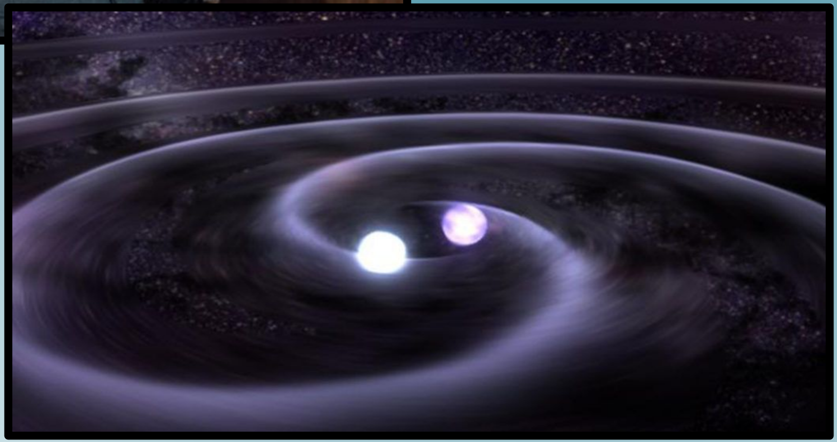
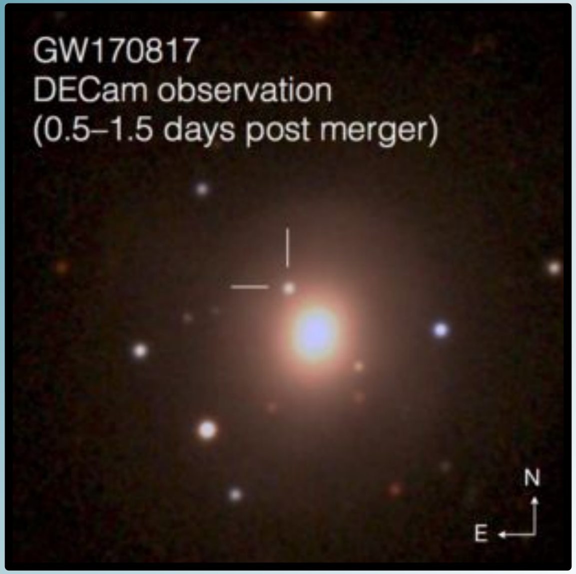
Marcelle Soares-Santos

is a physicist who uses **multi-messenger astronomy** to understand the nature of **dark energy**. She searches for **gravitational wave-emitting collisions** of neutron stars and black holes.





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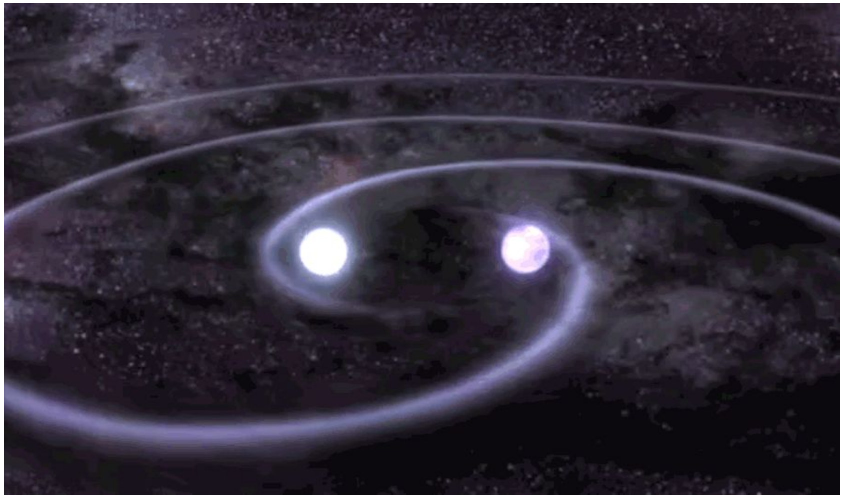
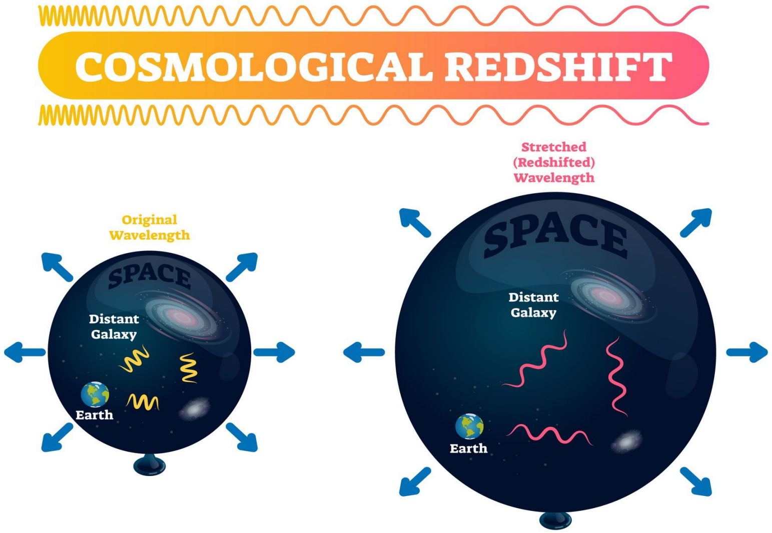
Massive accelerating objects (**supernovae, binary star systems**, etc.) cause **gravitational waves**: ripples in spacetime that propagate at the speed of light in all directions away from the source.





