Lecture 2 Notes: The Solar System and Planetary Science

Supplementary Material

August 2024

1 The Dynamic Solar System

While the lecture presented a snapshot of our current Solar System, it's important to understand that it's a dynamic system that has evolved significantly over 4.6 billion years. Key aspects to explore:

- Nice Model of Solar System evolution
- Migration of giant planets
- Late Heavy Bombardment
- Formation of the Moon through giant impact

For detailed reading on Solar System dynamics:

- Morbidelli, A. et al. (2007) "Dynamics of the Giant Planets of the Solar System in the Gaseous Protoplanetary Disk"
- Tsiganis, K. et al. (2005) "Origin of the orbital architecture of the giant planets of the Solar System"

2 The Sun's Internal Structure

2.1 Solar Interior

The lecture touched on the Sun's structure, but there's more to explore about:

- Helioseismology techniques
- Solar dynamo and magnetic field generation
- Solar neutrino problem and its resolution

Key references:

- Christensen-Dalsgaard, J. (2021) "Helioseismology", Living Reviews in Solar Physics
- Charbonneau, P. (2020) "Dynamo Models of the Solar Cycle"

3 Comparative Planetology

3.1 Terrestrial Planets

The lecture covered basic characteristics, but consider these additional aspects:

- Magnetic field generation and importance
- Atmospheric evolution and escape
- Impact of solar wind interaction
- Role of plate tectonics

For detailed exploration:

- Taylor, S.R. (2011) "Planetary Science: A Lunar Perspective"
- Solomon, S.C. et al. (2018) "Mercury: The View after MESSENGER"

4 Gas Giants and Ice Giants

4.1 Internal Structure Models

Current understanding of giant planet interiors includes:

- Metallic hydrogen layers
- Core erosion processes
- Helium rain
- Magnetic field generation

Recent developments from missions:

- Guillot, T. et al. (2022) "Jupiter's internal structure: The effect of different equations of state"
- Kaspi, Y. et al. (2018) "Jupiter's atmospheric jet streams extend thousands of kilometres deep"

5 Small Bodies in the Solar System

5.1 Asteroids and Meteorites

The connection between asteroids and meteorites provides crucial information about:

- Early Solar System conditions
- Planetary formation processes
- Distribution of elements
- Timeline of Solar System events

Key references:

- DeMeo, F.E. & Carry, B. (2014) "Solar System evolution from compositional mapping of the asteroid belt"
- Vernazza, P. et al. (2022) "VLT/SPHERE imaging survey of the largest main-belt asteroids"

6 Modern Exploration Technologies

6.1 Current and Future Missions

Active and planned missions as of 2024:

- Parker Solar Probe (Sun)
- Solar Orbiter (Sun)
- BepiColombo (Mercury)
- DAVINCI+ and VERITAS (Venus)
- Dragonfly (Titan)
- Europa Clipper (Jupiter system)

For mission updates and details:

- NASA's Solar System Exploration website
- ESA's Cosmic Vision program documentation

7 Research Problems for Advanced Study

Current open questions in Solar System science:

- Origin of Earth's water
- Formation mechanism of Saturn's rings
- Nature of Uranus's axial tilt
- Distribution of organic compounds
- Role of magnetic fields in planetary evolution

8 Additional Resources

Textbooks for deeper study:

- de Pater, I. & Lissauer, J.J. "Planetary Sciences" (Cambridge)

Online resources:

- NASA's Planetary Data System (`https://pds.nasa.gov`)
- Minor Planet Center Database (`https://minorplanetcenter.net`)
- Virtual Solar System (`https://solarsystem.nasa.gov/visualizations`)

9 Computational Tools

For orbital mechanics and planetary science calculations:

- SPICE toolkit (NASA Navigation and Ancillary Information Facility): `https://naif.jpl.nasa.gov/naif/toolkit.html`
- REBOUND (for gravitational dynamics): `https://rebound.readthedocs.io/`