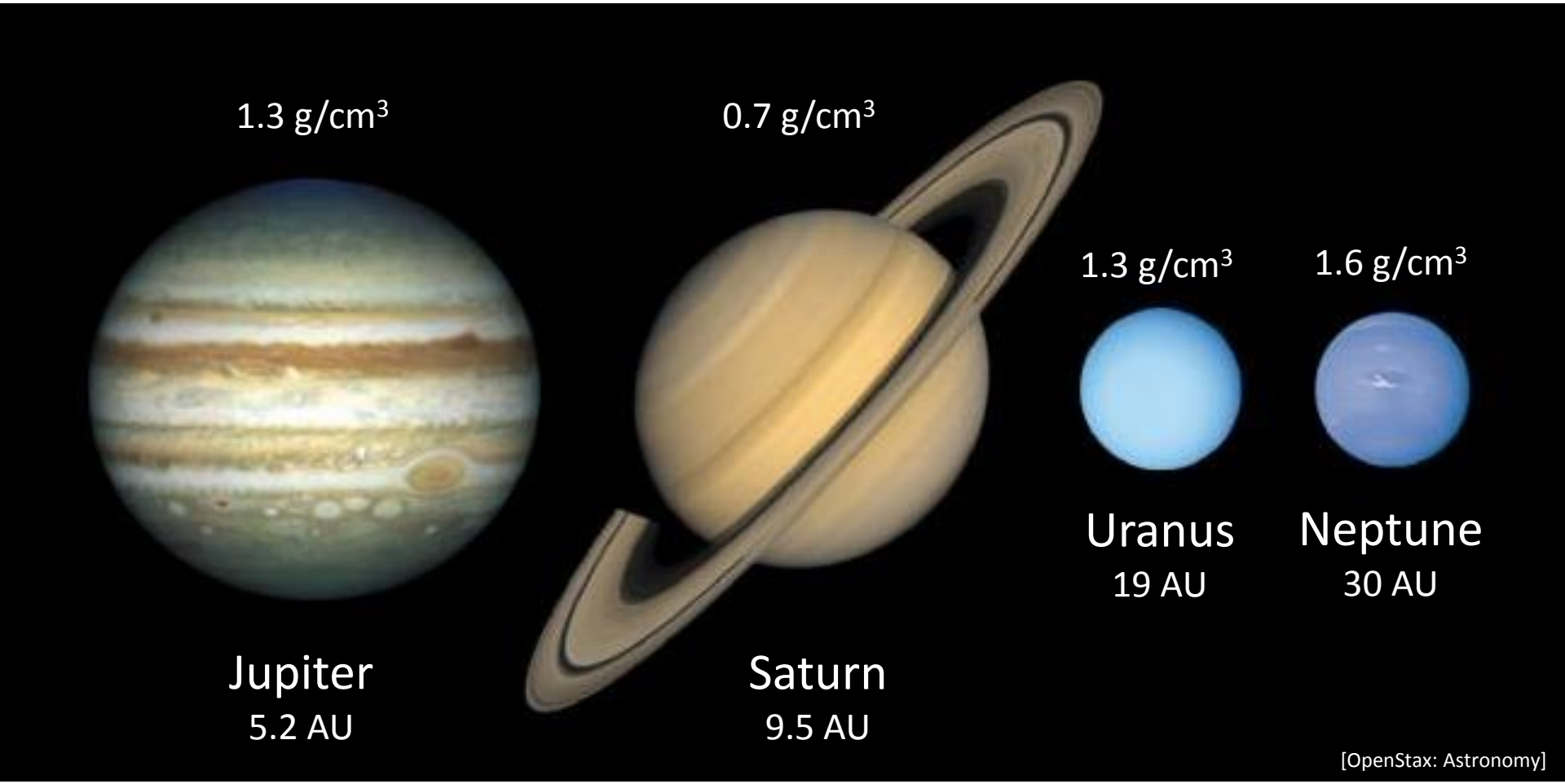
Today's Topics

Wednesday, October 22, 2019 (Week 8, lecture 21) – Chapters 11, 12.

