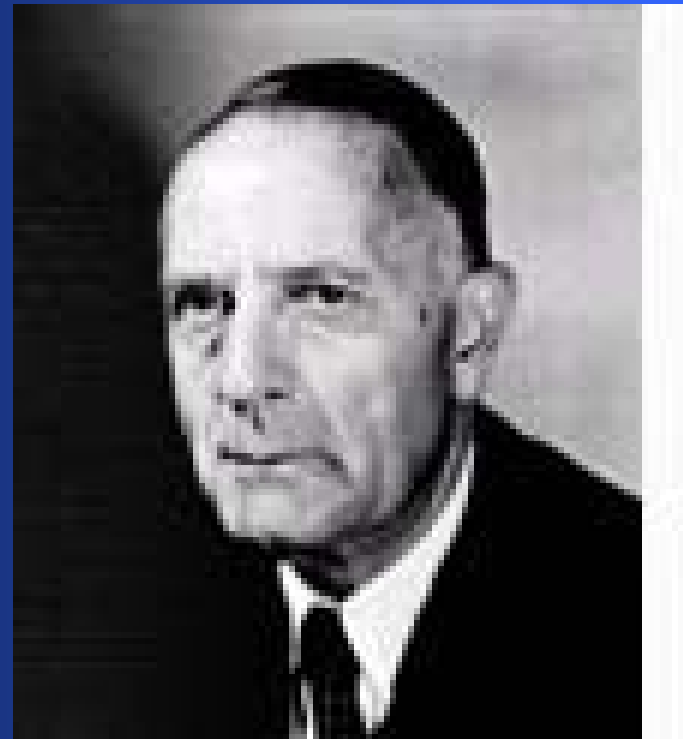


# The Hubble Space Telescope



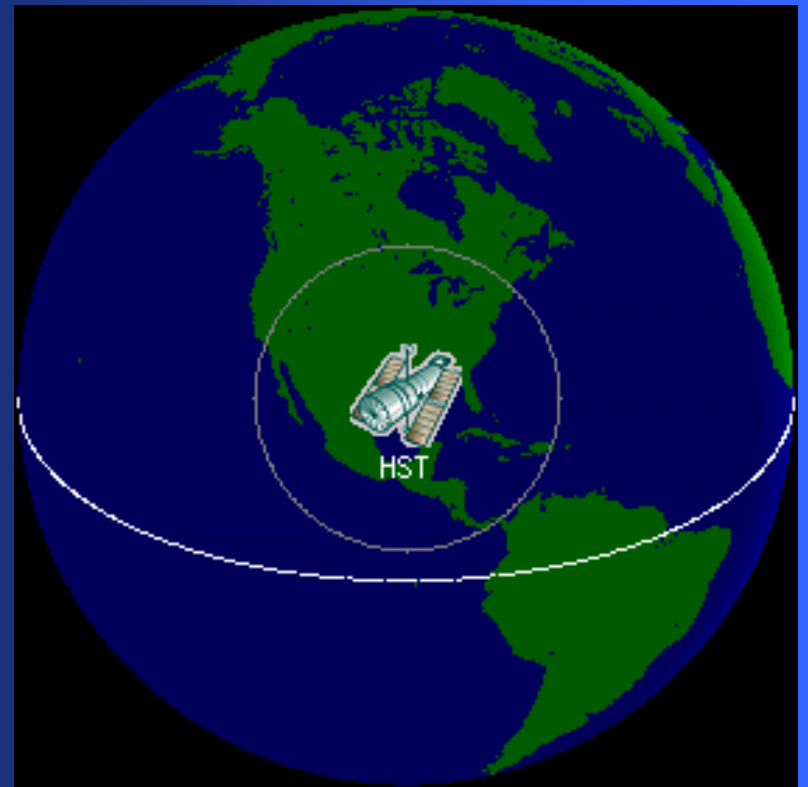
# History

- Named After Edwin P. Hubble (1889 – 1953)
  - He was first to discover galaxies outside the Milky Way
    - Andromeda Galaxy in 1923
  - Classified galaxies into three categories
    - Elliptical
    - Spirals
    - Barred Spirals
  - Helped prove that galaxies further away from each other are moving faster away from each other



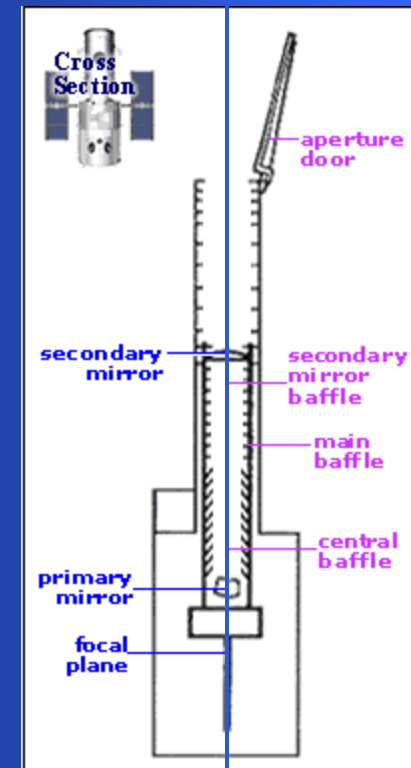
# History and Location

- Originally launched in 1990
- Since had 3 servicing missions
  - 1993, 1997, 2002
  - 4<sup>th</sup> Servicing mission planned for near future
- 575 km above Earth's surface
  - Above atmospheric disturbances
- Travels at 17,500 mph and orbits Earth every 97 minutes.



