

# Geometry of Space

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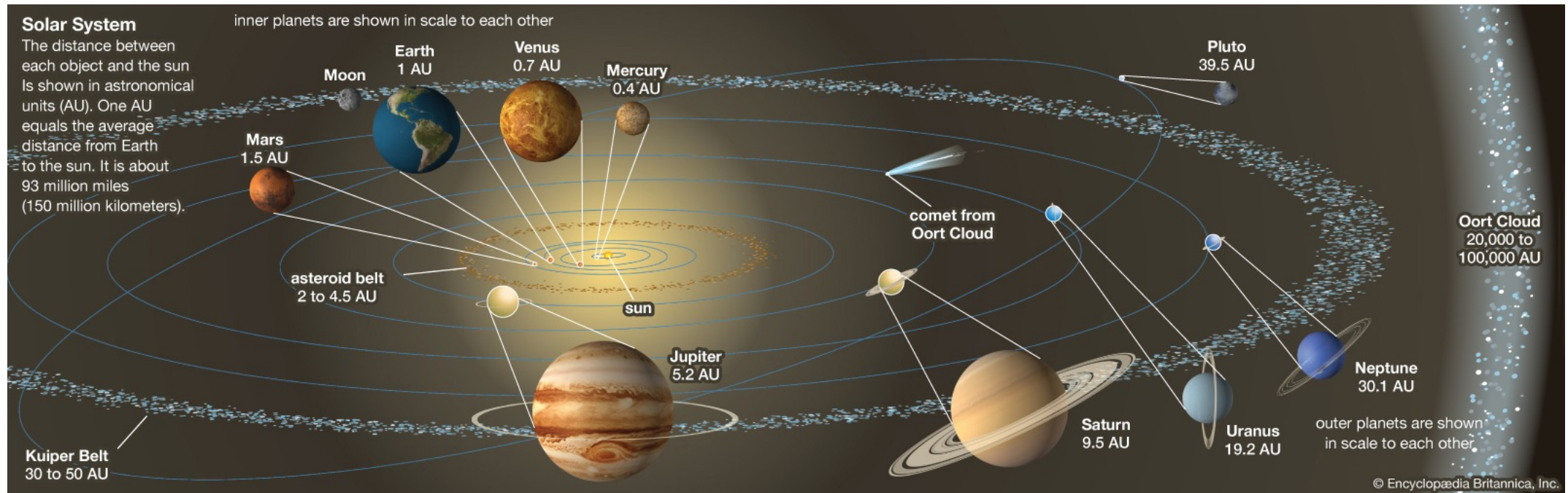
# What does the Universe look like?

- The main goal of our stream is to investigate the large-scale structure of the universe.
- On a small scale we can study the properties and distribution of star clusters.
- On a larger scale we can study the distribution of galaxies and clusters of galaxies.
- We can also look at the distribution of AGNs (Active Galactic Nucleus) and Quasars.