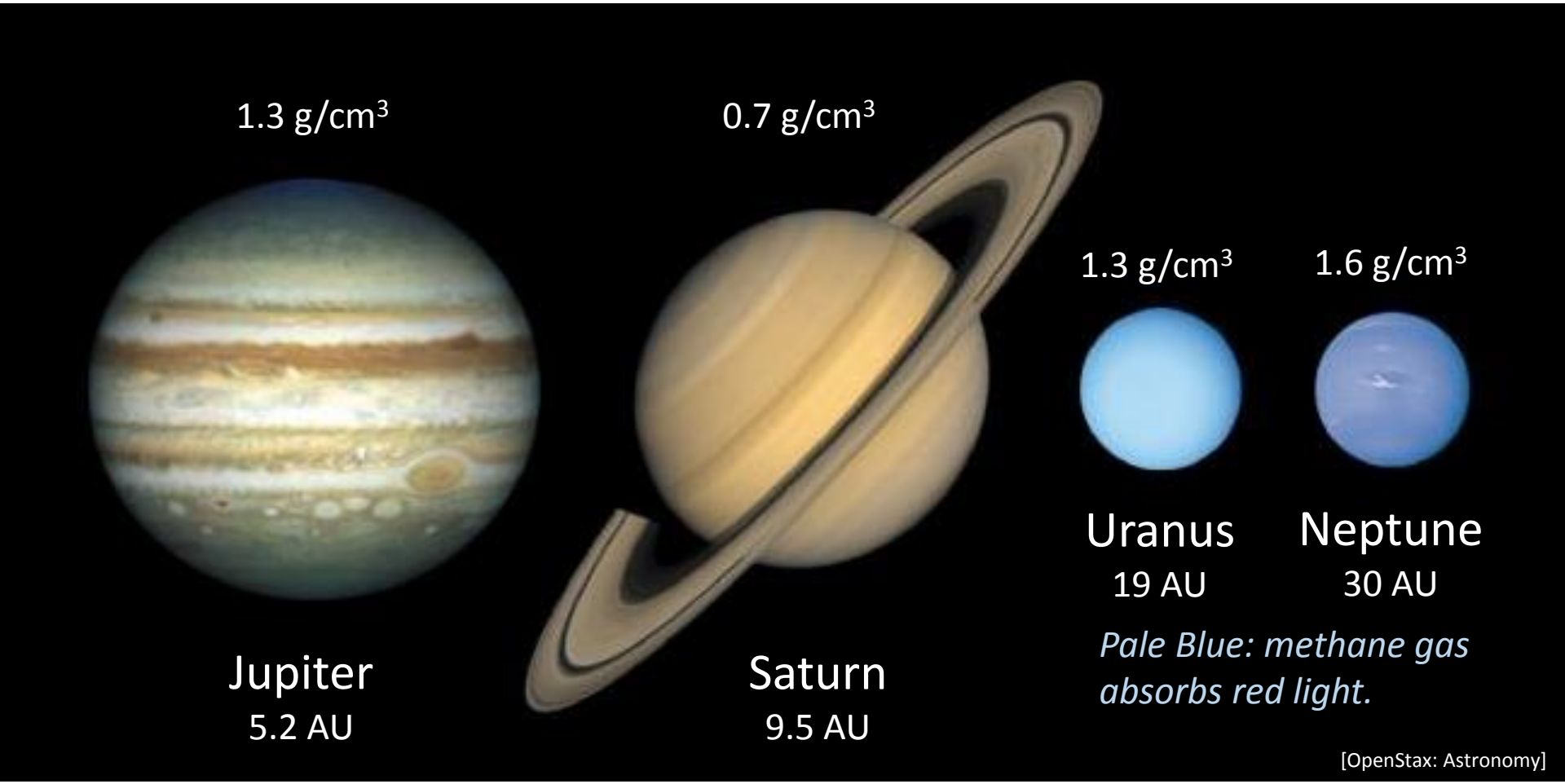
1. Icy Gas Giants

2. Presentation development (team workshop)

Icy Gas Giant Planets



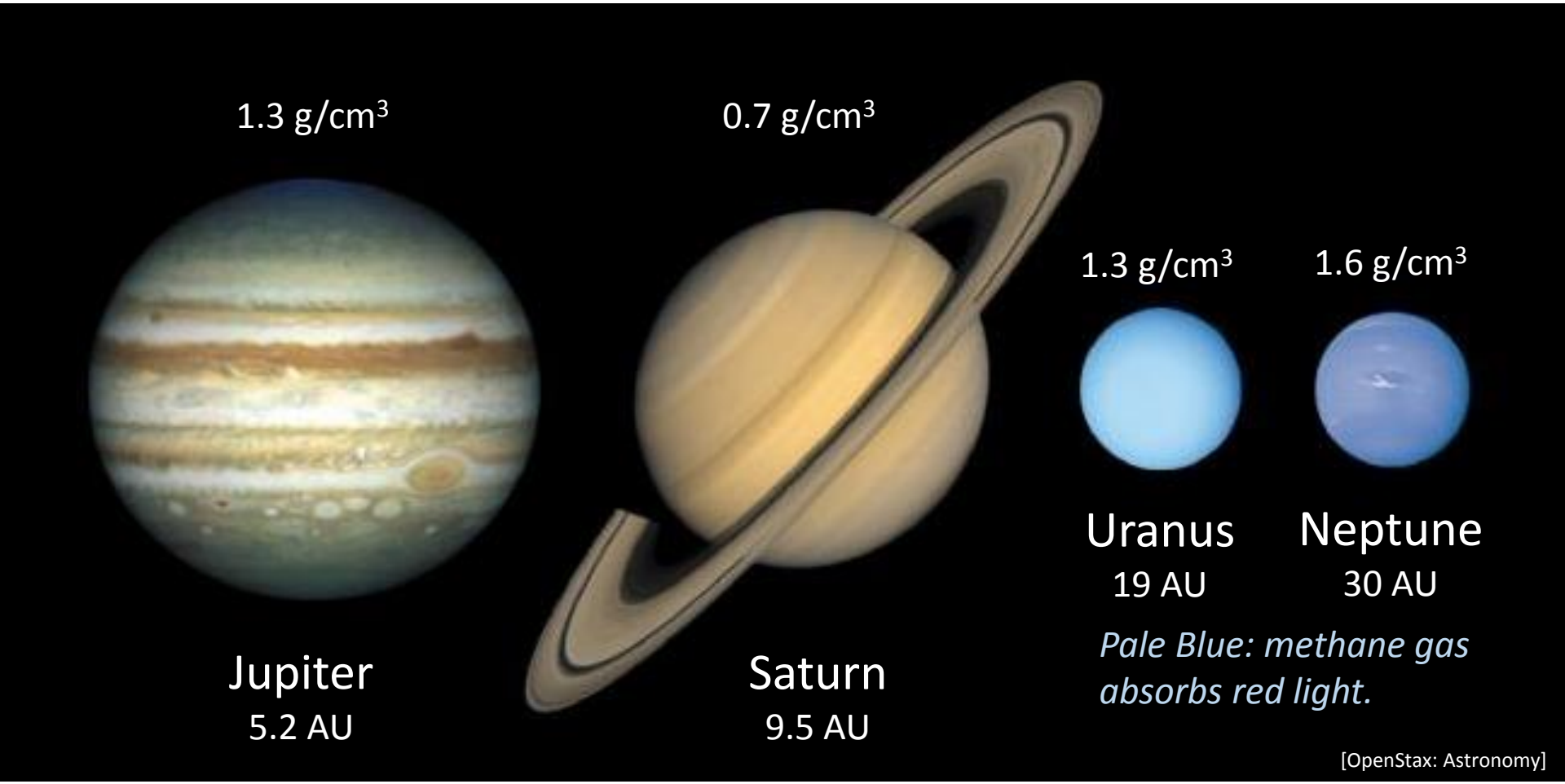
Icy Gas Giant Planets



White ammonia (NH_3) clouds, red-ish ammonium hydrosulfide (NH_4)HS clouds

Hydrogen and helium are basically colorless.

Icy Gas Giant Planets



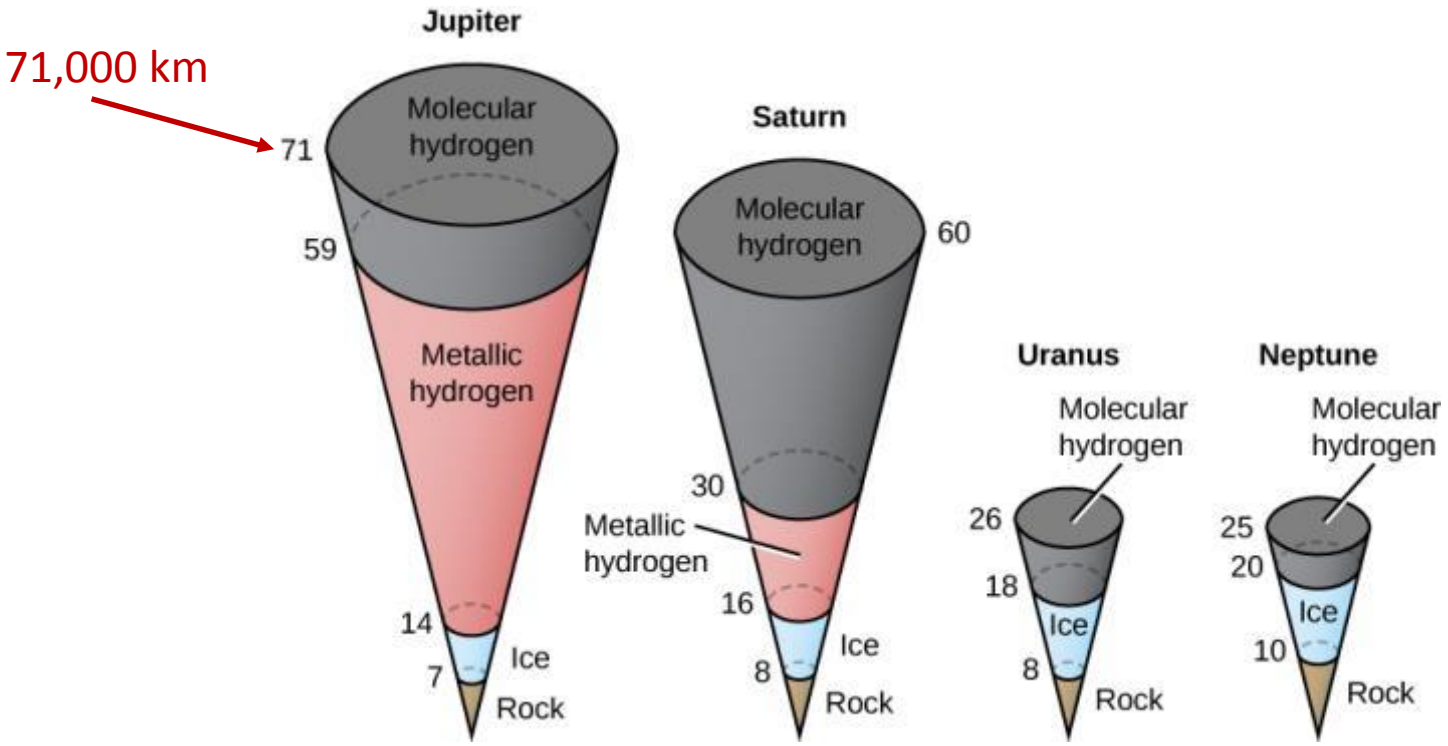
White ammonia (NH_3) clouds, red-ish ammonium hydrosulfide (NH_4)HS clouds

