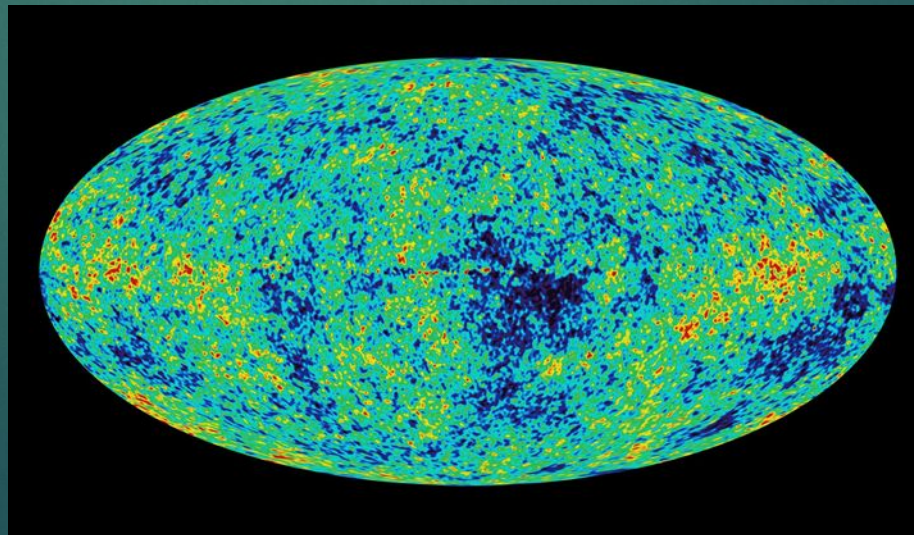


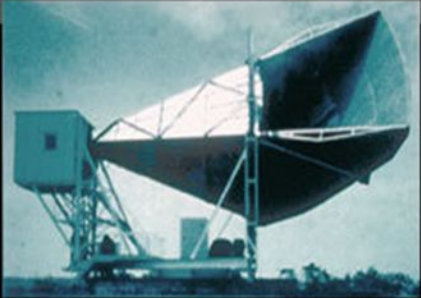
# Cosmic Microwave Background Radiation (CMB)

- ▶ CMB is the “after glow” or “leftovers” from the big bang that permeates (spreads) in all directions of the universe.
- ▶ Physicists agreed that CMB was leftover ‘heat’ in the form of microwave radiation, which was still cooling from the Big Bang.
- ▶ Original temperature of the universe: 3000 Kelvin
- ▶ Today, universe is approximately 3 Kelvin
- ▶ The amount of cooling says how far the light has travelled, which determined the age of the universe: 13.82 billion years.

