Hubble Provides First Census of Galaxies Near Cosmic Dawn

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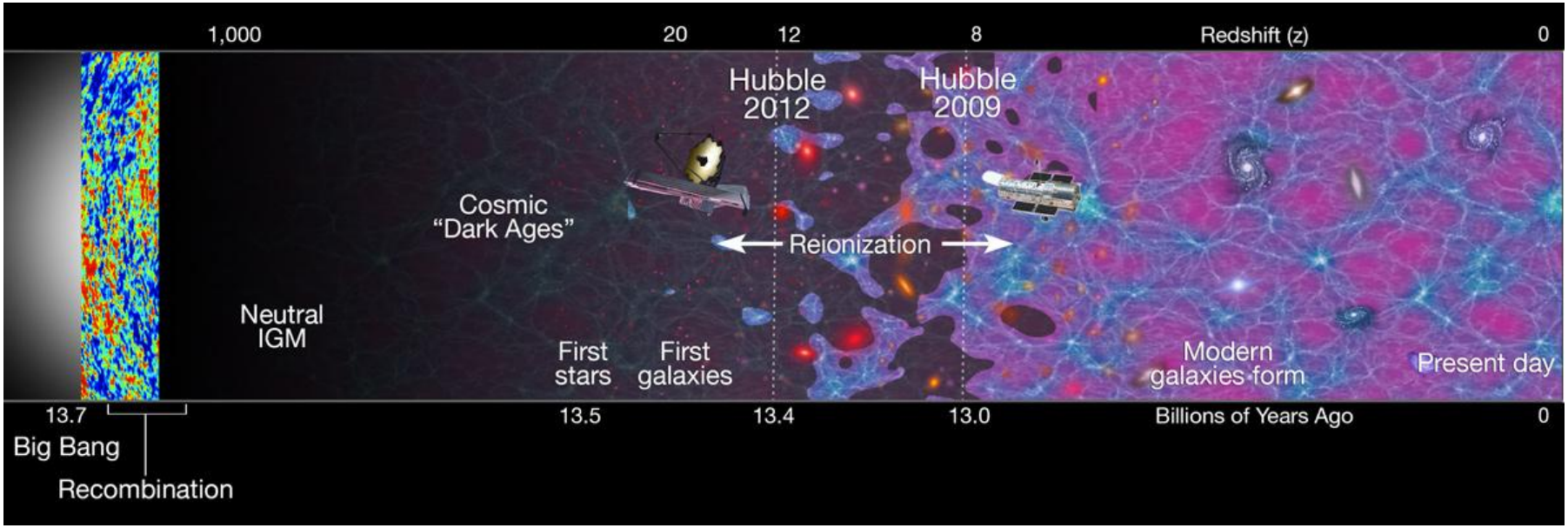
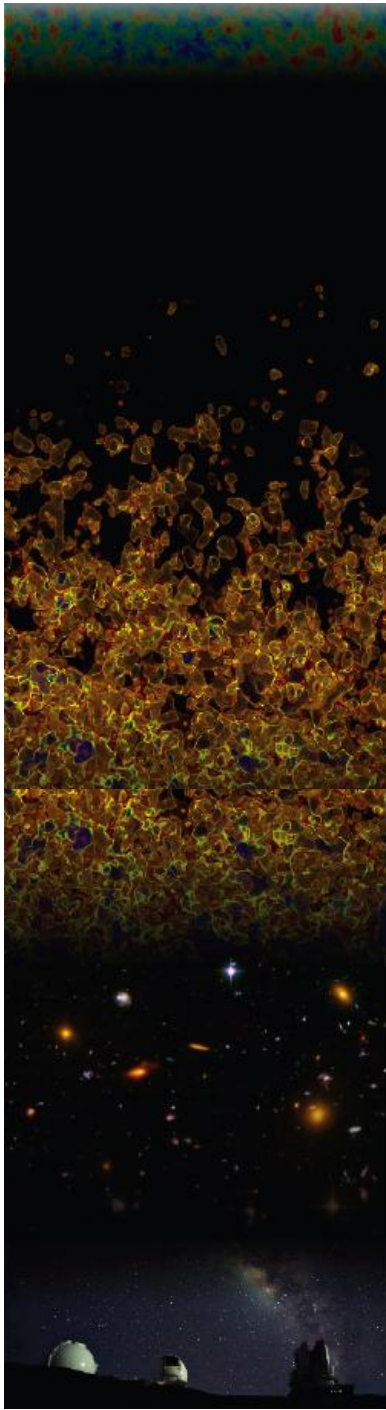