Hydrogen and helium are basically colorless.

Icy refers to the molecules made of light elements that condensed beyond the "frost line."

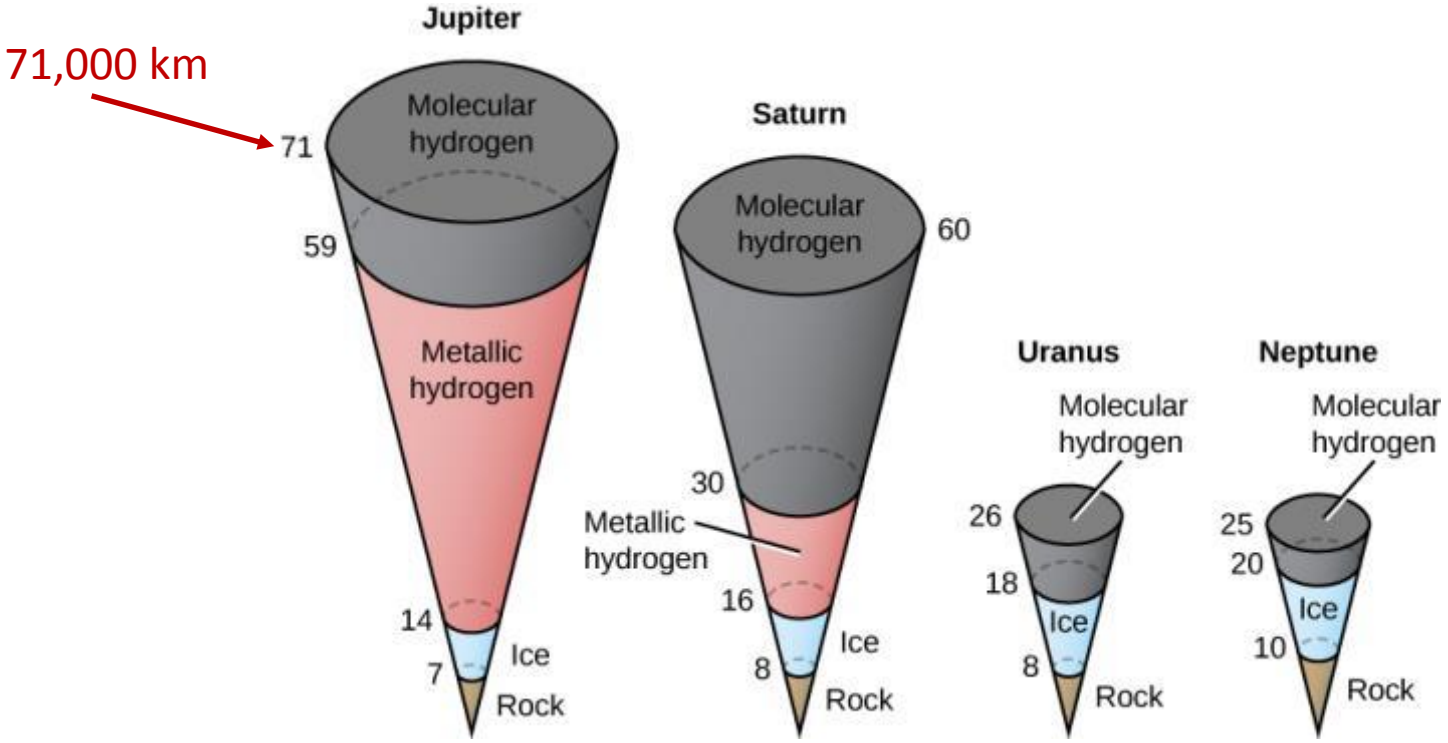
Gas refers to the thick layer/atmosphere of gas enveloping these planets.

Internal Structure of Jovian Planets



[OpenStax: Astronomy]

Internal Structure of Jovian Planets



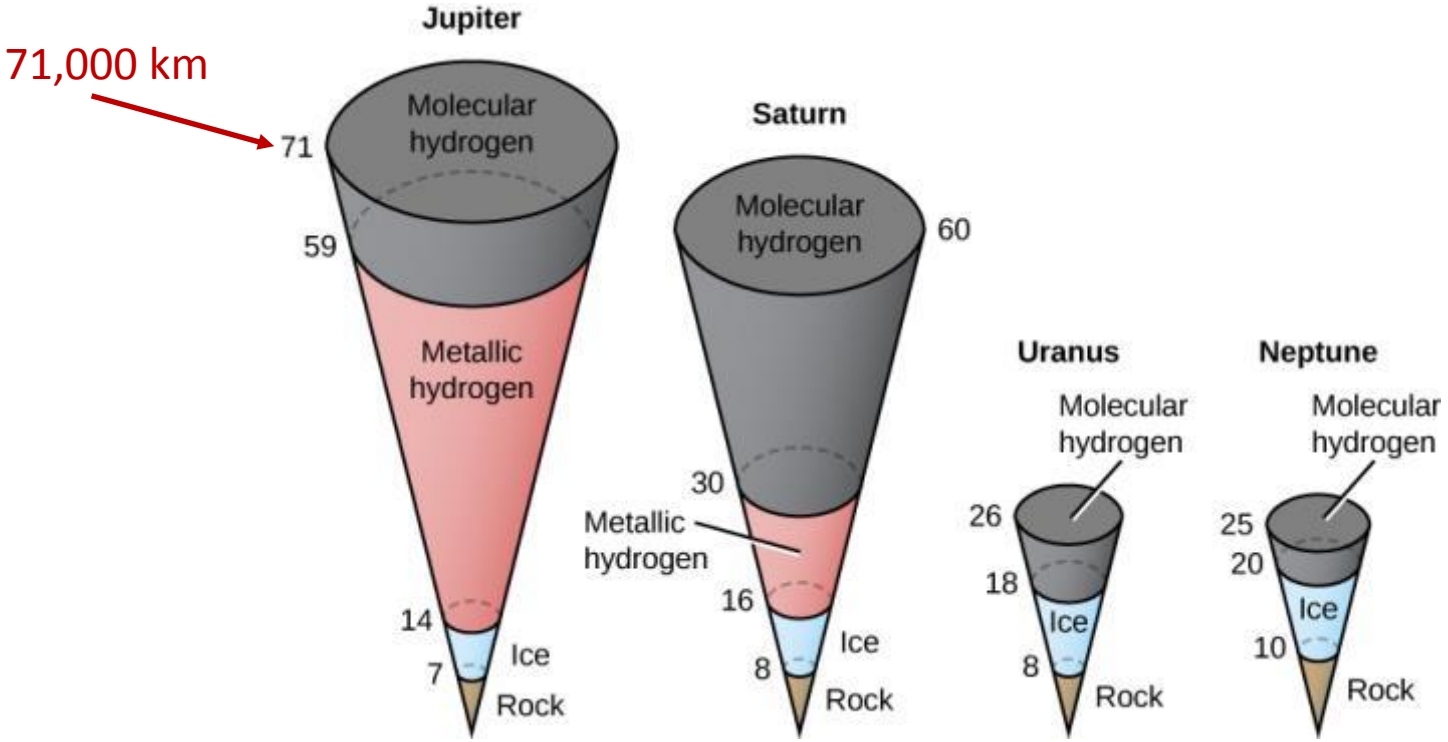
[OpenStax: Astronomy]