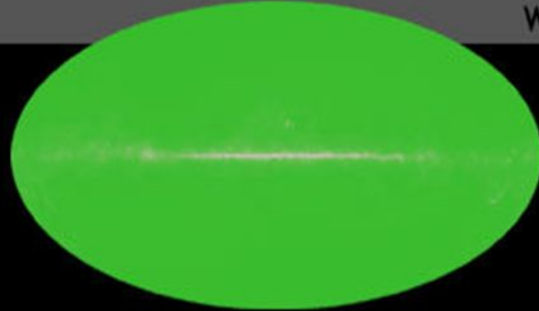


# Cosmic Microwave Background Radiation

1965



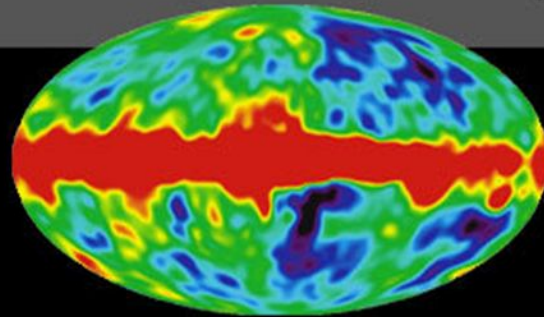
Penzias and  
Wilson



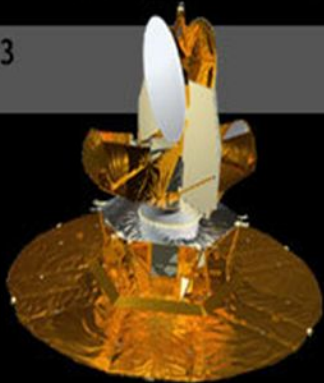
1992



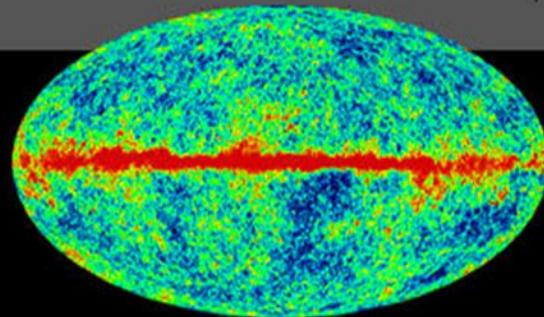
COBE



2003

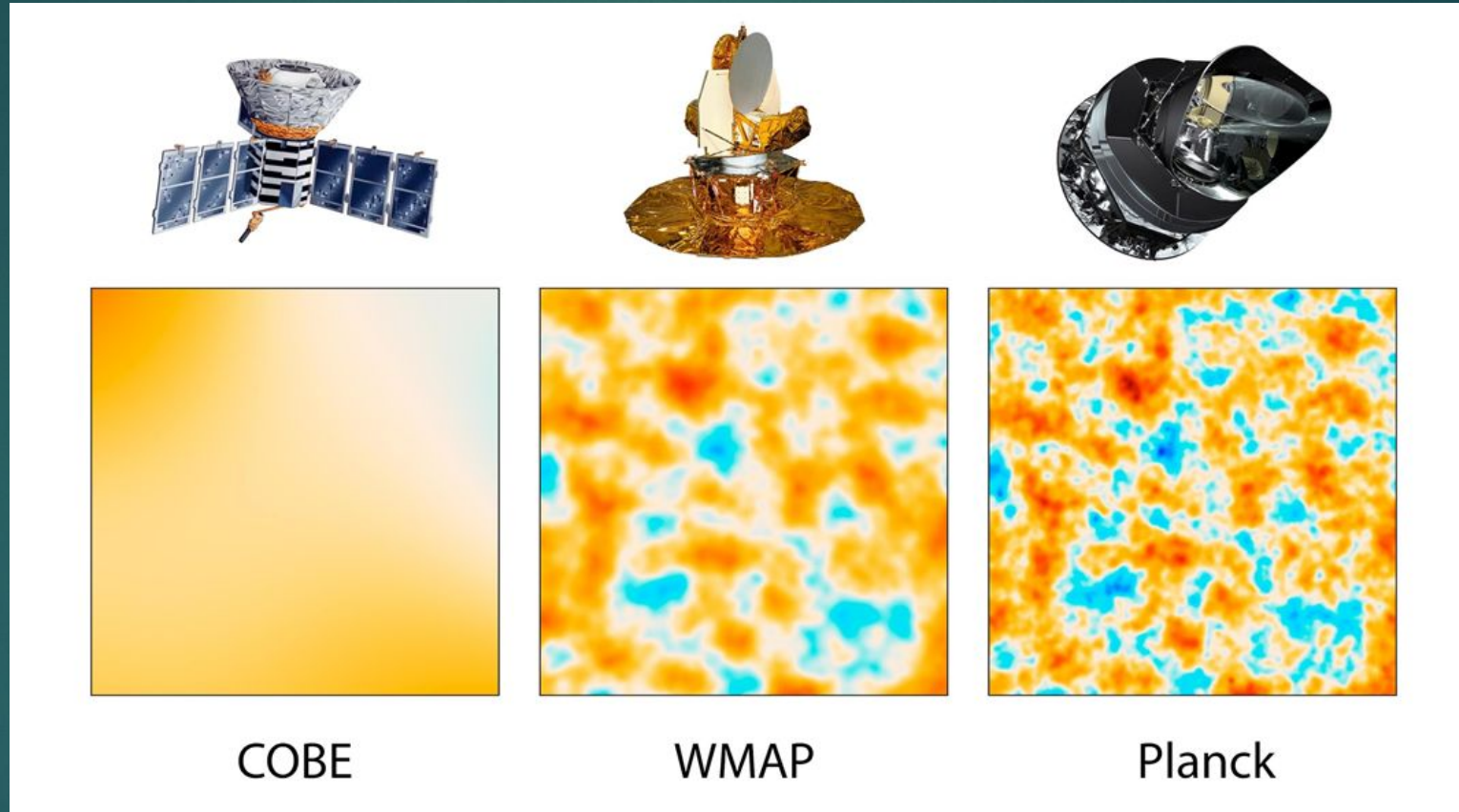


WMAP



- ▶ The first sound of microwave radiation was thought to be pigeon droppings! :) Their detection of this CMB was made from a Horn Antenna!
- ▶ COBE (Cosmic Background Explorer) was launched in 1989- 500 miles from Earth. Detected the near perfect blackbody spectrum in 1992.
- ▶ WMAP launched in 2001. In 2003, the WMAP satellite gave a better resolution of the small fluctuations of temperature
- ▶ (WMAP = Wilkinson Microwave Anisotropy Probe)

# Cosmic Microwave Background Radiation, continued



Planck satellite was a space observatory operated by the European Space Agency (ESA) from 2009 to 2013, providing us with the most accurate and detailed readings of Cosmic Microwave Background Radiation.