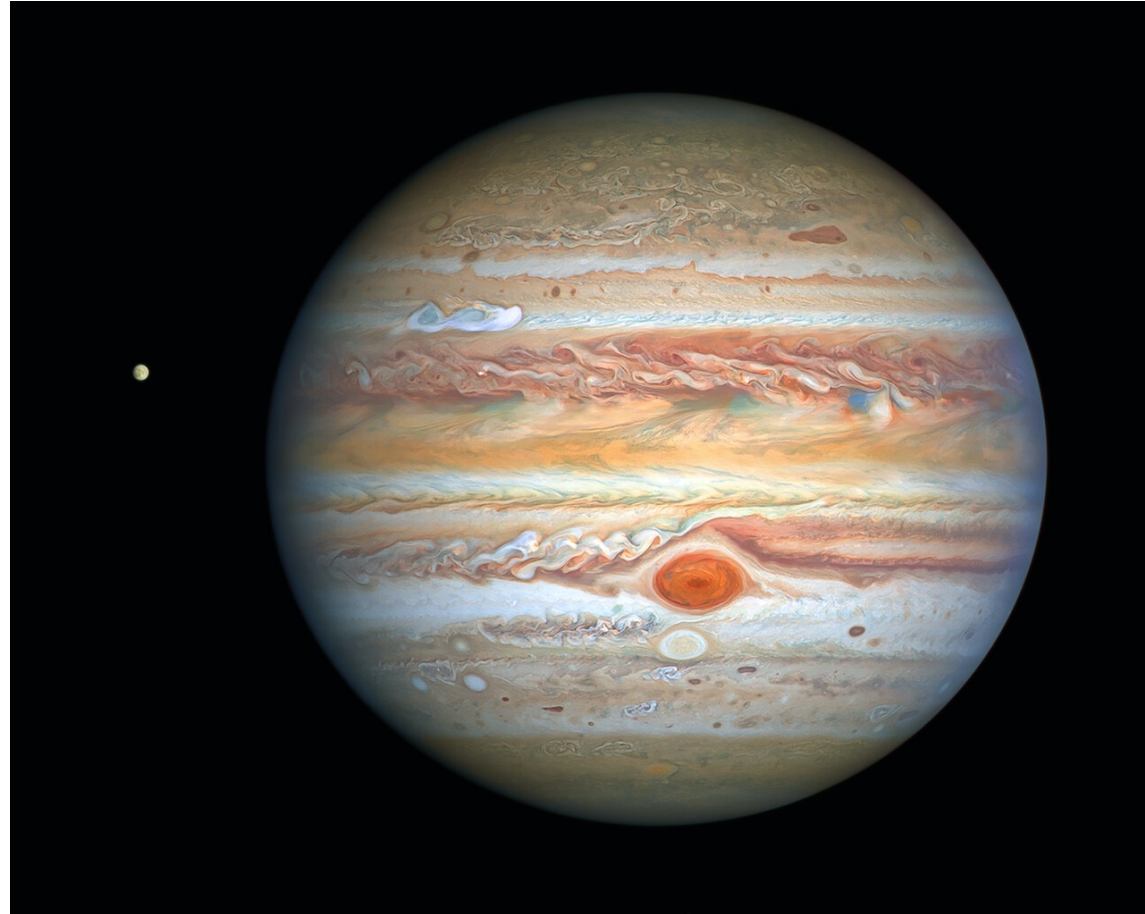
# Clustering Hierarchy in the Universe

- Solar System: Sun, Planets, Minor Planets, Asteroids, Comets
- Double Stars
- Star Clusters: Stellar Associations, Open Clusters, Globular Clusters
- Milky Way Galaxy: Stars, Gas, Dust, Dark Matter
- Local Group of Galaxies: Milky Way, M31, LMC, SMC
- Clusters of Galaxies: Virgo Cluster, Coma Cluster
- Superclusters: Local Supercluster, Southern Supercluster
- Third Order Clustering: clusters of clusters of clusters of galaxies

