Blog created over the observations of the Frontier Fields program. Program and blog have finished - still available to learn about the program, discoveries, and science.
Number of videos related to the science that James Webb will be exploring. Explore freely - a few in particular are

- Looking Back in Time, Ever Farther

- Minute Physics: Where Do Galaxies Come From?
  - https://webbtelescope.org/contents/media/videos/1068-Video

Minute Physics video in the full article
https://webbtelescope.org/webb-science/galaxies-over-time
https://apod.nasa.gov/apod/ap180305.html
Distant View of Galaxies

How do we go from the first baby galaxies to form in the universe to our grand spiral galaxy, the Milky Way?

How did we get here?
Distant View of Galaxies

How do we go from the first baby galaxies to form in the universe to our grand spiral galaxy, the Milky Way?

How did we get here?
A light year is a measure of: (0.53) (0.28 A)

a. time.
b. distance.
c. solar intensity.
d. mass.
e. gravitational attraction.
Telescopes are Time Machines

- Sun: 8 light-minutes
- Andromeda Galaxy: 2.5 million light-years
- Hubble Ultra Deep Field: up to 13 billion light-years
- Cosmic Microwave Background: > 13.7 billion light-years
Bizarre light patterns in the cosmos

Background galaxies distorted and magnified.

Einstein Ring Gravitational Lenses
_Hubble Space Telescope • Advanced Camera for Surveys_

NASA, ESA, A. Bolton (Harvard-Smithsonian CfA), and the SLACS Team

STScI-PRC05-32
An Activity of Optics
The Frontier Fields is a program developed collaboratively by the astronomical community. Despite the fact that observations are coming to an end, the wealth of data being added to NASA archives will ensure new discoveries for years to come.

The NASA Frontier Fields observations are providing the data for astronomers to

- expand our understanding of how galaxies change with time
- discover and study very distant galaxies
- refining our mathematical models of gravitational lensing by galaxy clusters
- explore the dark matter around galaxy clusters
- analyze the light from supernovae
- study the diffuse light emitted from gas within galaxy clusters
- study how galaxy clusters change with time
Chandra, Hubble, and Spitzer are building upon more than two decades of deep-field initiatives with 12 new deep fields (six galaxy cluster deep fields and six deep fields adjacent to the galaxy cluster fields).

By using Hubble, Spitzer, and Chandra to study these deep fields in different wavelengths of light, astronomers can learn a great deal about the physics of galaxy clusters, galaxy evolution, and other phenomena related to deep-field studies. Observations with Hubble provide detailed information on galaxy structure and can detect some of the faintest, most distant galaxies ever observed via gravitational lensing. Spitzer observations help astronomers characterize the galaxies in the image, providing details on star formation and mass, for example. High-energy Chandra X-ray images probe the histories of the giant galaxy clusters by locating regions of gas heated by the collisions of smaller galaxy sub-clusters.
By discovering background galaxies that are obviously multiply lensed, and measuring their distances, astronomers can use Einstein’s theory of general relativity to map out the distribution of mass (normal matter plus dark matter) for the galaxy cluster.

Once this mass distribution is known, astronomers can go back and look at regions where they expect the largest magnification of distant galaxies, again due to Einstein’s theory of general relativity. From these calculations, astronomers can develop magnification maps that highlight the regions where Hubble is most likely able to observe the most distant galaxies. This technique has allowed astronomers to detect ever-more distant galaxies in these fields and has helped astronomers better refine their models of mass distributions.
A triply-lensed galaxy was discovered in the Hubble Frontier Fields image of galaxy cluster Abell 2744. This is one of the faintest galaxies ever observed by Hubble. It would have been unobservable had they not been magnified by gravitational lensing. We are observing this galaxy as it looked about 13.3 billion years ago, or about 3% the present age of the universe (13.8 billion years). This is a true baby galaxy.
Einstein’s Theory of General Relativity Proves to be Successful
By studying Hubble Space Telescope deep imaging at the locations where gravitational lensing magnifications are predicted to be high, astronomers are detecting galaxies that are up to 100 times fainter than those observed in the famous Hubble Ultra Deep Field. Infrared observations by the Spitzer Space Telescope enable astronomers to better understand the masses, and other characteristics, of background lensed galaxies and those residing within a massive galaxy cluster.
Frontier Fields observations by NASA’s Great Observatories, along with additional ground-based observations, are building our understanding of the physics of massive galaxy-cluster mergers.
Expansion of Space - Cosmological Redshift
The Future - Infrared

James Webb Space Telescope (JWST) - expected launch year: 2021

Wide Field InfraRed Survey Telescope (WFIRST) - launching mid-2020s