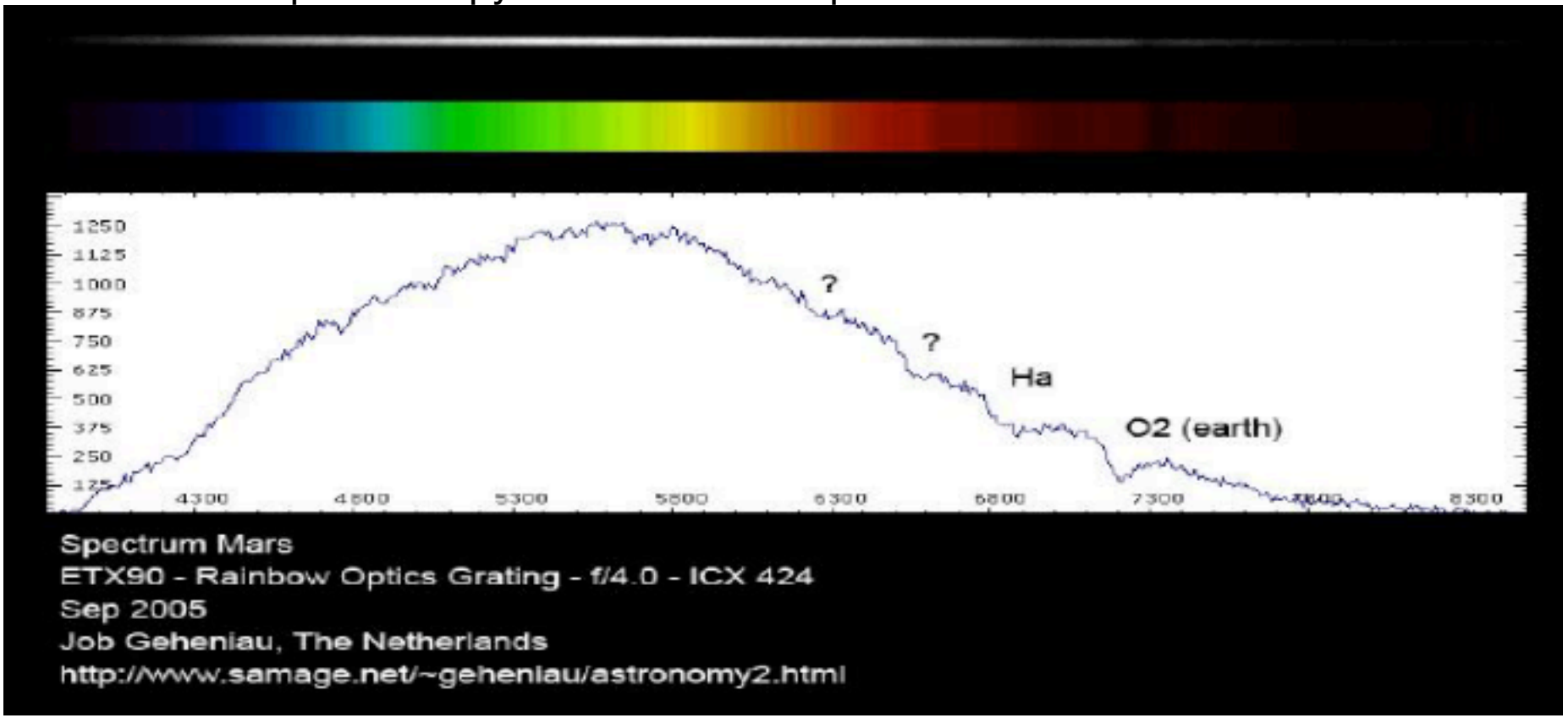
Atmospheres, Surfaces, and Interiors

Observations of Planetary Atmospheres

Spectroscopy of Gases: Absorption Lines & Emission Lines

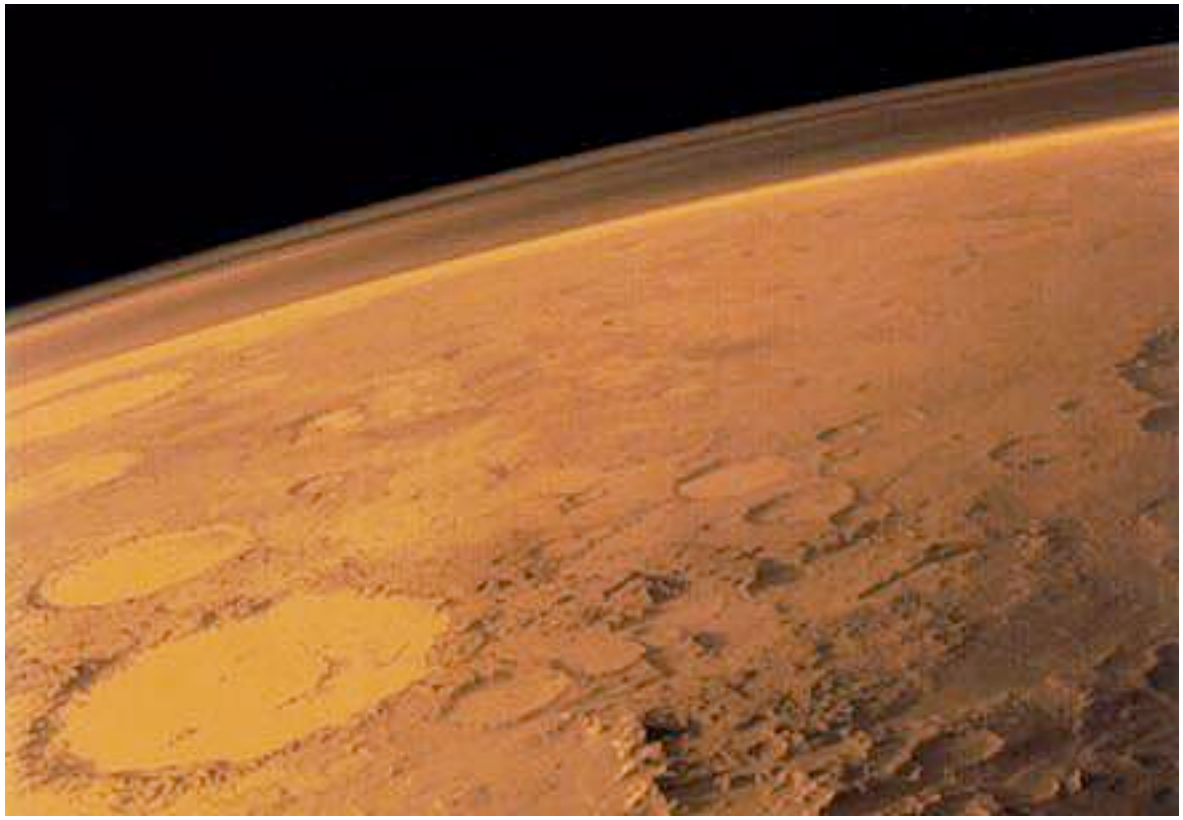


MARS

