

## **First Webb Images: *Ushering in a new era of astronomy***

**The first five Webb telescope images** released on July 12, 2022 were all stunning in their own ways. Each one demonstrated significant advancement over what was possible before Webb. In case you caught the ceremonial release of the images on that day, you would not have missed the passion and excitement in the voices of the astronomers who raised the curtain on each image. They all emphasized the same point: *if this is what the first images are like they can barely begin to imagine what cosmic secrets are about to be unlocked and what new mysteries about our universe will be spawned in the next few years.* The Webb telescope seems to have outdone all the expectations placed on it. If today is any indication of what is to come, there should be no doubt that the 10 billion dollars were well spent.

**Why were these 5 areas of the sky chosen as the first targets for Webb?** It was not easy to decide on the first few targets for Webb. A committee of experts worked for many years to finalize the list. A poll taken by thousands of astronomers yielded hundreds of first target proposals. The committee had the unenviable task of choosing 5 out of 70 finalists; the reaction evoked by the images suggests that they chose well.

The 5 images address the following **5 questions that Webb was built to help answer:**

- 1) How did the very first galaxies and their stars come into existence from the fog of hydrogen left behind by the big bang?
- 2) What role do galactic collisions and mergers play in the evolution of spiral galaxies like the one we live in?
- 3) How are new stars born out of the debris clouds (nebulae) of old dead stars floating in our galaxy?
- 4) How do stars die and what stuff do they leave behind in their wakes, including the formation of black holes?
- 5) How many of the thousands of exoplanets discovered so far have the conditions to support evolution of life?

The first images were not expected to provide answers to these questions, but what they have shown is making astronomers optimistic that significant progress can be made by Webb in all of these areas. **This is what the excitement is all about.**

To go into each image will take too long but here are a few facts from **the first deep field image from Webb.** This one is the most

exciting because it proves that Webb is capable of justifying its reason for existence - *to allow us to look further into space than any telescope has been able to do before and to thereby see what was going on in the universe in the first few hundred million years after the big bang.* That era is the magical time when ordinary hydrogen gas, the one you might have created in your high school chemistry lab, was being transformed to the most amazing objects in the universe - STARS! We know a lot about stars but we still don't understand very well how the first ones emerged in our universe.

Let there be no doubt that we are all children of the stars. Every atom in our body, other than hydrogen, was created inside a star and was later nurtured into life by one special one, our Sun. *So when we understand stars we are getting to know where we have come from - that is why we build telescopes.*

**What are all the little dots of light in this picture?** Other than a few stars in the foreground (the ones that are radiating rays of light) they are all galaxies each with hundreds of billions of stars. The round ones are facing us; linear ones are edge-ways and other angles are in between. Their colors indicate different types of galaxies - bluish white ones are making many new stars, yellowish red ones are hardly making any. The reason some of the galaxies appear warped is because we are looking at them in an area where a clustering of many galaxies has created a "gravitational lens" which magnifies and distorts the galaxies in the background. The distance of these galaxies from earth covers a huge range, from only a few hundred million light years to a maximum of 13 billion light years (remember that a light year is a measure of distance, not of time. It is the distance that light can travel during that time). The 13 billion year old light is from the ones that are the faintest. Those are the ones most exciting - *they hide the secret of how the first stars came into being.*

**How long was the camera exposure that created this image?** It took just 12 hours to complete the image. Compare this to the 2 weeks of constant exposure to take the Extreme Hubble Deep Field image which is nowhere close in sharpness and which missed the most distant and faintest galaxies all together.

**What part of the sky does this image represent?** A very, very tiny part. If you stretch your arm and hold a grain of sand in your hand then the area of the sky covered by that grain is what we are looking at. If you count all the very faint galaxies, the image includes a few

thousand of them in there. This gives us an idea of how many galaxies reside in the universe and how vast it truly is.

**Why did some astronomers cry when they saw this image?** Look at the GIF at the link below that compares this image with the best we had of the same part of the sky from previous telescopes. It will help you understand the tears. Some faint dots in the old image are so sharp now that one can see structure within the galaxy. *This is like being able to study from Earth the atomic structure of a small pebble lying on Mars.*

<https://twitter.com/i/status/1546626672488632321>

To be able to engineer a telescope like Webb and station it a million miles from Earth is a tribute to not only human ingenuity but also to human curiosity. *It is my fervent hope that what it reveals will someday help bring humanity together into a single peaceable community aligned with the cosmic powers that brought it into being.*