The Wonder That Is Webb, Part 1 August 11, 2022

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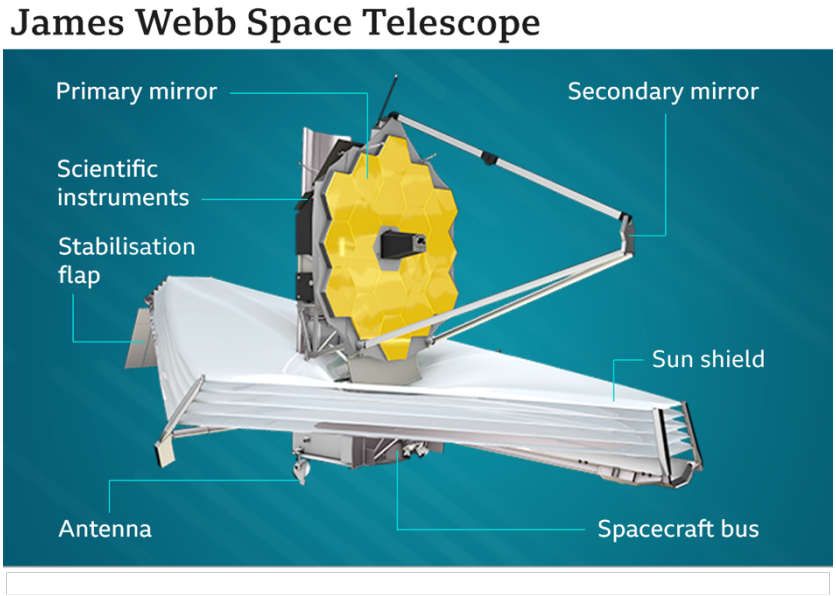
We have been hearing so much about the James Webb Space Telescope (JWST) in the news these days, so I thought I would put together some information to share about this amazing instrument. In Part 1, I give a general overview of the purpose and design of the JWST. In Part 2, I will talk a little more about the telescope design itself, as well as the Canadian connection.

This brand-new space telescope is named after James E. Webb (1907–1992), the NASA administrator from 1961 to 1968. While Webb was known more for his leadership during the Apollo program, he was also known for his passionate commitment to space science.

The purpose of the JWST is to help us understand the origins of the universe. To accomplish this, the telescope will study the earliest galaxies, which formed over 13.5 billion years ago. The JWST will also study objects in our solar system.

While the Hubble Space Telescope takes images in visible light, the JWST takes images primarily in infrared light. There are two reasons why: First, when these early galaxies formed, they emitted visible light. But over the 13.5 billion years of their existence, the wavelengths of visible light have stretched because the universe is expanding. The light waves are now longer, in the infrared range. Second, unlike visible light, infrared light goes through dust, and the universe is a very dusty place. So, the JWST can detect the infrared light in these old and distant galaxies more easily.

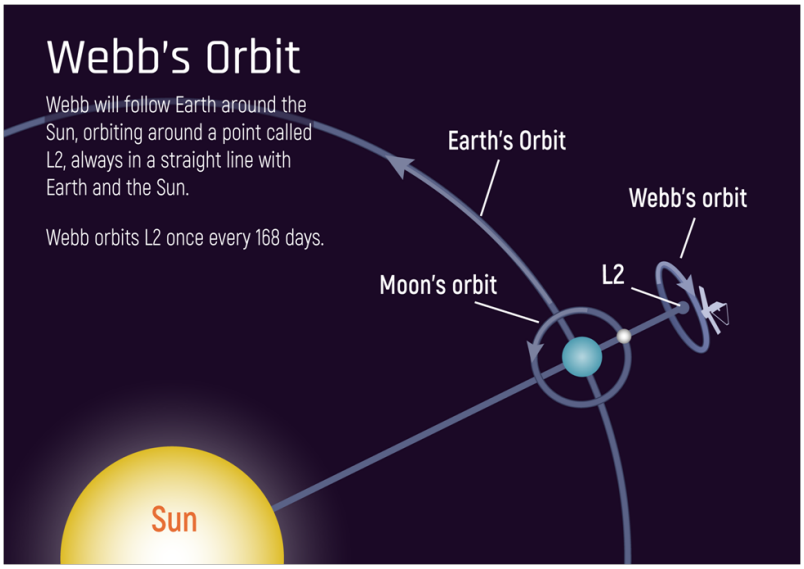
We also know infrared as heat. Essentially, the telescope is taking pictures of heat. The infrared light from these old galaxies is pretty faint, so the instruments on the JWST need to be protected from interference from other sources of heat, such as the Sun and Earth, and the instruments need to be as cold as possible. So the telescope sits on a Sun shield, which separates the instruments from the heat from Sun and Earth.



The main components of the JWST. The mirror is made up of 18 gold-plated hexagon mirrors, for a total diameter of 6.5 metres, about the size of a two-storey building. The Sun shield is about the size of a tennis court. Credit: NASA

But how is the Sun shield able to constantly protect the telescope's instruments from heat from the Sun and Earth? This is the brilliant part of the technology.

The JWST orbits a point in space, called a Lagrangian point. The math regarding Lagrangian points makes my head hurt. So, here's all you need to know: a small body, like a spacecraft, stays at rest relative to two large bodies, like the Sun and Earth, at a Lagrangian point. So, the JWST orbits the Sun, at a Lagrangian point (L2 in this case) that is 1.5 million kilometres from Earth, but the telescope stays the same distance from Earth as they both go around the Sun. This unchanging distance to Earth ensures unbroken communication between the JWST and Earth. Plus, the telescope's orbit around L2 allows the Sun shield to stay between the instruments and the Sun and Earth, as seen in the diagram below.



The orbit of the JWST is perpendicular to Earth's orbit. This way, the Sun shield is always between Earth and the Sun and the telescope's instruments. (L2 is the name of the Lagrangian point.) Credit: NASA/Space Telescope Science Institute

After computer processing and colorization, we get outstanding images!

The Cartwheel Galaxy, in the constellation Sculptor (seen in the Southern Hemisphere), is the result of a galactic collision. Credit: NASA, ESA, CSA, STSc