Atmospheric Activity: Weather & Evaporation

Also Non-Planetary Atmospheres: Titan & Io; Comets

The Martian Atmosphere



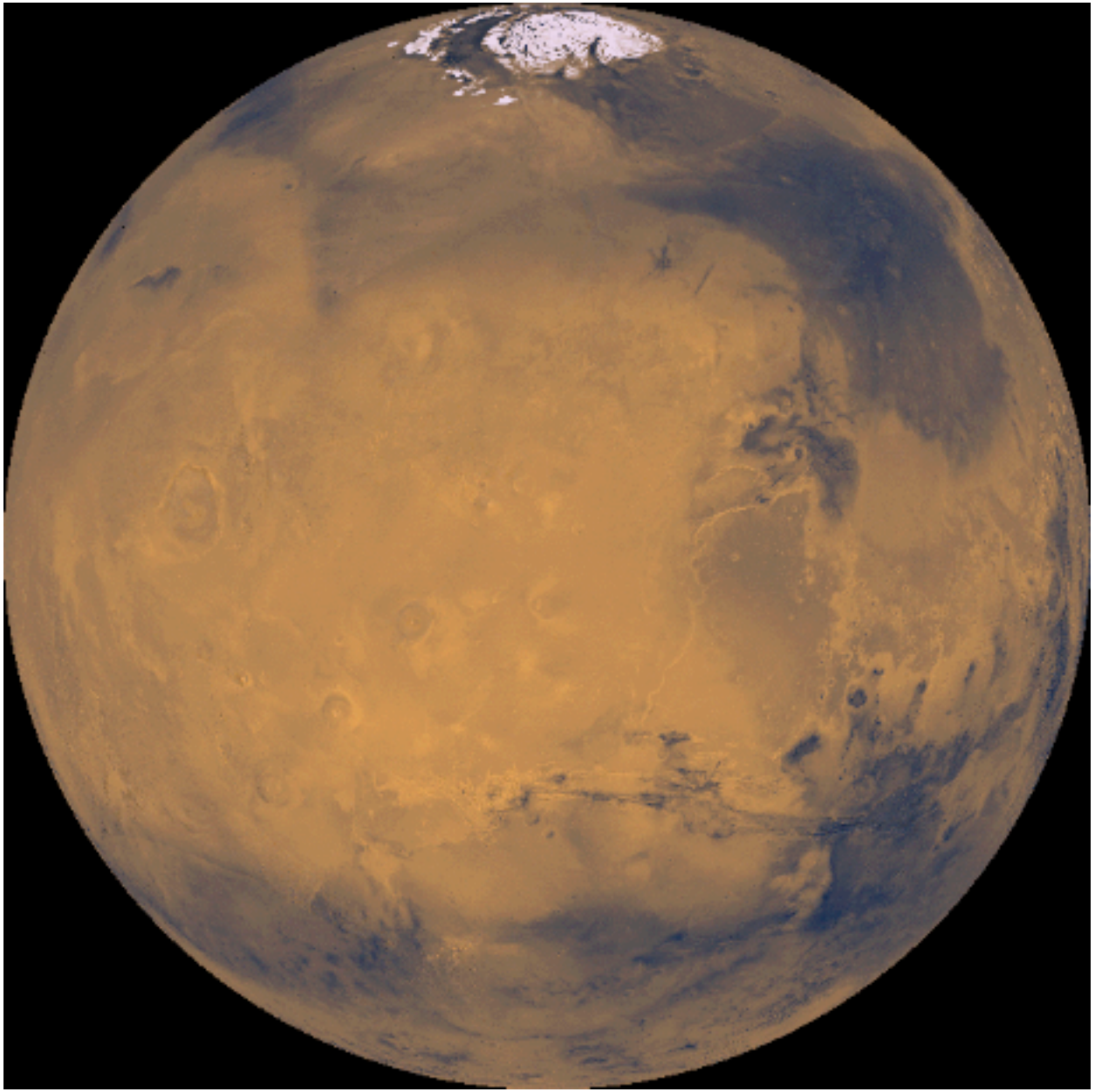
The Surfaces of Planets
(Terrestrial Planets & Asteroids)

Topography