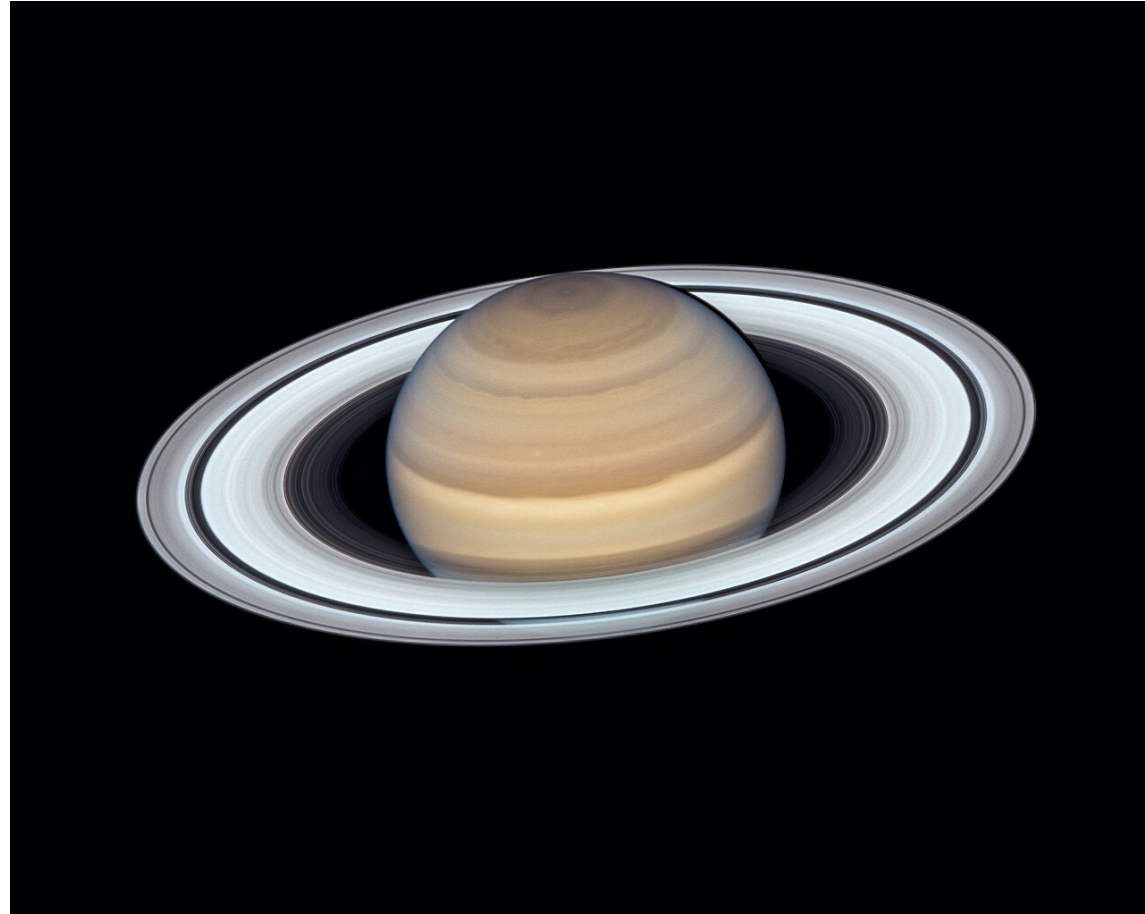
# Solar System



# Jupiter



# Saturn



# Double Star - Albireo



# NGC 4755 Jewel Box