Outer/Visible Atmosphere

- **Jupiter** and **Saturn** are composed primarily of **hydrogen (H_2)** and **helium (He)**.

  → H_2 / He by volume: Jupiter 89% / 10%, Saturn 96% / 3%.

Internal Structure of Jovian Planets



[OpenStax: Astronomy]

Outer/Visible Atmosphere

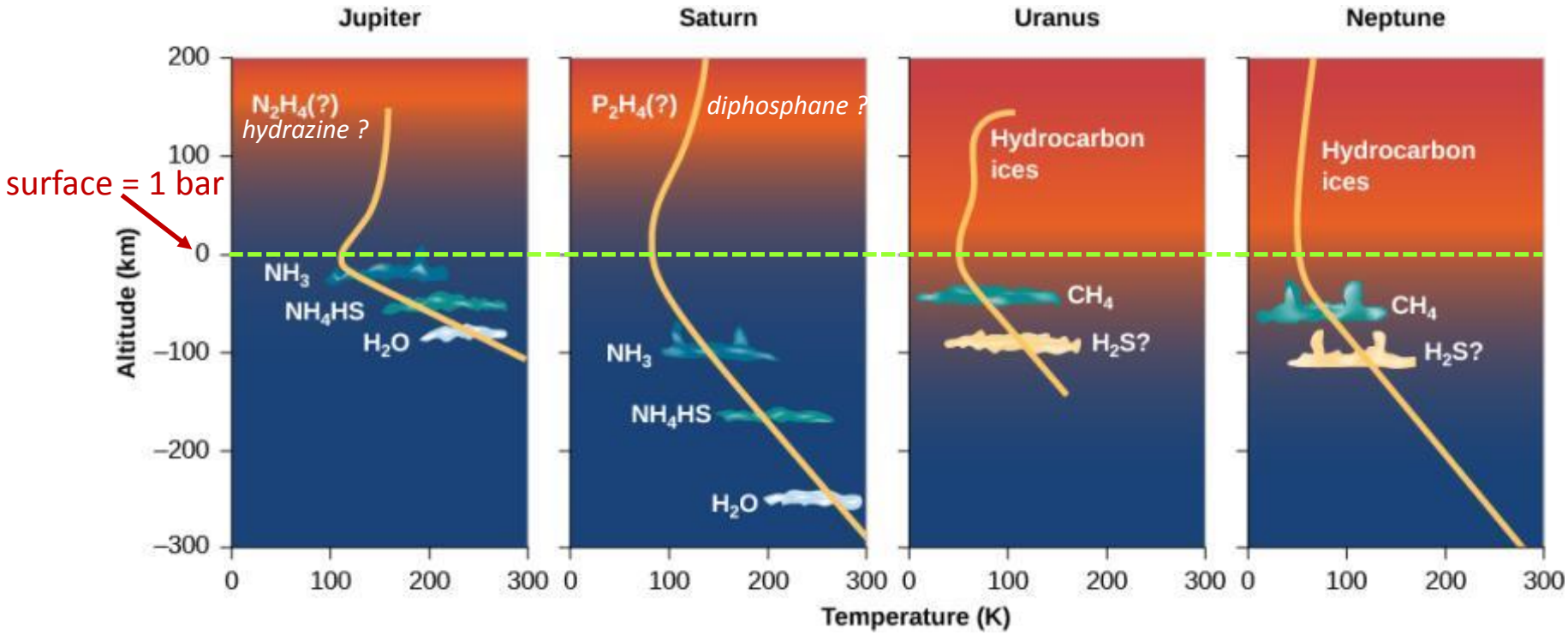
- **Jupiter** and **Saturn** are composed primarily of **hydrogen (H_2)** and **helium (He)**.

  → H_2 / He by volume: Jupiter 89% / 10%, Saturn 96% / 3%.

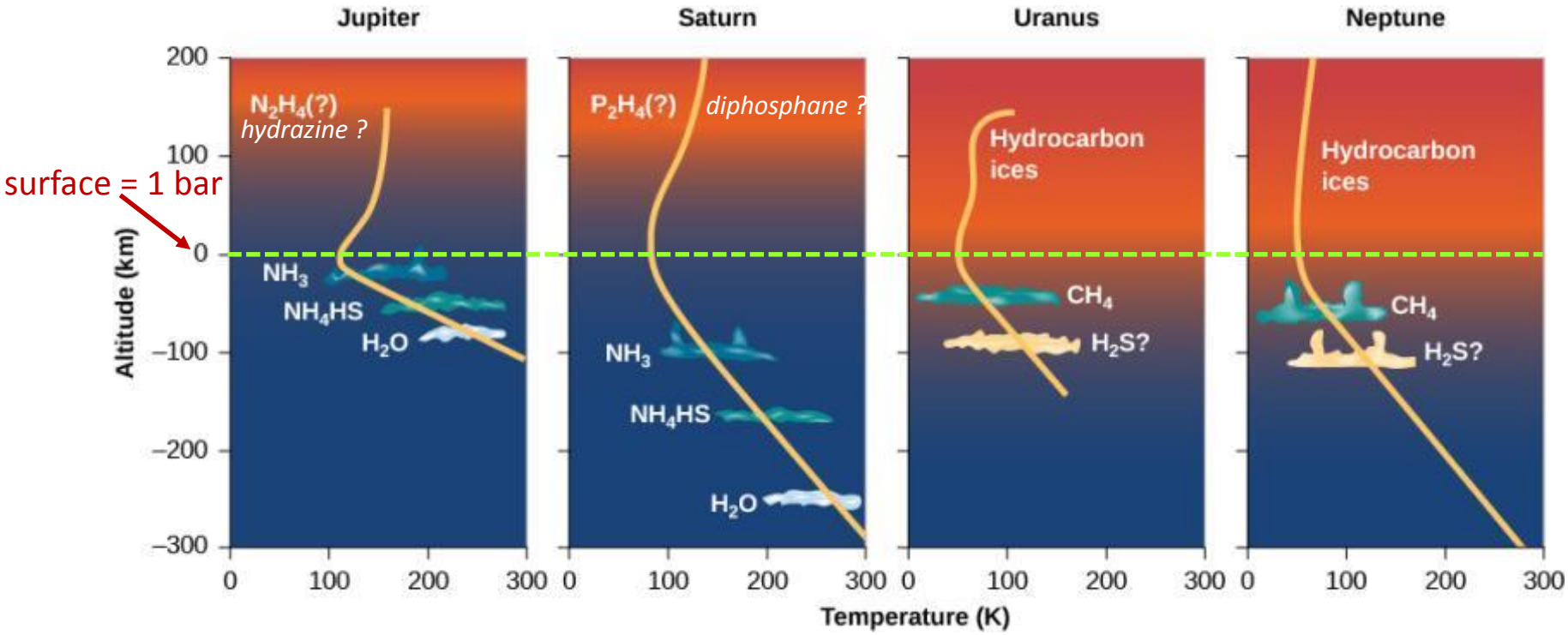
- **Uranus** and **Neptune** are largely hydrogen and helium, but also include **methane gas (CH_4)**, **water ice**, and **ammonia ice**.