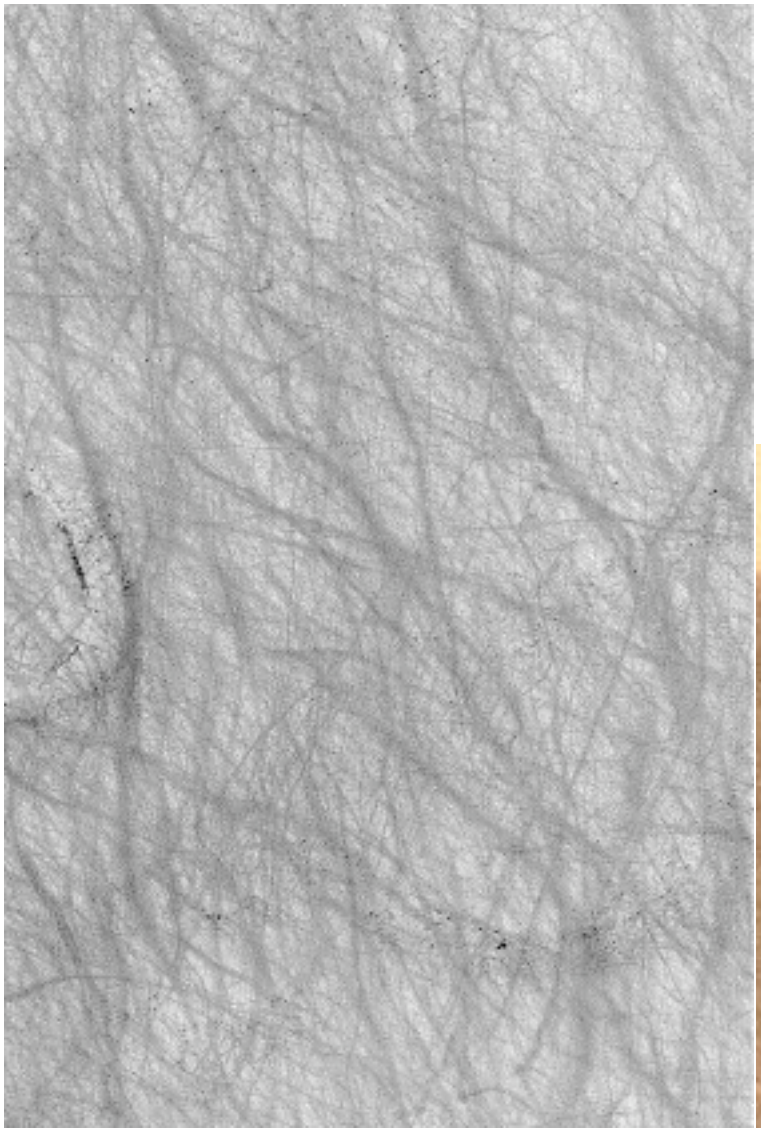
- Continents & Rifts
- Oceans & Lakes, Rivers & Puddles
  (Then and now)
- Mountains & Mountain Ranges
- Volcanoes & Craters
  (Active and inactive)
- Polar Caps and Snow Fields
  (Seasonal changes)

