Studying (Analogues to) the Earliest Galaxies in the Universe

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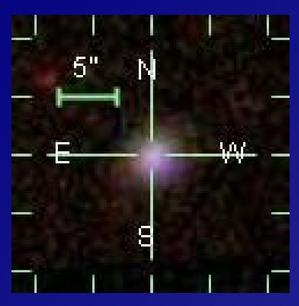


SDSS

Why Study Distant Galaxies?

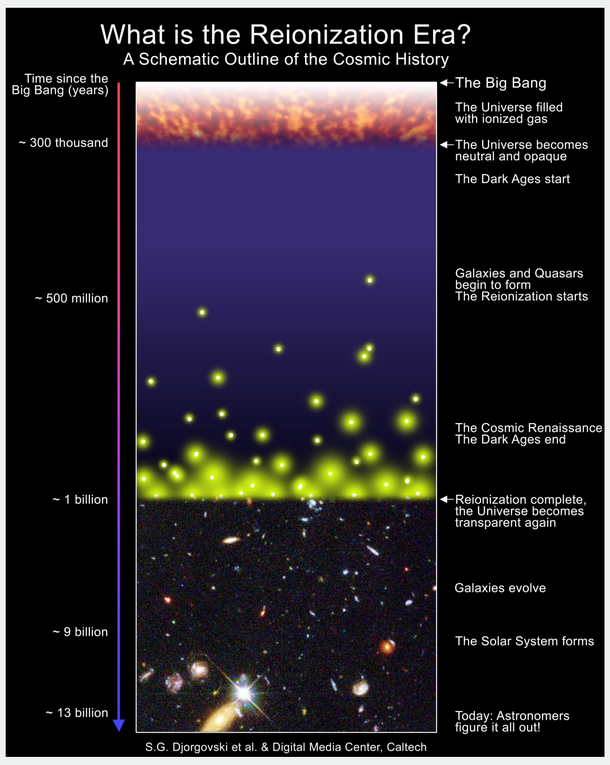
Galaxies began forming about 1 billion years after the Big Bang. Those early galaxies are thought to be the precursors of today's elliptical galaxies and spiral galaxies' central bulges. They are also thought to be responsible for making the Universe transparent through the heat generated by their constituent stars.

By studying those galaxies we are not only learning about the history and evolution of the Universe, but also about the origin of our own Milky Way, and therefore ultimately our own origin.

The First Galaxies

After the formation of the first stars when the Universe was approximately **500 million years** old, the **first galaxies formed** out of millions of them.

These massive young stars produced enough **ultraviolet** light to heat the interstellar and intergalactic medium and to cause a change in its state, making it **transparent** to almost all light. This process is called reionisation and ended the cosmic “dark ages” that went before it.

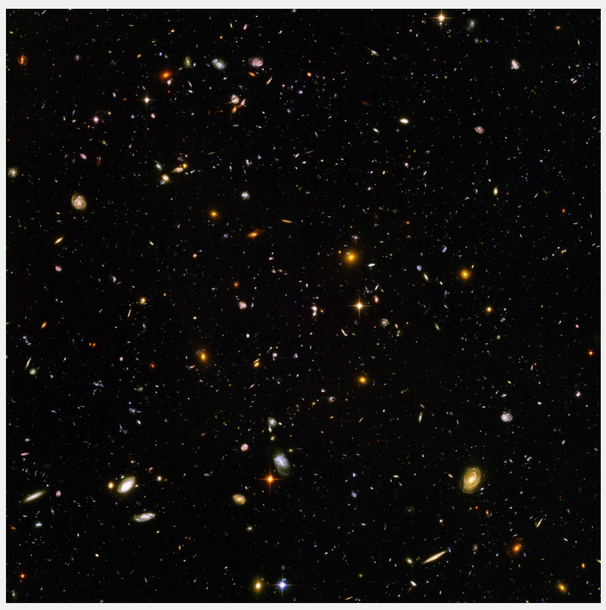


When this first and short-lived population of stars died, the resulting **supernovae** explosions created most of the **heavier elements** which make up humans and the Earth.

How to Study the Earliest Galaxies?

Astronomers study the **light emitted** by the stars in a galaxy to learn about the constituents of the galaxy: massive young stars produce a lot of UV light, while interstellar dust particles emit infrared light. By looking at the **spectrum** of a galaxy, these properties can be studied.

Problem:
The earliest galaxies are approximately 12-13 billion light years away, so they appear both **faint** and **small** – making it difficult to study their light.



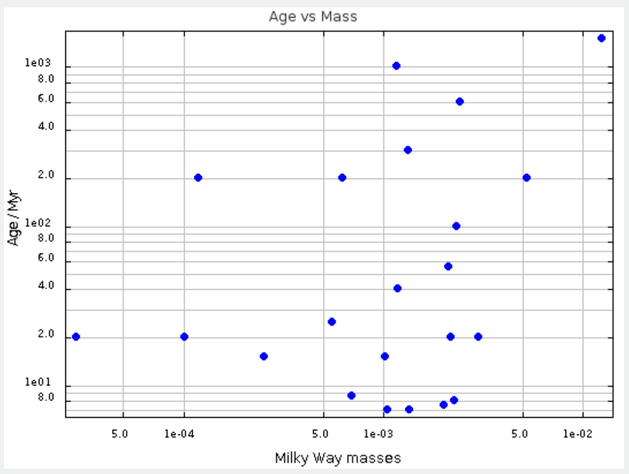
NASA and the European Space Agency

The galaxies in this image are several billion light years away.

Solution:
Study **galaxies which are more nearby** and appear similar to the earliest ones, but due to their smaller distance from us they appear brighter and larger.

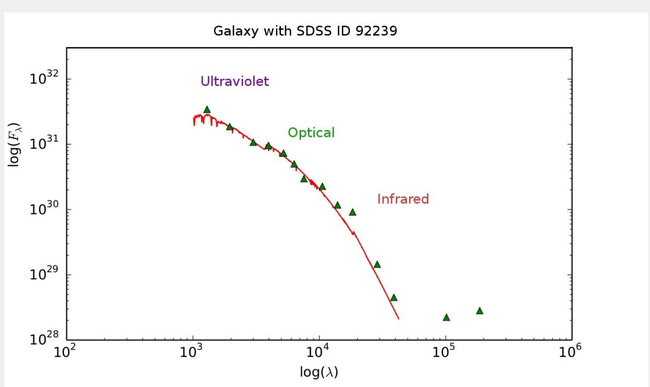
My Research

In my research I compare the light profiles observed for **22 nearby (up to about 2 billion light years away) star-forming galaxies** with models of stellar evolution. The best-fitting model can tell us about the stellar population in the galaxy, its age and mass, as well as how quickly the stars formed and how much dust there is.



The analogue galaxies are found to be **less massive than the Milky Way** by about a factor of 100-10,000, and range in **age** between 7 million and 1.5 billion years.

Their **star formation rates** are comparable to those of the earliest galaxies, forming on the order of 10 solar mass stars per year.



Comparison of Model with Observed Spectrum

Future Plans:

Further study of their spectrum will tell us about the **chemical abundance** within them,as well as provide another measure of how **dusty** they are.

Obtaining **radio** data for them should confirm that their observed brightness is due to their stars and not another physical process.

For further information, please see: Stanway & Davies (2014); Stanway, Greis et al. (2014, submitted); Greis et al. (2014, in prep).; my website (http://www2.warwick.ac.uk/fac/sci/physics/research/astro/people/greis/) on the Warwick Astronomy and Astrophysics Group;

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