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National Aeronautics and
Space Administration

November 16, 2022

Committee on Science, Space, and Technology

United States House of Representatives

Statement by:

Dr. Mark Clampin, Division Director, Astrophysics Division, Science Mission Directorate
National Aeronautics and Space Administration

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INTRODUCTION

My name is Mark Clampin, and I am the Director of the Astrophysics Division of NASA's Science Mission Directorate. As one of the many people who have worked on the James Webb Space Telescope (JWST) over the years, I could not be happier to join you this morning to share some tantalizing science NASA and our partners at the European and Canadian Space Agencies are set to explore using JWST: about the earliest, most distant light we can see; how galaxies form and evolve; the lifecycle of stars; and planetary systems and the origin of life.

I know many of you were excited to see us come together with our partners and audiences around the world for JWST's major milestones so far – from launch, provided by the European Space Agency and Arianespace, to the first images rollout events at NASA's Goddard Space Flight Center, here on the Hill, and at the Space Telescope Science Institute in Baltimore, which operates the telescope. The anticipation of what the world's premier space science observatory might deliver is beginning to come to fruition. In just the first few months of using its amazing American, Canadian, and European instruments: a Near-Infrared Camera, Near-Infrared Spectrograph, Mid-Infrared Instrument, and Fine Guidance Sensor and Near Infrared Imager and Slitless Spectrograph; we already have myriad results showing that JWST will dramatically advance our understanding of the universe. As is always true with NASA science, our need to explore further only deepens with each new discovery.

The End of the Dark Ages: First Light and Reionization

NASA's JWST is already setting this stage with new discoveries that were previously beyond our reach. In one of its very first full-color images, the observatory delivered the deepest and sharpest infrared image of the distant universe so far. JWST's First Deep Field was galaxy cluster SMACS 0723, an image teeming with thousands of galaxies – including the faintest objects ever observed in the infrared. The combined mass of this cluster of galaxies acts as a gravitational lens, magnifying more distant, background galaxies, including some seen when the universe was much less than a billion years old.

Within this first deep field, scientists have already identified the most distant globular clusters ever seen. These clusters are dense groups that contain millions of stars, some of which may be the first and oldest stars in the universe. We are now seeing the details of the earliest phase of star formation, advancing immediately beyond what was possible with previous Hubble Space Telescope (HST) imaging.

New results also point to some of the most distant galaxies ever observed, using only a few days' observation time. Some likely date back to nearly 350 million years after the Big Bang. And while the distances of these early sources still need to be confirmed, astronomers have been surprised to find that many of these early galaxies are extremely compact and bright. This brightness poses a serious science question for us: What was more common in the early universe – many large, low-mass stars, or fewer, blazingly bright stars?

Assembly of Galaxies

JWST is also already offering insights about how galaxies form and evolve over time. One surprising discovery was a cluster of massive galaxies in the process of forming around an extremely red quasar, a powerfully active galactic nucleus that existed 11.5 billion years ago. JWST's extremely sensitive instruments allowed simultaneous spectroscopic measurement of a wide enough area to show how the quasar and a cluster of at least three galaxies around it, in an area likely full of dark matter, interact in what is one of the densest known areas of galaxy formation in the early universe.

JWST is revealing new perspectives on previously studied targets, thanks to its infrared instruments' ability to peer through dust. The Cartwheel Galaxy, a large pink, speckled galaxy resembling a wheel, is the result of a high-speed intergalactic collision, and now sports two rings — a bright inner ring and a surrounding, colorful ring. JWST has been able to uncover how the expanding rings drive star formation, as well as peer at hydrocarbons, silicates, and other compounds in the dust in the spokes of the wheel.

The Birth of Stars and Protoplanetary Systems

The Pillars of Creation, famously imaged by HST in 1995, is a region where many new stars are forming within dense clouds of gas and dust. But JWST can help us understand how many emerging stars can be found there with much more precision. Its newest view of the Pillars of Creation will help researchers revamp models. Over time, we will begin to better understand how stars form and burst out of these dusty pillars over millions of years. JWST's ability to observe and quantify gas and dust also helps us understand the properties of this rapidly changing area in sharper detail than ever.

Astronomers studying Wolf-Rayet stars have also recently discovered the best evidence yet that the huge amounts of gas pushed into space by these powerful late-stage stars produce carbon-rich dust. And the dust shells that JWST can spot tell us that this dust can remain in the hostile environment between stars and supply material for future stars and planets.

The Tarantula Nebula is the largest and brightest star-forming region near our Milky Way, and it is home to the hottest, most massive stars known. The nebula has a similar type of chemical composition as the gigantic star-forming regions observed when the cosmos was only a few billion years old and star formation was at its peak. JWST is providing astronomers the opportunity to compare and contrast star formation in the Nebula with that of distant galaxies from the actual era of peak star formation, called "cosmic noon."

Planetary Systems and the Origin of Life

Excitingly, JWST's unmatched infrared sensitivity is also revealing new hints about worlds outside our solar system. JWST confirmed the first clear evidence of carbon dioxide in the atmosphere of a planet called WASP-39 b. The planet's discovery, reported in 2011, was made based on ground-based detections of the subtle, periodic dimming of light from its host star as the planet transits in front of the star, and previous observations from NASA's HST and the Spitzer Space Telescope revealed the presence of water vapor, sodium, and potassium in the planet's atmosphere. JWST has studied WASP-39 b's atmosphere in unprecedented detail, offering evidence that this powerful observatory may also be able to detect and measure carbon dioxide in the thinner atmospheres of smaller rocky planets.

