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The James Webb Space Telescope is an amazing advancement of space technology which may prove extremely useful to scientists and astronomers. Orbiting the sun 1.5 million kilometers from Earth, it has already revealed many amazing images to scientists on Earth. The first of these was Webb's First Deep Field, which was revealed by President Joe Biden on July 11, 2022.

These amazing images, which may be vital to learning more about our universe, would not have been possible without the many components that make up the James Webb Telescope. The Integrated Science Instrument Module (ISIM) is a key component to Webb. The ISIM contains the Near-Infrared Camera (NIRCam), the Mid-Infrared Spectrograph (MIRI), the Fine Guidance Sensor/Near InfraRed Imager and Slitless Spectrograph FGS/NIRISS, and perhaps the most important, the Near-Infrared Spectrograph (NIRSpec).

Not to be confused with the NIRCam, NIRSpec operates on a infrared wavelength range of 0.6 to 5 micrometers. "A spectrograph (also sometimes called a spectrometer) is used to disperse light from an object into a spectrum." (webb.nasa.gov). Using spectrums, scientists can find out valuable information about an object, such as physical properties, like temperature, mass, and chemical composition.

This is invaluable to scientists and astronomers because if James Webb captures enough light from any celestial object, such as a galaxy or a star, even, to create a spectrum, scientists can analyze that spectrum. Doing so may unlock secrets about the universe previously unknown to humankind.

However, James Webb's mission period is only five years, starting from Christmas 2021. As of now, over a year of Webb's five has elapsed. And to add onto that, most of the celestial

objects that Webb is studying, such as some of the first galaxies formed following the Big Bang, are so faint that Webb's mirrors must face them for hundreds of hours to collect enough light to form a good spectrum. In order to be able to maximize its mission time, Webb was programmed to look at 100 objects simultaneously. While this sounds impossible, Goddard scientists and engineers invented entirely new technology to install into NIRSpec.

This technology, called a "microshutter array", contains approximately 250,000 individual shutters, or "windows" , that can be controlled individually to open or close via a magnetic field. It took over six years to perfect, and each shutter had to be opened thousands of times to get it just right. This long amount of time required to design the new technology should promise top-of-the-line technology for the James Webb Telescope.

Each shutter is 100 by 200 micrometers in dimension, or about the width of a human hair. Although the microshutter arrays had much potential, there were some challenges when designing the new technology. For example, NIRSpec operates at cryogenic temperatures, so the microshutters had to be able to open and close without, for example, freezing shut at such frigid temperatures. Other design challenges were present, such as the need for the microshutters to be able to open and close repeatedly (if needed) without fatigue. Not only did they need to be able to resist fatigue, they had to have the ability to open completely individually, and open wide enough to meet science requirements for space viewing.

In order to resist fatigue, scientists chose to incorporate silicon nitride into the microshutters. Silicon nitride has very high strength and high resistance to fatigue. In order to be able to control the microshutters individually, they are able to be commanded to open or close using a magnetic arm. The arm sweeps past, and controls when it sends out an electric signal or not. The microshutters, when they receive one of the electric signals, open or close based on the

signal. The microshutters, when open, will allow light into the system to create a spectrum. When closed, they will block unwanted light that would otherwise disrupt a perfect spectrum.

This allows Webb to view its 100 objects all at once, and create good spectrums for each of them. The magnetic arm opens certain microshutters that will allow the light in from specific celestial bodies, while blocking light from unwanted ones. For example, if there is an extremely faint galaxy that Webb wants to study, and a very bright star that it doesn't, the bright star would interfere with the light from the faint galaxy, and therefore potentially ruin the galaxy's spectrum. So Webb would open one (or however many it needs) microshutters to view the faint galaxy, but keep many closed to block light from the bright star. This would allow the light from the faint galaxy to create a much more accurate spectrum than if the bright star was interfering.

Utilizing all of NIRSpec's abilities can lead us to discover much about the universe. Scientists will use NIRSpec and all of its technological advancements, specially designed for interstellar research, designed over several years for NIRSpec, to learn many things about our universe.

Webb will use its abilities to study some of the first galaxies to form after the Big Bang. It will point its microshutters at distant galaxies-so distant, in fact, that Webb will only see them as being a few years old, when, in reality, they are millions or billions of years old. These galaxies, which Webb will view as very young, appear that way because light only travels so fast. The light from these galaxies takes millions to billions of years to reach our solar system. So, it will be millions of years more for anything in the solar system to see it as it is now-and by then, it will have changed again.

So, when Webb studies these galaxies, scientists can study their perfect spectrums, courtesy of James Webb, to learn more about what the galaxy was like billions of years ago, right after the Big Bang.

While the James Webb Telescope does have many carefully constructed parts, the Near-Infrared Camera, with its all-new microshutters, is by far the most important, which scientists will utilize to learn more about the universe.

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