Meteorology

- Wind & Weather: Erosion
  ("Ages" of surfaces)
- Vapor Clouds & Dust Clouds

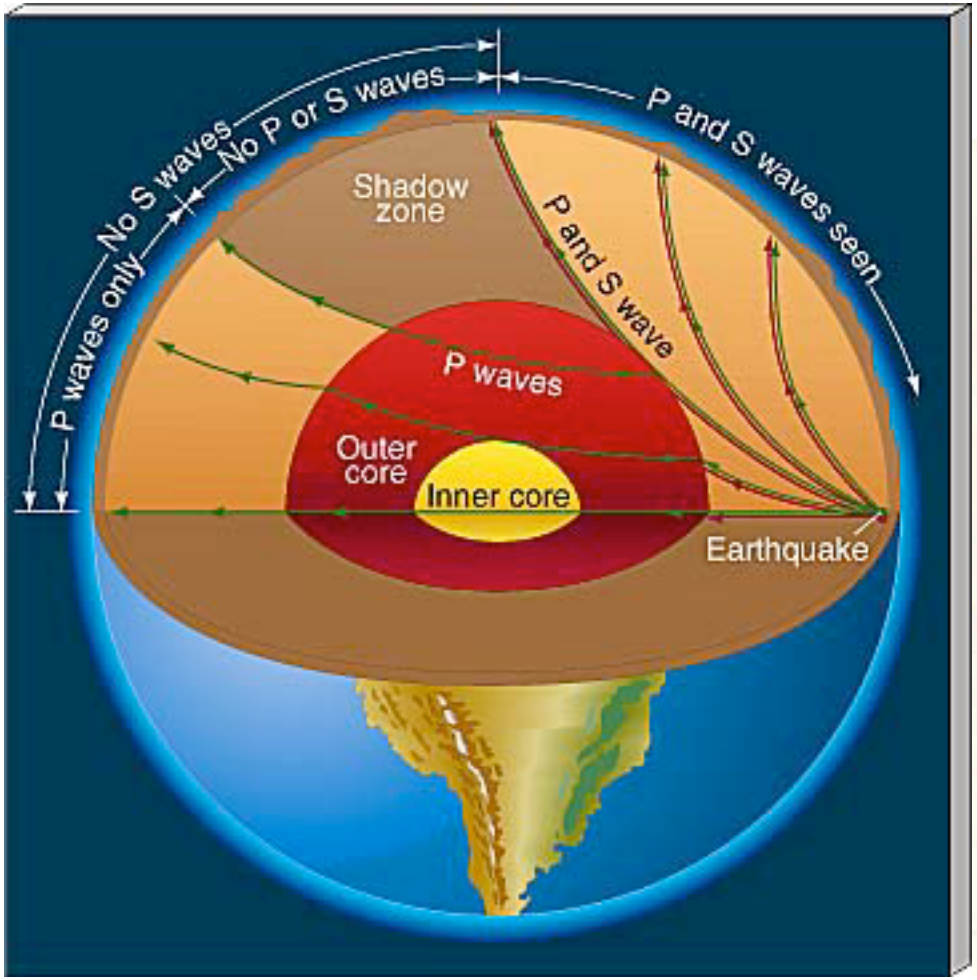


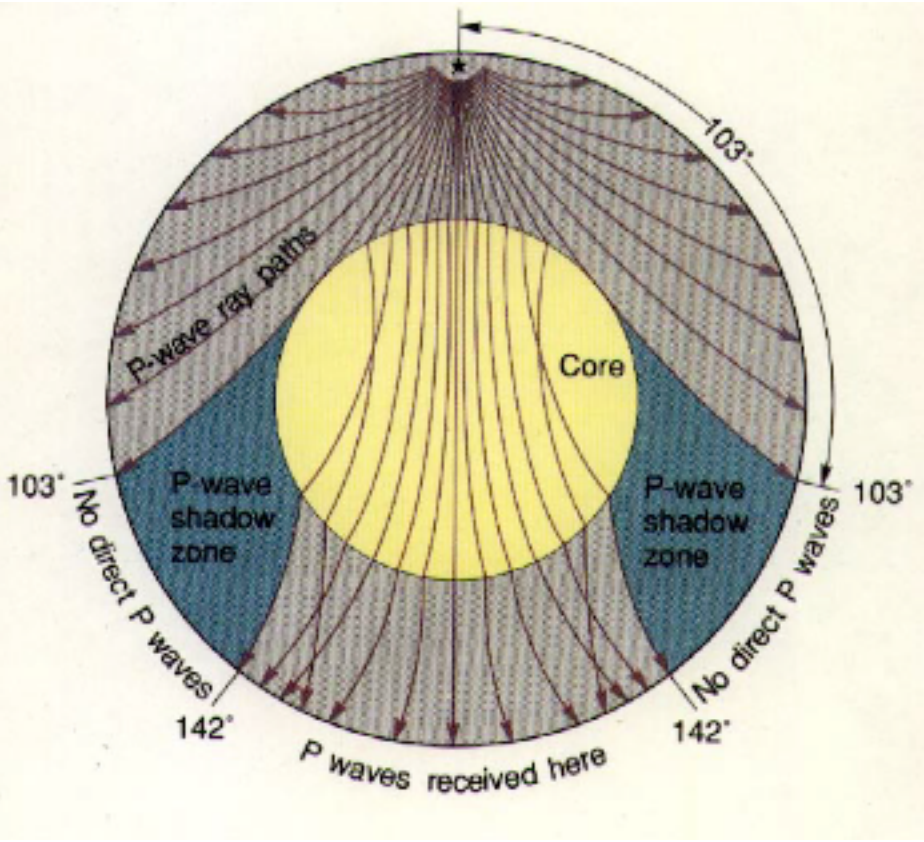
Martian Dust Devils



Seismology: The Earth's Interior

Seismic Waves: **P**ressure Waves & **S**hear-Waves (**P-** & **S**-Waves)
Wave Propagation: Wave Speed; Reflection & Refraction





Interiors of Terrestrial & Jovian Planets

Observational Inputs:

- Masses & Dimensions: Mean Densities $\langle\rho\rangle$
- Spectroscopy & Photometry: Surface and/or Atmospheric Composition
- Satellite Orbit Evolution: Internal Mass Distribution
- Seismic Data (Earth): Internal Density Distribution; Fluid/Solid Structure
- Other Clues: Compositions of meteorites, comets, solar atmosphere, ...

Other Information:

- Laboratory Data
  - Chemical properties (Reactions, molecular combinations, etc.)
  - Physical properties of materials (densities, melting points, etc.)
  - Compressibility of solid and liquid materials.
  - Conductivity of materials
- Theoretical Input
  - Laws of Mechanics (e.g., Law of Gravity, hydrostatic equilibrium, ...)
  - Gas Laws: $P = nkT$; $n = \rho/\mu m_H$, etc.

Planetary Structure as an "Inverse Problem"

- The uniqueness problem
- The rôle of history: Initial Conditions

So what <u>are</u> the likely structures of planetary interiors?

Interiors of Terrestrial & Jovian Planets