  → H_2 / He / CH_4 by volume: Uranus 83% / 15% / 2%, Neptune 80% / 19% / 1.5%.

Atmospheric Structure



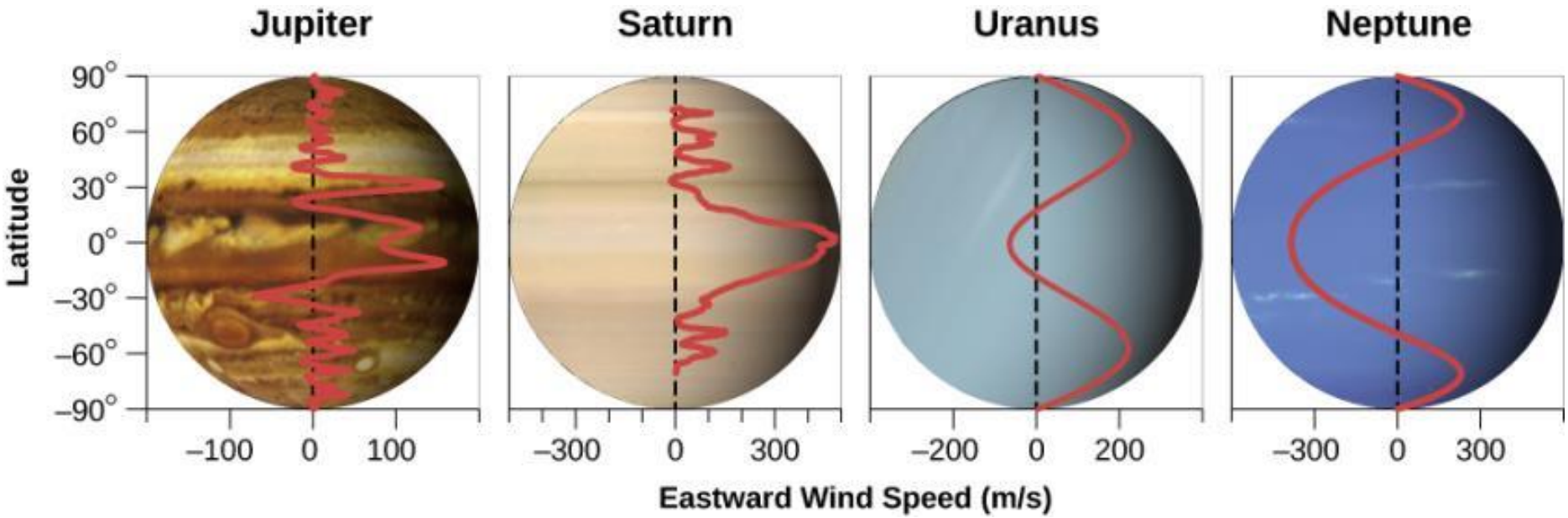
Atmospheric Structure



- The **"surface" (1 bar) temperature** drops from Jupiter through Neptune.
- The **temperature increases** as one penetrates **deeper** into the atmospheres.
- **Cloud composition** depends on altitude, i.e. temperature.
- **Jupiter's temperature** increases relatively quickly with depth.

Atmospheric Wind

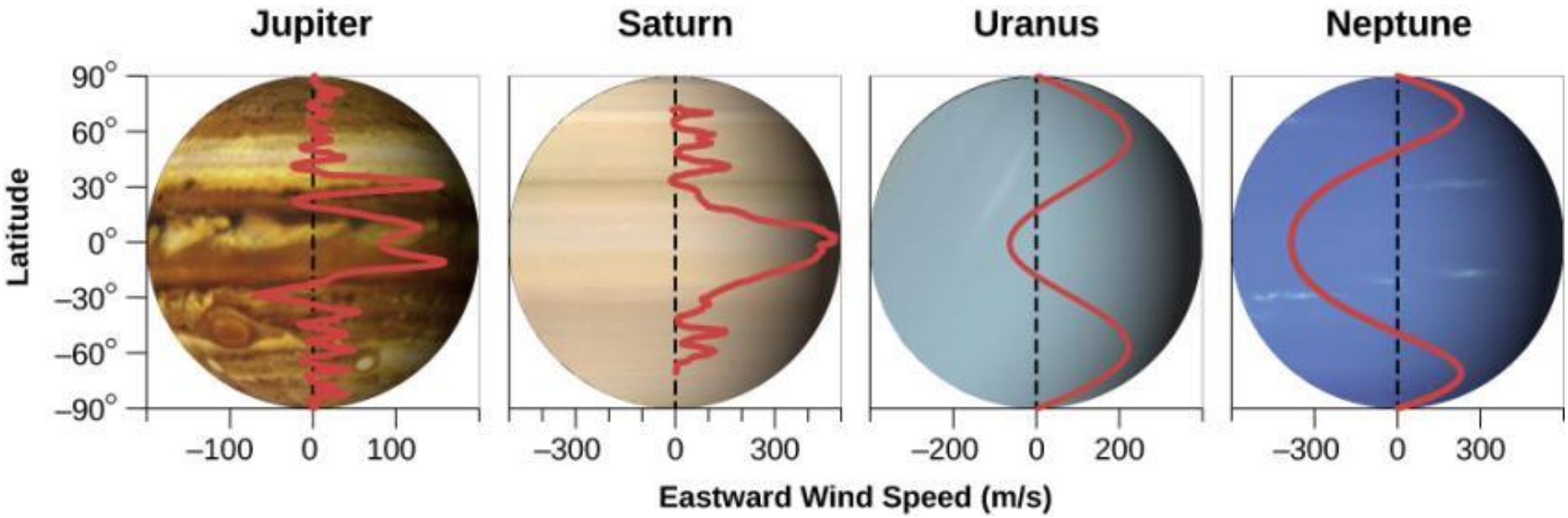
[OpenStax: Astronomy]