Results from the Hubble Ultra Deep Field 2012 Campaign
Further information on http://udf12.arizona.edu/

Cosmic Dawn

- Universe began with **Big Bang** 13.7 billion years ago
- Hydrogen formed 400,000 yrs later but the Universe remained **Dark**
- Hydrogen clouds collapsed 200 million years later and formed the first stars and galaxies – **Cosmic Dawn**
- Universe was bathed in light breaking hydrogen into protons and electrons **– Cosmic Reionization**
- Galaxies grow in mass and size, chemical elements are synthesized and life develops – **Present Universe**



The Big Questions

1. When was Cosmic Dawn?

   Was it a dramatic event in a narrow period of time or did the birth of galaxies happen gradually?

2. Can we be sure light from early galaxies caused cosmic reionization?

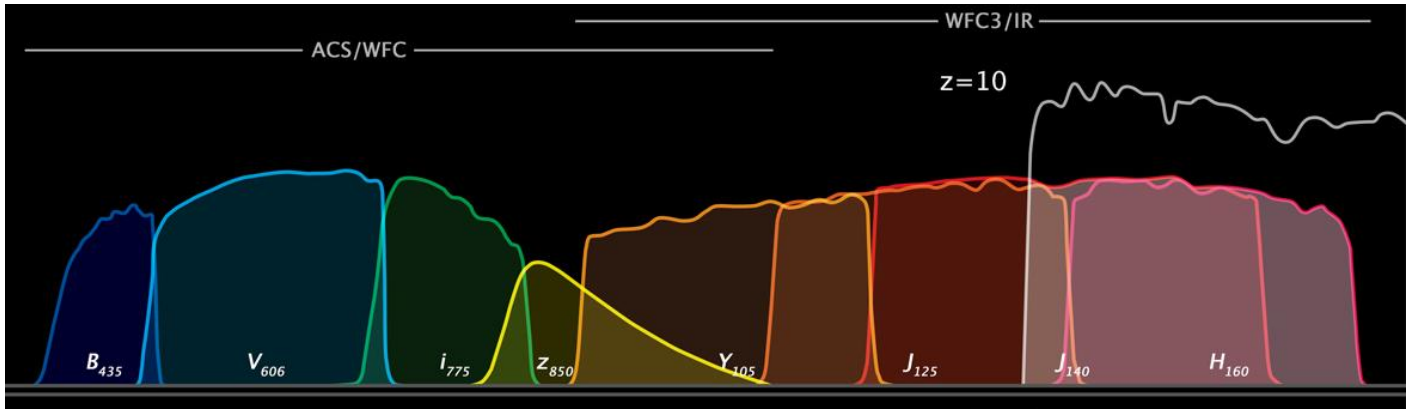
   We have some guide on when reionization occurred from studies of the microwave background

We need to search for early galaxies to answer these questions

Looking back in time with Hubble

- Deep exposures with Hubble look back in time; we directly witness the past
- Images from the Hubble Ultra Deep Field 2012 campaign reach back to 13.3 billion years ago when the Universe was less than 3% of its present age
- This corresponds to a time when reionization was well underway according to studies of the microwave background
- So a census of the early galaxy population at that time can address these important questions