# How it Works

- Reflecting telescope
  - 2 mirrors
    - Primary mirror is 2.4m in diameter
    - Second mirror is 0.3m in diameter
- “The Relay”
  - How we get the images
    - Hubble to Tracking Data Relay Satellite Systems (TDRSS)
    - TDRSS to White Sands Antennae Array in White Sands, New Mexico.
      - 60ft. Microwave Antennae
    - White Sands to Space Telescope Optics Control Center (STOCC) in Beltsville, Maryland
    - STOCC to Space Telescope Science Institute in Baltimore



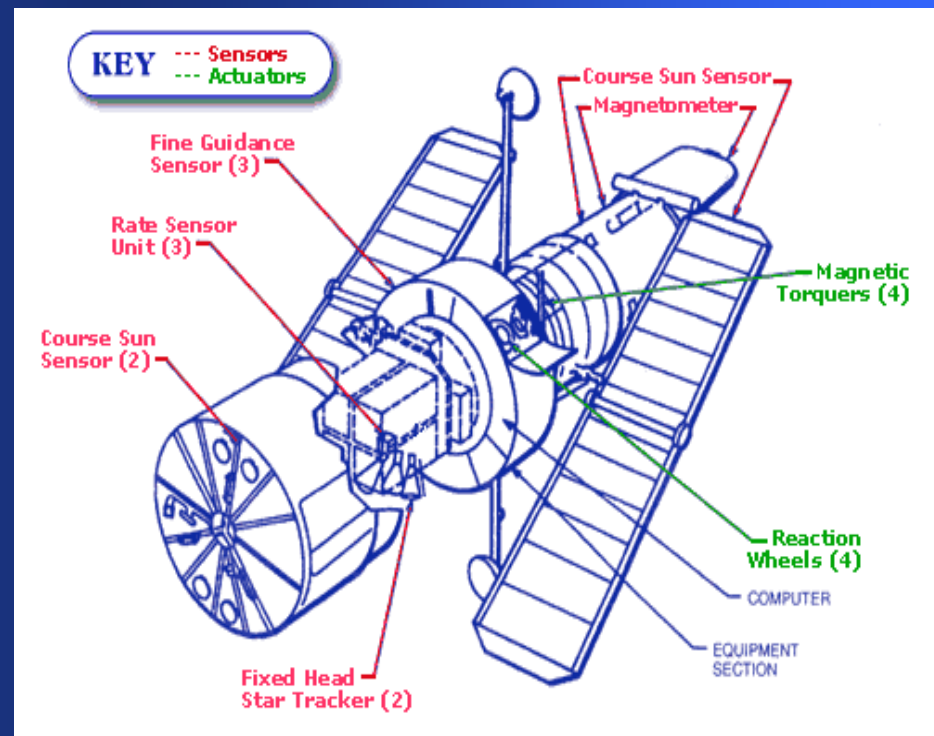
# The Spacecraft

- 13.2 meters long and up to 4.2 m wide
- 2 Solar panels to convert sunlight into electricity
- 2 Communication antennae to relay information to TDRSS
- Computer Support Systems Module
  - Houses the Hubble computers that control the spacecraft
- Electrical Boxes
  - House the batteries and computer equipment
- Aperture Door
- Light Shield
- Pointing Control System (PCS)
  - Locks onto targets
  - Get within 0.01 arcsec.
  - System of sensors and actuators



# Pointing Control System (PCS)

- Sensors
  - 3 Fine Guidance Sensors
    - Lock onto guide stars
  - 2 Coarse Sun Sensors
    - Orientation to the sun
  - Magnetic Sensing System
    - Measures the position related to the Earth's magnetic field
  - 3 Rate Sensor Units
    - 2 Gyroscopes that measure the motion of the spacecraft
  - 2 Fixed Head Star trackers
    - Detector that finds and tracks a specific star
- Actuators – Adjust Position and Orientation
  - 4 Reaction Wheel Actuators
    - Rotate or brake a large flywheel to create momentum and turn Hubble
  - 4 Magnetic Torquers
    - Act against magnetic field to help control wheel speed and angular momentum



# The Scientific Instruments

- 4 instruments in the axial bays behind the primary mirror
  - Advanced Camera for Surveys (ACS) – 2002
  - Near Infrared Camera and Multi-Object Spectrometer (NICMOS) – 1997
  - Space Telescope Imaging Spectrograph (STIS) – 1997
  - COSTAR
    - Corrective optics system for primary mirror
    - 1993
- 1 Instrument in radial bay
  - Wide Field / Planetary Camera 2 (WFPC2) – 1993

# 4<sup>th</sup> Servicing Mission

- Planned for late 2007 – Early 2008
- Goals
  - Install Cosmic Origins Spectrograph (COS) and Wide Field Camera 3 (WRC3)
  - Install 6 batteries, 6 gyroscopes and a new Fine Guidance Sensor
  - Hope to fix STIS
    - Not working since 2004

# Accomplishments

- Views of earliest galaxies
- Proof of black holes
- Images of quasars
- Birth of stars
- Death of stars
- Auroras on other planets
- Electrical activity in solar system
- Images of Shoemaker-Levy 9 comet collision with Jupiter
- Images of planets