positive wind speed = same direction as planet rotation

Atmospheric Wind

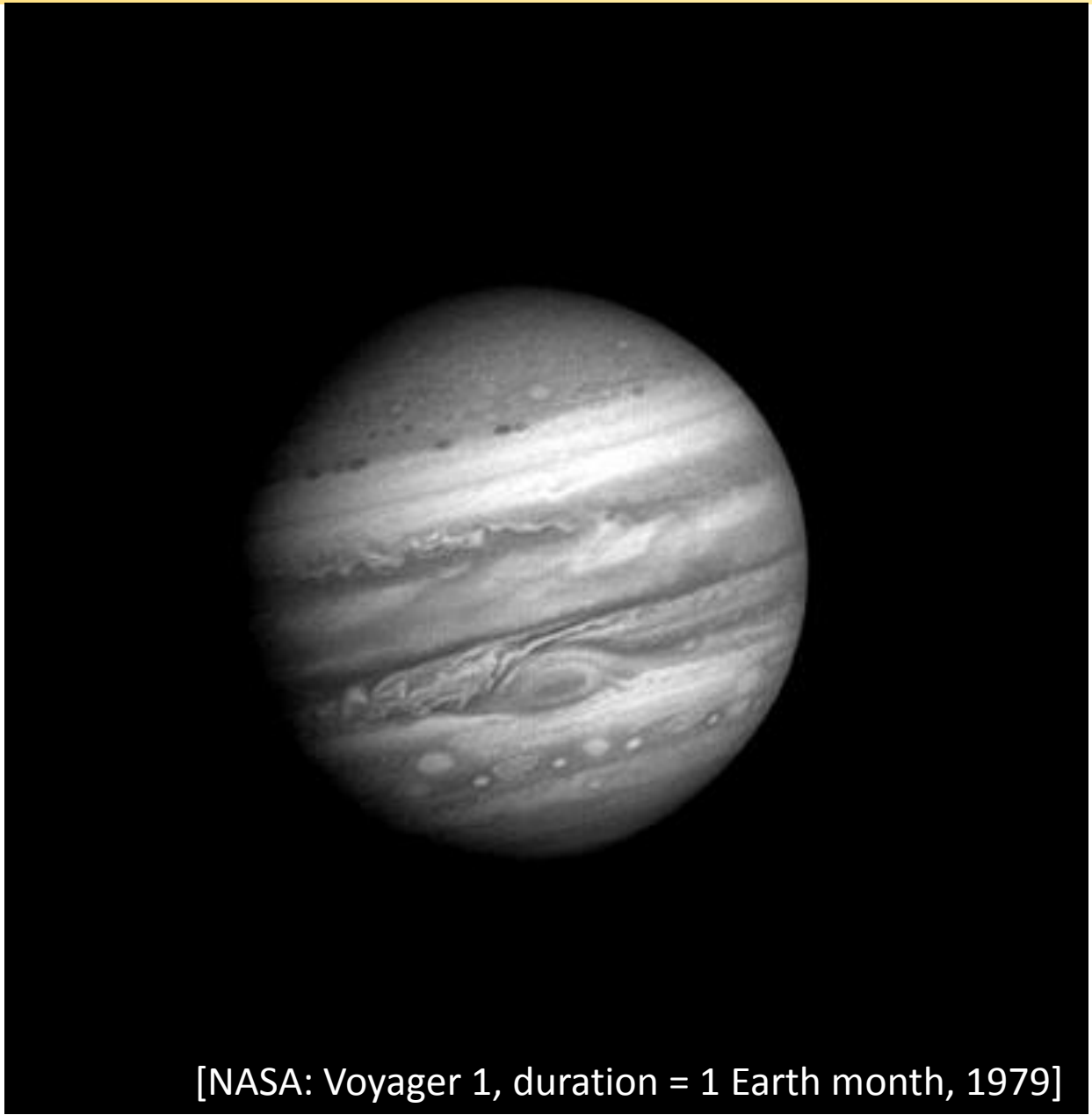
[OpenStax: Astronomy]



positive wind speed = same direction as planet rotation

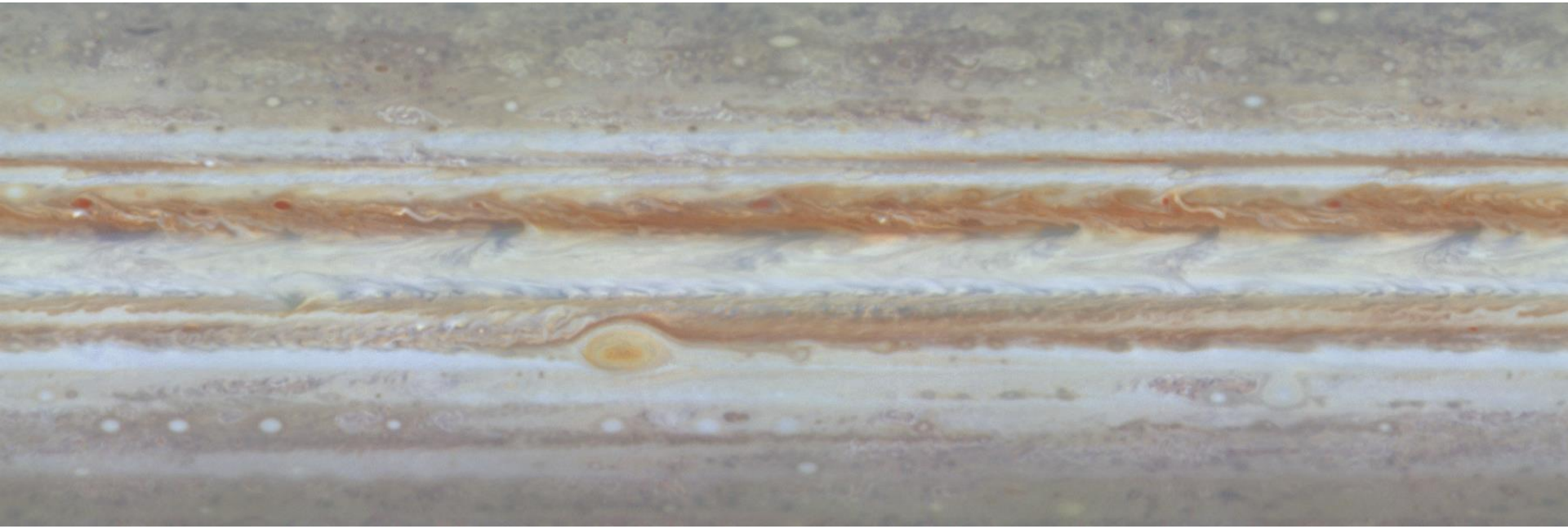
- Winds tend to be **mostly in the direction of rotation** of the planet's core.
- Wind direction and strength is **strongly dependent on latitude**.
- **Saturn's** equatorial winds reach **1800 km/h** (500 m/s).
- **Neptune** can have winds as high as **2100 km/h** (supersonic !).