The Hubble Ultra Deep Field 2012

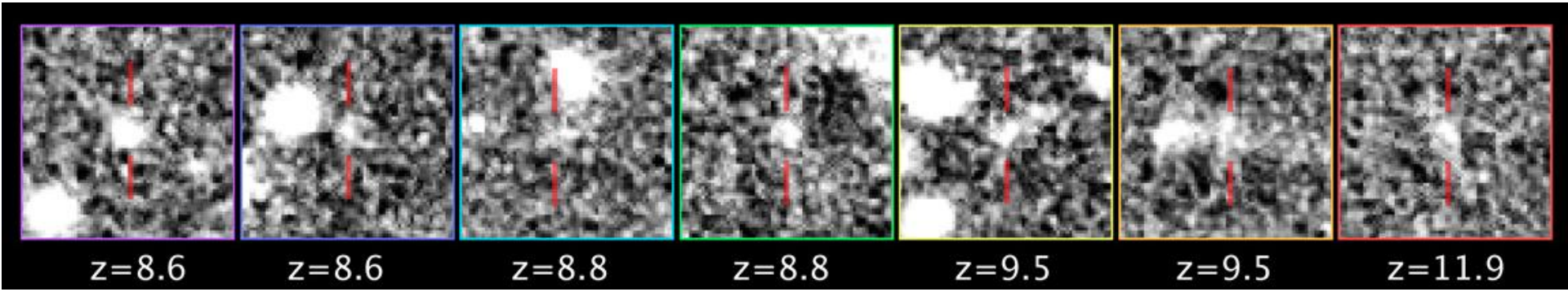


- During August and September, Hubble studied this small field for over 100 hours with its powerful infrared camera WFC3

- Together with earlier data taken in this field, this provides the deepest Hubble images so far

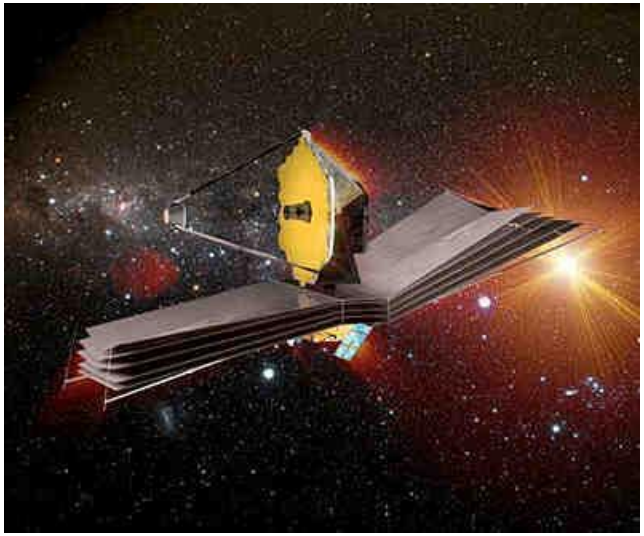
- A new observing strategy was designed to search for galaxies 350 to 600 million years after the Big Bang, when reionization was fully underway:
    - infrared exposures twice as long as in 2009
    - four times longer in the key filter used to isolate early galaxies
    - deeper data and much better precision

The Results



- We located 7 galaxies in the time period 400-600 million years after Big Bang
- One is a potential record-breaker at the highest redshift (11.9) yet observed
- The data provides the first reliable census of this uncharted period of cosmic history
- Compared to galaxy numbers at later times, we see a smooth decline as we penetrate deeper into the reionization era

Implications and the Future



- Reionization is an extended process associated with gradual galaxy growth
- Cosmic dawn was likely not a dramatic event
- There must be galaxies beyond those Hubble has seen:
  a rich hunting ground for James Webb Space Telescope

Further information: UDF12 web page: http://udf12.arizona.edu/
Refereed science article: Ellis, R.S. et al Astrophys. J. Lett. (in press)
http://xxx.lanl.gov/abs/1211.6804