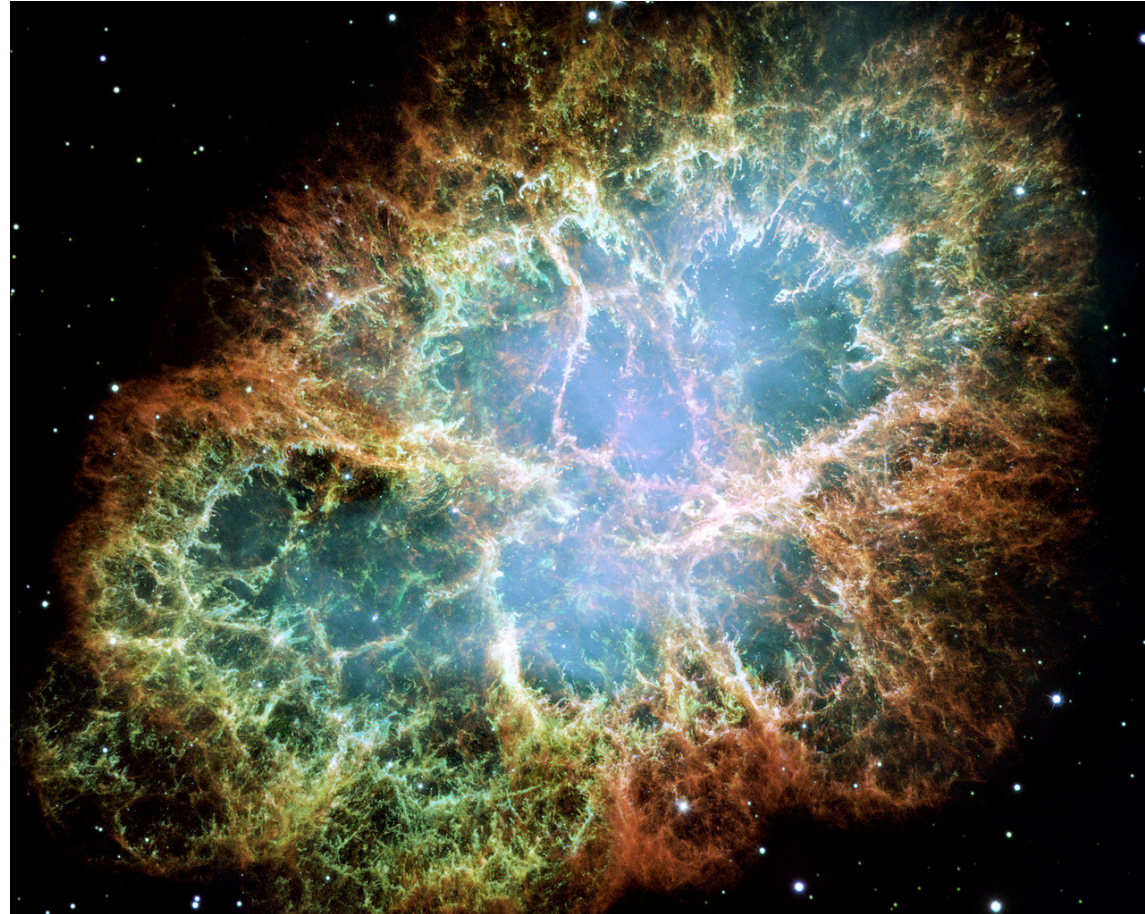




# NGC 1866 Young Globular Cluster



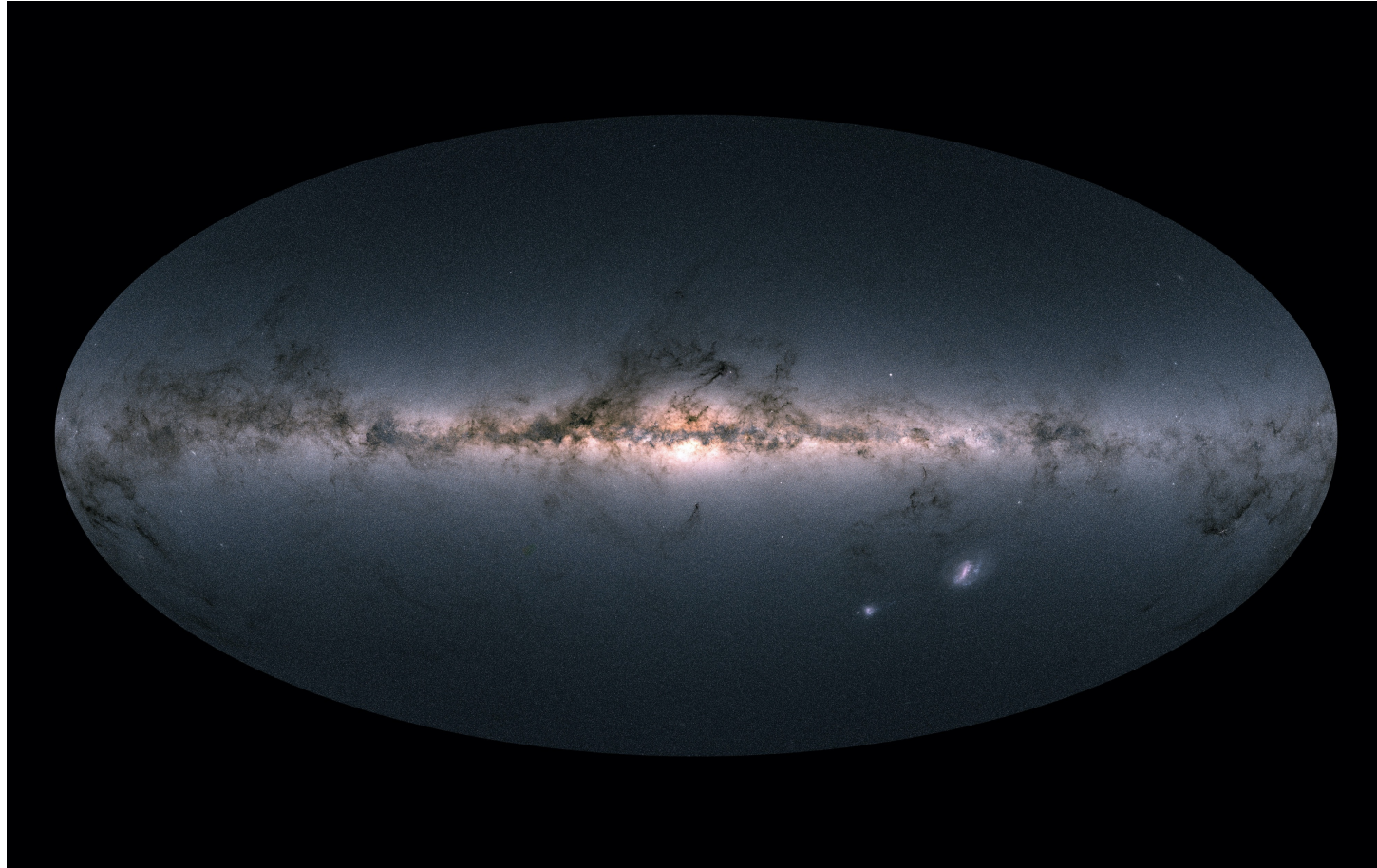
# Crab Nebula (Supernova Remnant)