Jupiter Winds



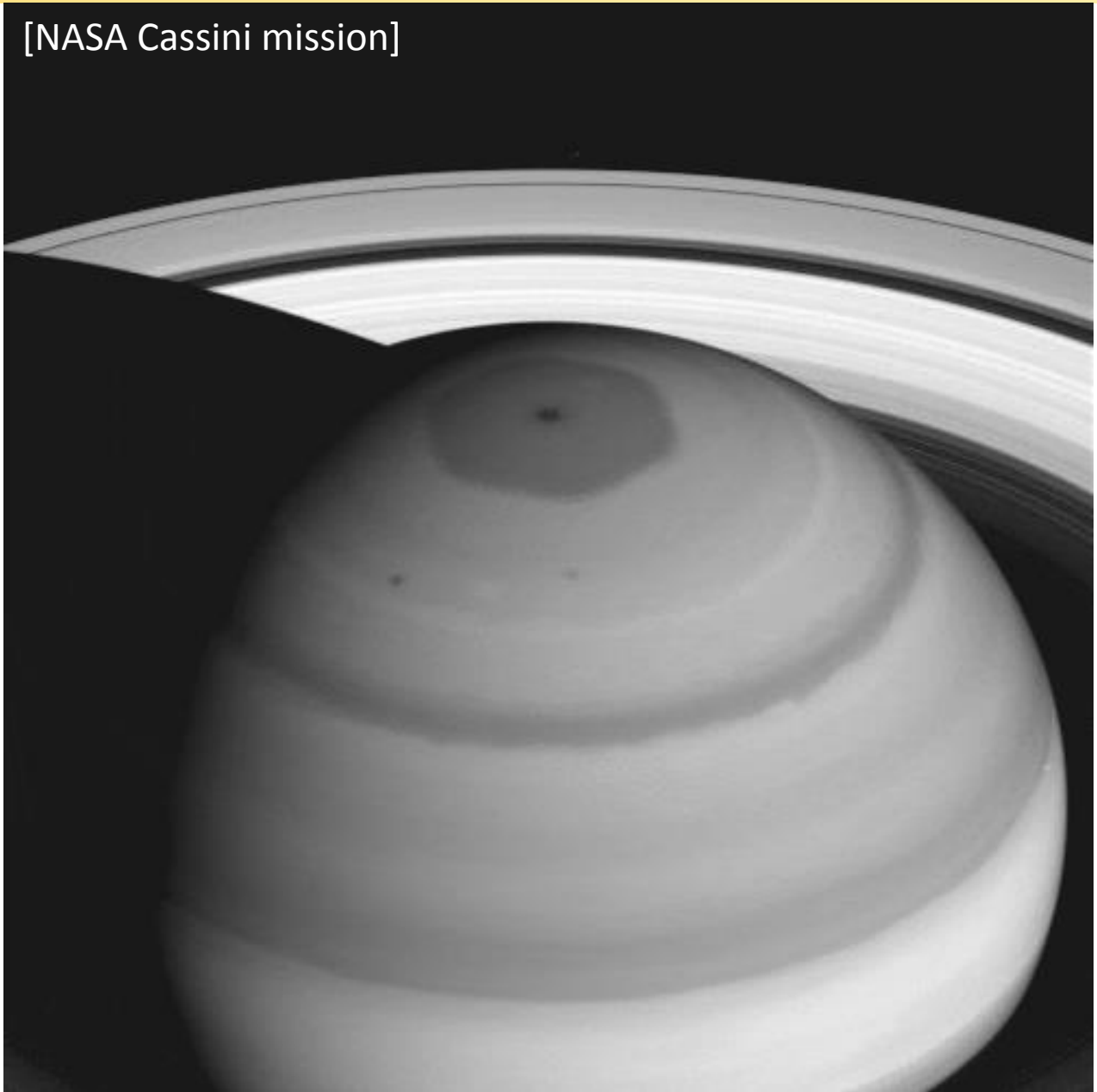
[NASA: Voyager 1, duration = 1 Earth month, 1979]

Jupiter Winds



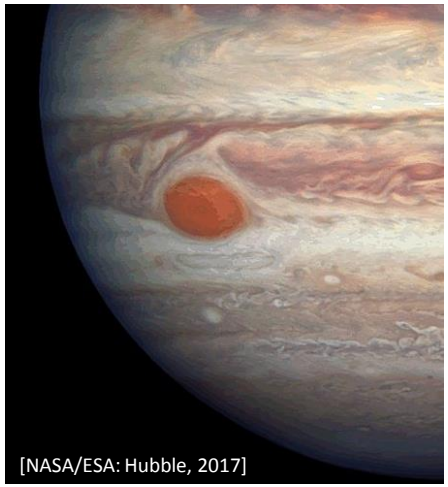
[NASA: Cassini mission, duration=10 Earth days, 2000]

Saturn's Hexagon

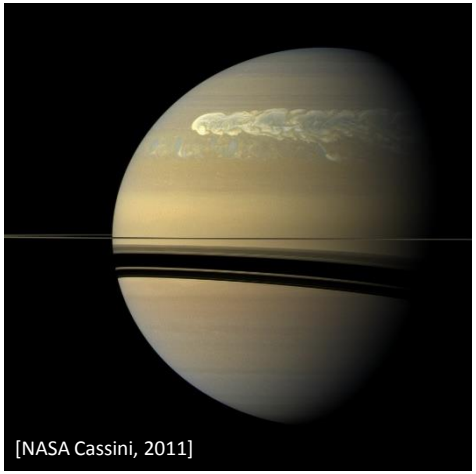


Storms

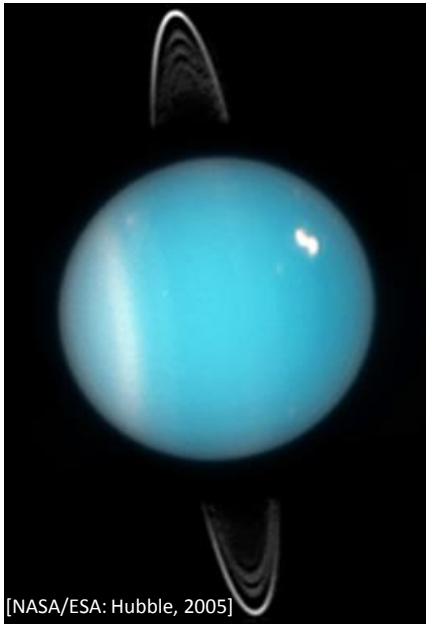
All of the gas giants have storms.



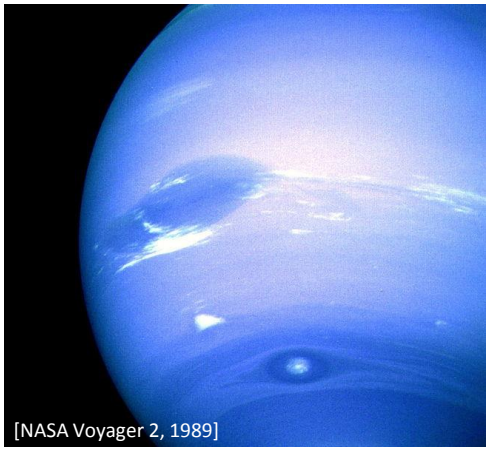
"Great red spot"
- *Composition unknown.*
- *Existed since 1600/1800s.*
- *Currently shrinking.*



"great white spot"
- *Periodic (27-30 years)*
- *First seen in 1876.*



Uranus clouds



"Great dark spot"
- *Winds up to 2100 km/h*
- *No longer visible*

Magnetospheres

- All of the icy gas giant have magnetospheres.
- The magnetospheres of Jupiter and Saturn are thought to be supported by their **metallic hydrogen layer/core**.

