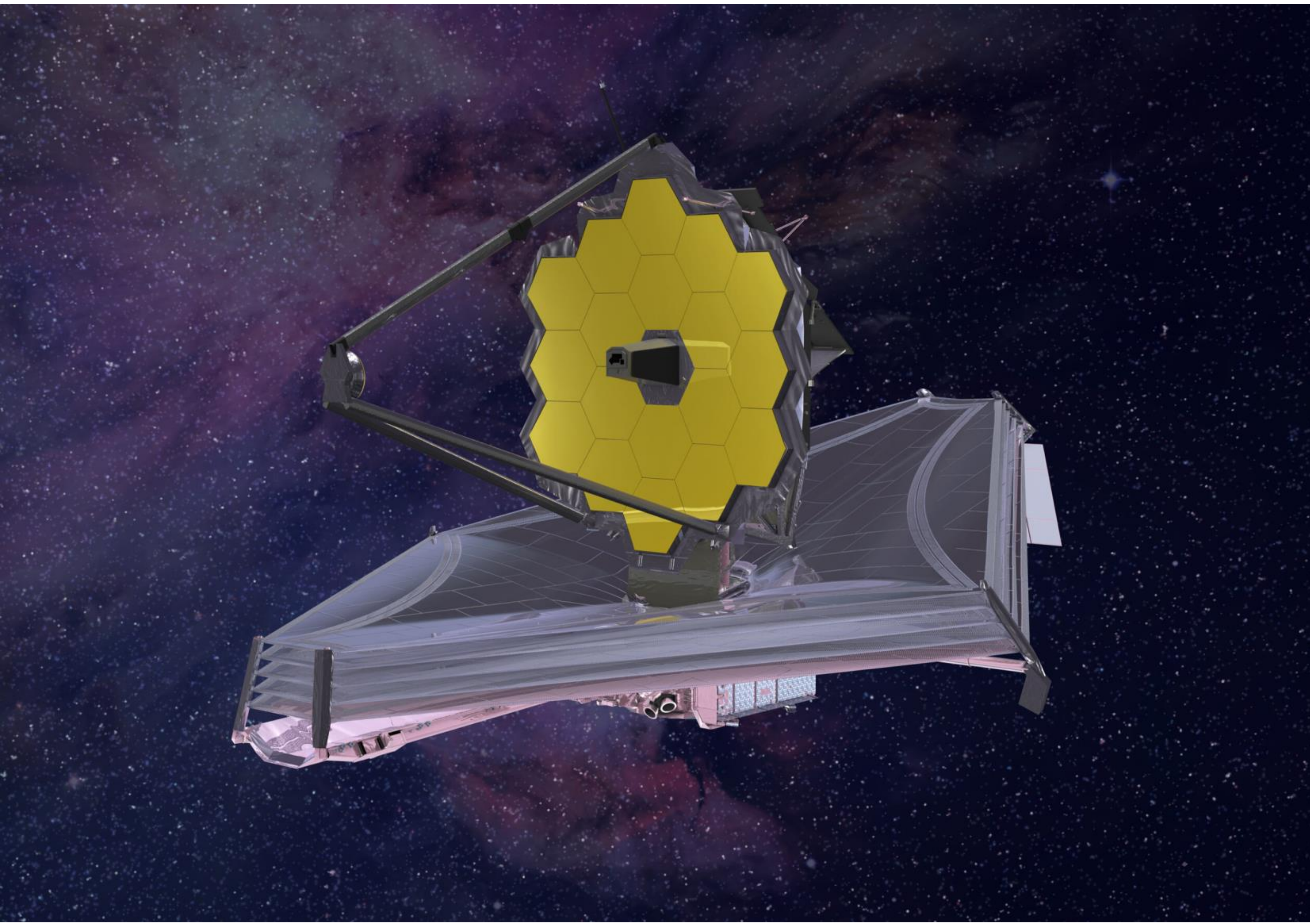
THE JAMES WEB SPACE TELESCOPE



CAPABILITIES

The James Webb telescope has futuristic capabilities that will outweigh those of previous telescopes: it will be able to look back over 13.5 billion years into space, which will help them understand the processes that took place at the origin of our universe or even transform our whole understanding on the structure of space.

What will enable the James Webb telescope to look so far back into space is the long wavelengths it can capture (0.6 to 28 microns) which will enable the telescope to look more into the infrared spectrum. This will allow scientists to capture pictures of more distant objects (whose light warped into infrared by the time they reach us).

Then, the James Webb telescope is also equipped with a set of cameras that will allow an even deeper analysis of space:

The main set of eyes of the telescope is NIRcam, which is expected to view the oldest stars and galaxies in the universe and the planets forming around them.

The near-infrared spectrograph will give information about the physical and chemical properties of objects in space.