# Planetary Nebula



# Milky Way Galaxy



# Whirlpool Galaxy



# Barred Spiral (NGC 1300)



# Starburst Galaxy M82



# Pinwheel Galaxy





# Clusters of Galaxies



# Abell 1703 Cluster of Galaxies



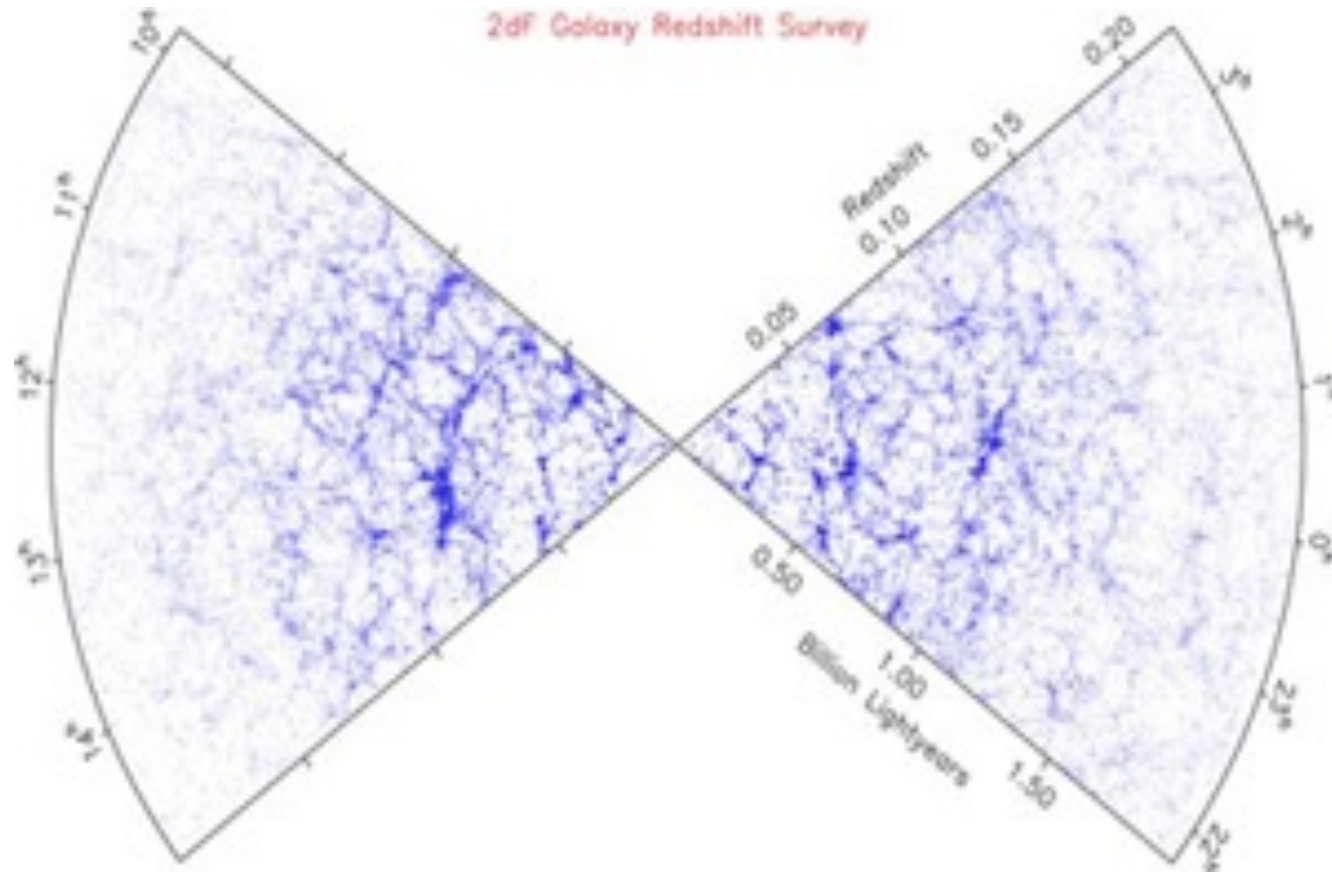
# Rings of Relativity



# Clusters of Clusters of Galaxies



# Large Scale Structure of the Universe



# Sources of Data

- We use existing sources of data
- Sloan Digital Sky Survey (SDSS)
- Gaia
- NASA Extragalactic Database (NED)
- SIMBAD Astronomical Database

# Tools Used

- All our programming is in Python
- Python packages used
  - Jupyter Notebooks
  - Matplotlib
  - NumPy
  - SciPy
  - Pandas
  - Plotly
- SQL for Database Query

# Time Commitment

- Goal is to publish one or two papers
- Must be committed to spend at least two semesters (Spring 2022 and Fall 2022)
- Take this as an independent study course
- There are no exams
- But there is reading of original research papers and writing of reports
- We will have a small cohort of students who will work together on the research projects