JWST also captured the distinct signature of water in the atmosphere of a hot, puffy gas giant planet called WASP-96 b. While HST has analyzed many exoplanet atmospheres over the past two decades, capturing the first clear detection of water in 2013, JWST's immediate and more detailed observations hint at the significant role the telescope will play in the search for potentially habitable planets in coming years. JWST's powerful new view of this planet also showed evidence of haze and clouds that previous studies of this planet did not detect.

A true highlight of our early research is JWST's ability to take a direct image of a planet outside our solar system. Taking direct images of exoplanets is challenging because stars are so much brighter than planets. HIP 65426 b is an exoplanet discovered in 2017 using the SPHERE instrument from the European Southern Observatory's Very Large Telescope. HIP 65426 b is more than 10,000 times fainter than its host star in the near-infrared, and a few thousand times fainter in the mid-infrared. JWST was able to image such a dim object so early in its mission, thanks to the coronagraphs on its instruments, which served to suppress the light of the host star – a capability that points toward exciting new observations of other worlds in the future.

Closer to home, JWST images of Jupiter have been able to showcase several levels of its auroras and clouds, from high-altitude auroras above to the northern and southern poles to swirling hazes and deeper main clouds. Streaks and spots identified in JWST data likely reflect convective storms. Wider field images capture Jupiter's faint rings and tiny nearby moons. Planetary scientists are already working out what these new data mean for Jupiter's chemistry and atmosphere.

JSWT's first image of Neptune captured the clearest view of this distant planet's rings in more than 30 years. Some of these rings had not been detected since NASA's Voyager 2 first observed Neptune during its flyby in 1989, along with Neptune's dust band. High-quality images show a vortex at Neptune's southern pole and more subtly suggest other weather activity. JWST also imaged Neptune's highly reflective icy moon Triton, with plans to image this system again in the coming year.

Conclusion

Since it began observations, JWST has simply been amazing. We have been very pleased with its better-than-expected performance and observations. We are managing the observatory in such a way that we expect it to provide dramatic scientific surprises for many years to come. But we at NASA are far from satisfied with what we have learned, insofar as it tells us there is infinitely more to learn from the heavens. We continue to learn from observations gained from missions like Hubble, Chandra, TESS, and IXPE, among many others. In the future, you should expect great things from the Roman Space Telescope, COSI, GUSTO, and the missions we build toward in response to the 2020 Astrophysics Decadal Survey. In just a few years, I hope you will invite us back to see the first results of Roman's massive infrared survey so we can discuss how these systems can provide complementary observations to target future JWST missions. We will, as always, be prepared to share with you and the public everything that we and the scientific community are able to find with these complementary assets.

Mr. Chairman, we would be happy to respond to any questions you or the other Members of the Subcommittee may have.

Dr. Mark Clampin, Director, Astrophysics Division
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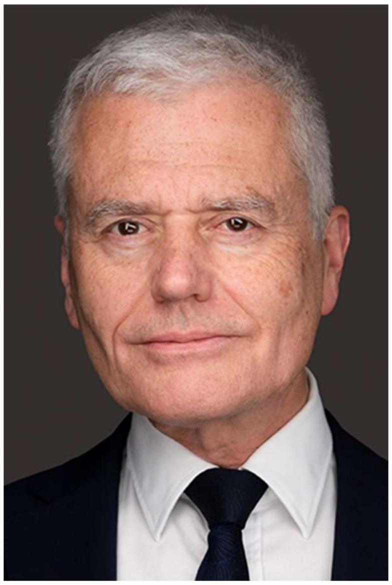

Dr. Mark Clampin is the Astrophysics Division Director in the Science Mission Directorate at NASA Headquarters in Washington, DC. Until August 2022, Dr. Clampin was the Director of the Sciences and Exploration Directorate (SED) at the Goddard Space Flight Center (GSFC) where he led the Astrophysics, Solar System, Heliophysics and Earth Science Divisions, together with the high performance computing office.

At GSFC, he previously served as the James Webb Space Telescope (JWST) Observatory Project Scientist, and subsequently as Director of the Astrophysics Science Division and Deputy Director of SED. Prior to joining GSFC, Dr Clampin was the Advanced Camera for Surveys (ACS) Group Lead at the Space Telescope Science Institute (STScI), where he worked on the first four Hubble Space Telescope (HST) Servicing Missions.

Dr. Clampin is a Co-Investigator with the Transiting Exoplanet Survey Satellite (TESS), and the Advanced camera for Surveys (ACS) science team and served as the Detector Scientist, responsible for the delivery of three focal plane camera systems. His research interests focus on studying the formation and evolution of planetary systems. Dr. Clampin has also designed ground-based telescope instruments including adaptive optics systems, coronagraphs and detectors.

Dr. Clampin graduated from the University of London with a BS in Physics and from the University of Saint Andrews in Scotland, with PhD in Astronomy. Dr. Clampin is the recipient of the Meritorious Presidential Rank Award, NASA's Exceptional Achievement and Scientific Achievement Medals, and is a Fellow of SPIE and the Royal Astronomical Society,. Until recently he was the Chief Editor of the SPIE peer-reviewed Journal of Astronomical Telescopes, Instruments and Systems, a position he held for 7 years. He is married with one daughter, and enjoys running and his lifelong passion scuba diving.