The NIRISS camera is aimed at finding earthlike exoplanets. In fact, Webb will be able to tell information about the density of these planets and the composition of their atmosphere.

The MIRI mid-infrared instrument will allow us to see stars being born and astronomers hope it will help in the research of the mysterious 9th planet of the solar system.

The mirrors are the most important part of the James Webb telescope: a telescope sensitivity is directly related to the mirrors and the James Webb telescope is equipped with a 6.5 meters mirror (much bigger than Hershel's 3.5 or Hubble's 2.4 meters mirror). These huge mirrors will therefore help Webb collect more light from the objects observed and therefore peer further back into time.

THE SUNSHIELD

Webb primarily observes infrared light, since the telescope will be observing the very faint infrared signals of very distant objects it needs to be shielded from any bright, hot sources.

The sunshield serves to separate the sensitive mirrors and instruments from not only the Sun and Earth/Moon but also the spacecraft bus. For this reason, the telescope is split into two parts, a "hot side" facing the sun, with the communication systems on board, and a "cold side" facing away from the sun with the equipment to observe deep space.

THE LAGRANGE POINT

The James Webb Space Telescope will not be in orbit around the Earth, like the Hubble Space Telescope, but it will orbit facing the Sun 1.5 million kilometers away from the Earth, around what is called the second Lagrange point or L2. This orbit allows the telescope to stay aligned with the Earth as it moves around the Sun.

This allows the satellite's large sunshield to protect the telescope from the light and heat of the Sun and Earth, to maximize the sunshield effectiveness against the light and heat of the Sun, the Earth, and the Moon, these three bodies all must be in the same direction.

ENGINEERING OBSTACLES

The launch vehicle Ariane5 is part of the European contribution to the mission and is one of the world's most reliable launch vehicles. Once in orbit, the empty first stage separates from the upper stages. The exposed telescope is delicate and must be protected from the sun's sphere heat. To avoid overheating and damage, a carefully designed series of oscillations are performed that provide the necessary protection.

Webb's big initial transformation is the deployment of the sunshield pallets. This happens when the telescope nears its third day in space. But to open the sunshield, around 150 release mechanisms must fire correctly over the course of three days. The complicated deployment involves around 7,000 parts, including 400 pulleys, eight motors and 140 release actuators. The covers over the core region release back, then the mid boom extends, and the sunshield assumes the typical tennis court shape. It is now time to tension the sunshield membranes, each tinnier than a human hair, pulling each of the unique size and shape layers to their optimal position.

On the seventh day, Webb's 6.5-meter primary mirror will begin to unfurl. First, two "wings" will swing out and lock into place like pieces of a folding table. Then tiny actuators will push or pull each of the mirror segments into a micron-precise alignment, producing the primary mirror's singular focus. Deploying and aligning the primary mirror will involve 132 actuators and motors, each of which must function properly. The aft deployable radiator releases and springs into position allowing the instruments to radiate their waste directly into space and away from the telescope. Disposing of excess heat is crucial to the mission so that it does not overwhelm the faint infrared signals to be collected from the cosmos.

While the first month is the densest part of the deployment, it will take six months for all the instruments to be turned on, calibrated and commissioned. Only then will scientists see "first light" from the telescope.

The challenges of keeping the telescope safe in space:

Doing cryogenic testing for every part and component to make sure that it doesn't crack or break when exposed to extreme cold, since it will contract.

Having a "sunshield" which will constantly keep the telescope in the shade, because since it is an infrared telescope heat and light may affect its accuracy and efficiency.

Since it is not protected from Earth's magnetic field, every component had to be made radiation-proof and encased so that it doesn't deteriorate over time.

Being prepared for possible micro-meteor strikes that could cause some minimal damage and making sure that after such an event, the telescope still works.

Doing vibration-testing to make sure that the telescope won't get damaged during launch since it is so delicate.

Finally making it totally independent and sustainable with the use of solar panels although NASA has stated that a service-mission could be scheduled if needed.

THE HUBBLE LEGACY

We must admit that anything said before would not be possible without the most famous James Webb ancestor, the Hubble space telescope, which has been orbiting around the Earth since 1990. Hubble was as revolutionary as James Webb at those times, since it made possible to calculate more precisely the Hubble constant, which represents the rate of expansion of our universe and hence used to compute its age, and to these days is one of the most productive and quoted scientific program ever made.

We also cannot forget the beautiful deep field images that Hubble took for us during these years, images that have driven, and which will drive, the curiosity about space and the ambition of the entire mankind for years. And thus is it clear that James Webb telescope bears a heavy legacy upon its shoulders, a thing that we can easily understand by the maniacal attention that researchers and engineers are paying to this project.

You know how it is, James Webb: with great power comes great responsibility. We know the challenges you will face, as well as we know your capabilities. So go out there and make us know how beautiful our universe is.