When the Universe expands, it **stretches the wavelength of light** causing it to shift toward the red end of the electromagnetic spectrum (**redshift**).

Detections of gravitational waves can provide information about the current **rate of expansion of the Universe** and the composition of **dark energy**.

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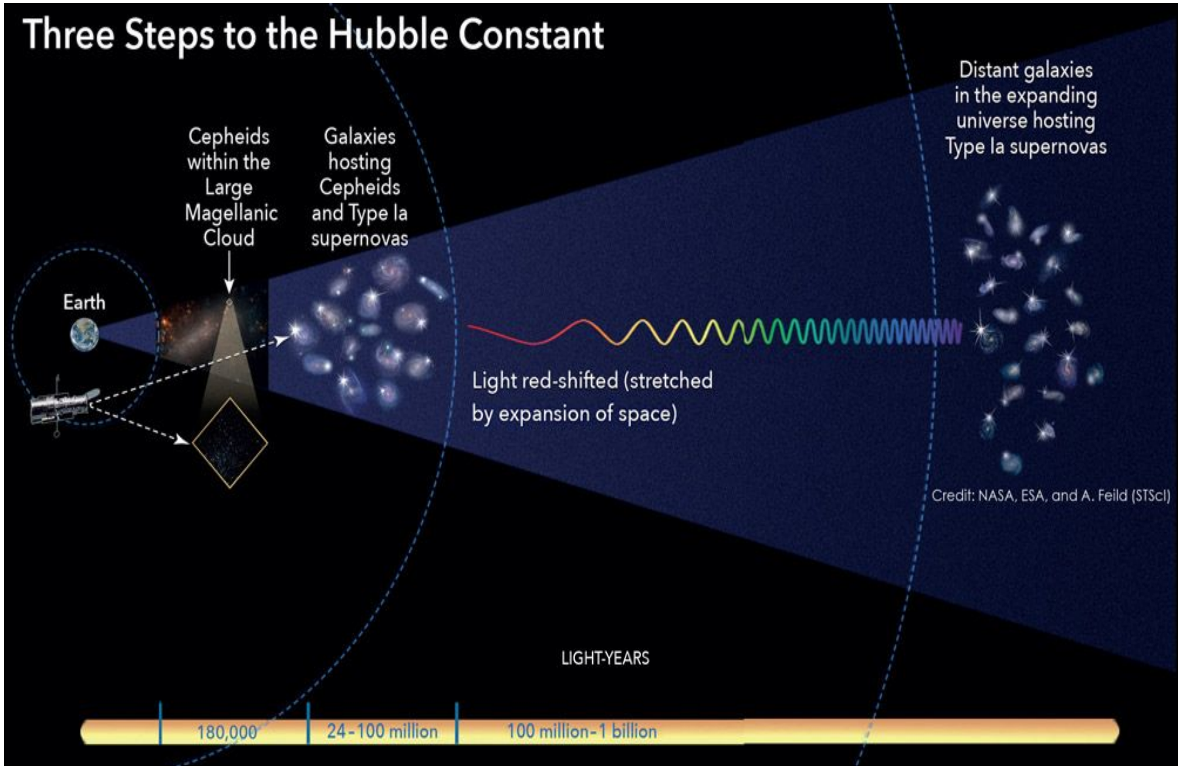
To understand the **accelerating expansion of the Universe,** cosmologists have tried to accurately determine the **Hubble constant** by measuring the **redshift** of celestial objects and their **distances** from us.

Distances are computed using a "**standard candle**": an object that always has the **same standard brightness**.

Astronomers measure how dim the object's light appears on Earth compared to its known brightness at the source.



