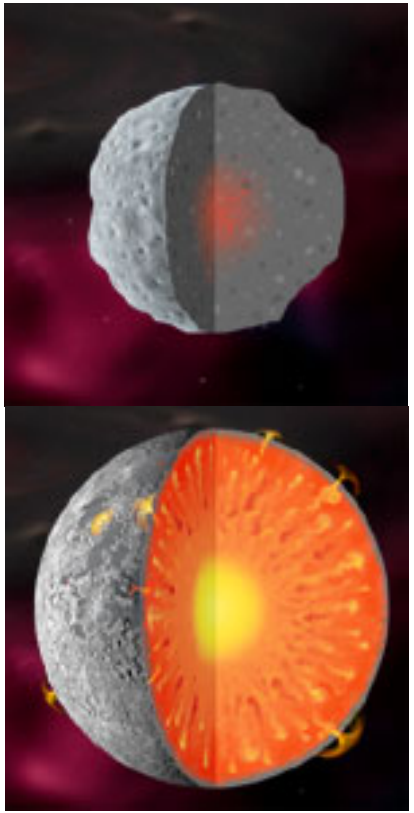
Dust to Planetesimals

- Grains of dust (solids) collide and adhere
- Larger grains grow to 10^9 planetesimals of size 1km - gravitationally bound
- Keplerian orbits sweep through dust
- Gravitational interaction increasingly important, growth rate ~R^4 for 100Ky



Protoplanets

- Form hundreds of protoplanets R≤1000km
- Heat of collisions along with radioactivity melts protoplanets
  - Objects this large are spheres: no mountains in the ocean
  - Chemical differentiation: heavier material sinks to core
- Gravity opposed by pressure gradient
- Compression heats core



A Live Protoplanet

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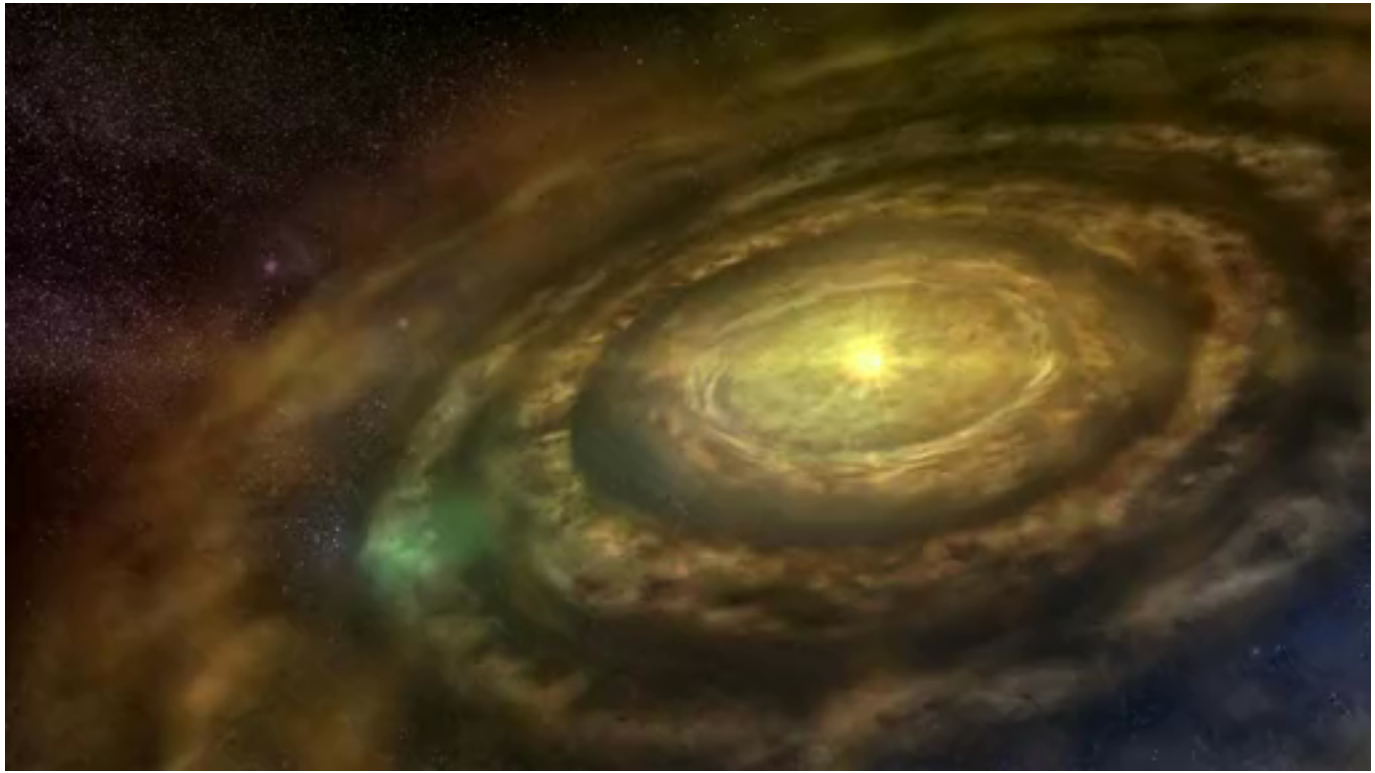
Planets

- Larger protoplanets accrete remaining planetesimals
- End with 100 Moon-Mars sized protoplanets in cleared gaps in disk
- Gravitational interactions distort orbits
- Remaining planetesimals ejected
- Collisions lead to merger or ejection leaving large Venus and Earth
- Mercury stripped to core
- Mars does not grow
- Orbits settle to near-circular in 10-100My



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Credits

- 51 Ophiuchi Disk: NASA/JPL-Caltech/T. Pyle (SSC) http://www.nasa.gov/centers/goddard/news/topstory/2009/dust_disks.html
- Chemical Differentiation: Smithsonian Museum of Natural History: The Dynamic Earth http://www.mnh.si.edu/earth/text/5_1_4_0.html
- Vesta Rotation: NASA/Dawn Mission http://www.nasa.gov/multimedia/videogallery/index.html?collection_id=65362&media_id=152548561
- Planet formation animation: NASA/University of Copenhagen/Lars Buchhave http://www.nasa.gov/multimedia/videogallery/index.html?collection_id=14471&media_id=146251701