  → Jupiter and Saturn have the strongest & largest magnetospheres of all the planets.

  → Magnetic axis is somewhat tilted with respect to rotation axis (like Earth).

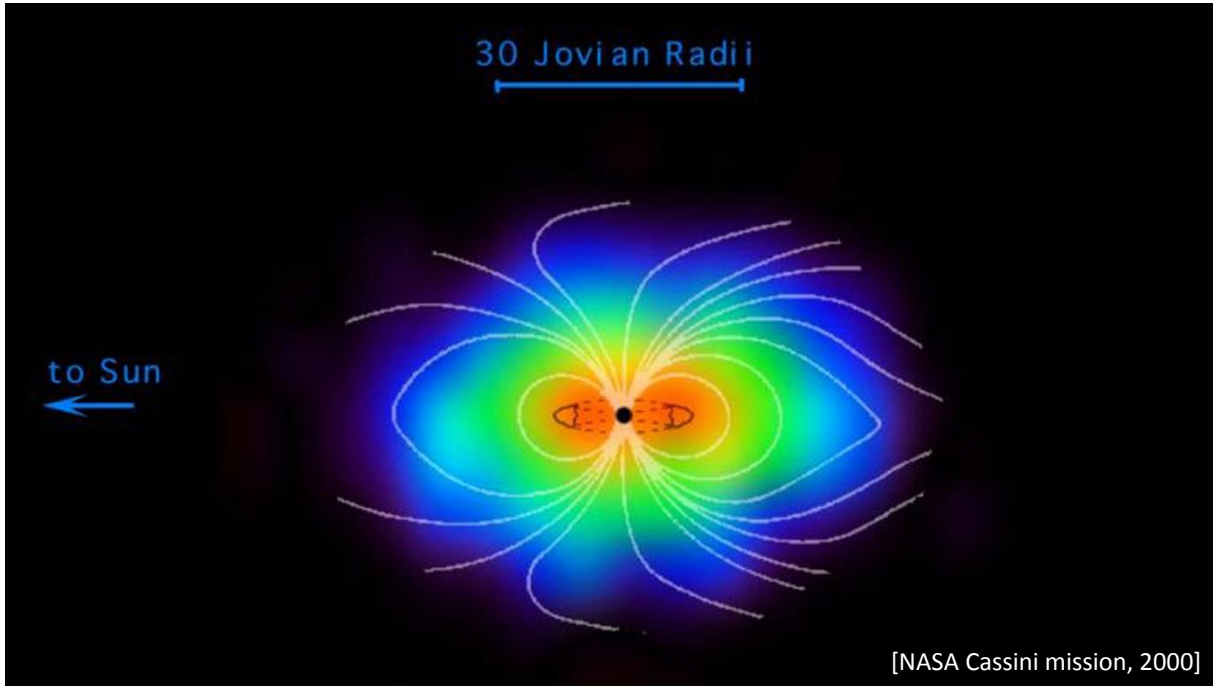


Image of ions and neutral atoms in Jupiter's magnetosphere.

- The ions and atoms are fed by the ***moon Io.***

- Jupiter's magnetosphere is ***huge****: it has 2-3 times the angular size of the Moon.*

Magnetospheres

- All of the icy gas giant have magnetospheres.
- The magnetospheres of Jupiter and Saturn are thought to be supported by their **metallic hydrogen layer/core**.

  → Jupiter and Saturn have the strongest & largest magnetospheres of all the planets.

  → Magnetic axis is somewhat tilted with respect to rotation axis (like Earth).

- The magnetospheres of Uranus and Neptune are thought to originate from a **thin shell of conducting fluid** (NH_3, CH_4, H_2O).

  → Uranus's and Neptune's magnetospheres look like they are produced **by two crossed bar magnets** (quadrupole character).

  → Magnetic axis is **strongly tilted** with respect to rotation axis and does go through center of planet.

- Rotation period of magnetosphere define the **official rotation period** of planet.

Presentation Development

Team Workshops

Presentation format

- About 10 minutes long (about 8 slides, i.e. 6-10 slides).
- About 2 slides per team member.
- Try to have one graphic per slide (or more).
- Each team member must speak (roughly equal time).

Presentation Development

Team Workshops

Presentation format

- About 10 minutes long (about 8 slides, i.e. 6-10 slides).
- About 2 slides per team member.
- Try to have one graphic per slide (or more).
- Each team member must speak (roughly equal time).

Objective: Develop ideas for your team presentation.

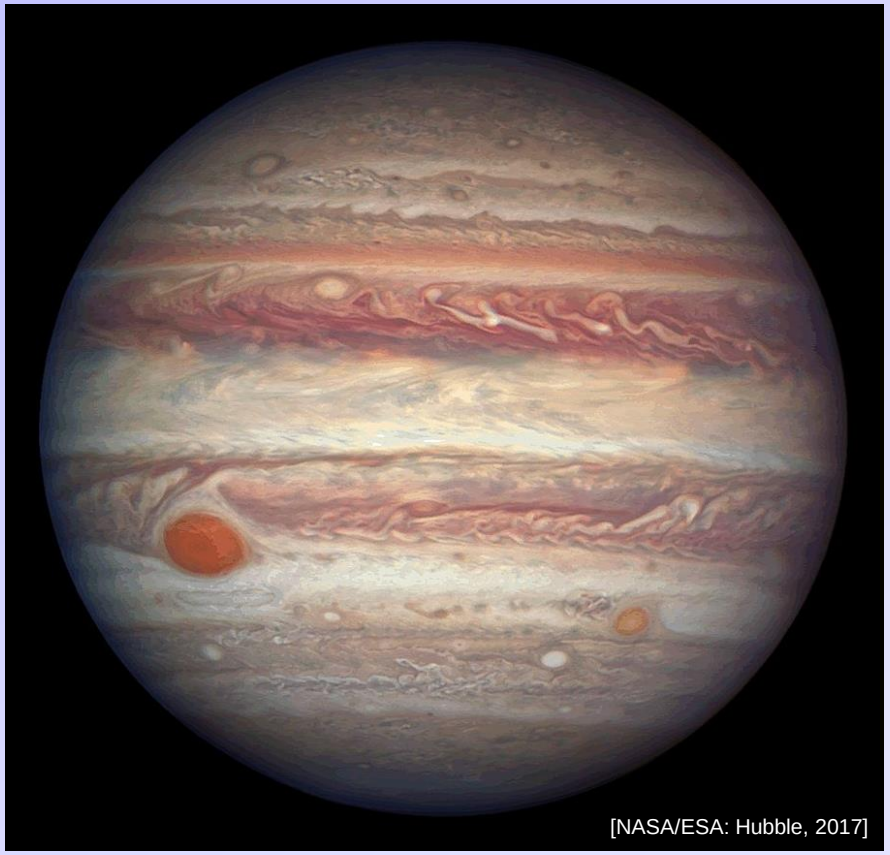
Steps

- Each team member should state their specific interest(s) in the chosen topic.
- Team discussion to develop common themes/topics/subtopics.
- Start to decide on main ideas and subtopics for your presentation.

Task

- Write down (on the form) the main ideas and subtopics for your presentation.
- *If possible:* Decide on specific slide topics that each member will develop.

Jupiter


[NASA/ESA: Hubble, 2017]