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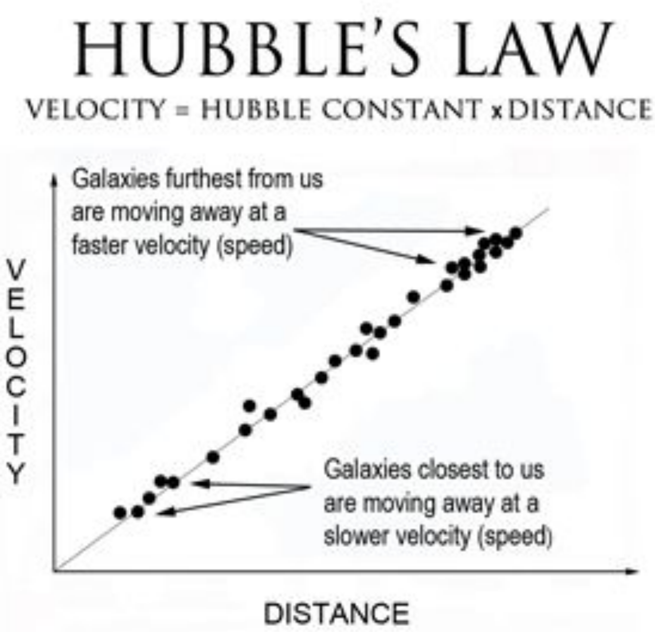
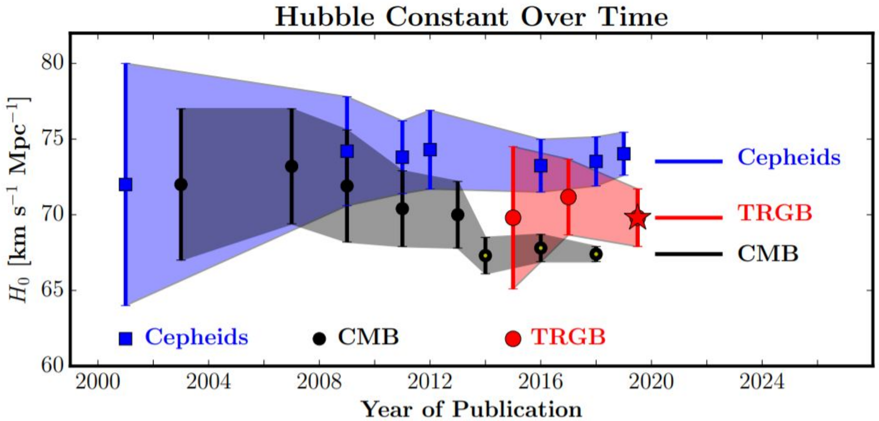
Cosmologists currently have **different values for the Hubble constant**. One was calculated using the **cosmic microwave background**, and one uses **Type 1a supernovae**.

Gravitational waves can be used as "**standard sirens**" to determine the distance to an object and might yield a different value of the Hubble constant.





Unlike standard candles, a standard siren can be used to **compute distances directly**.

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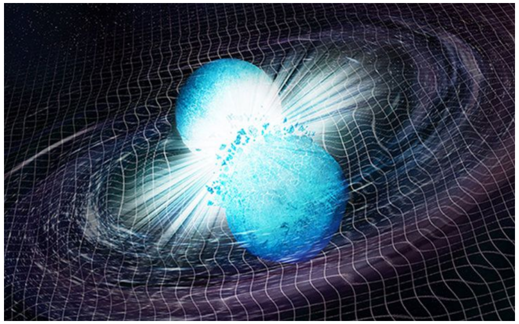
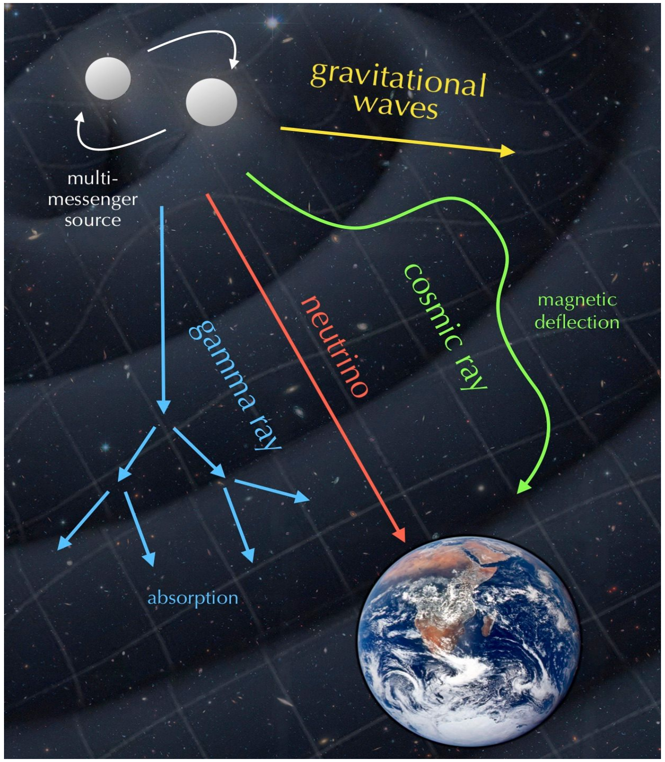
Astrophysical events (such as **supernovae**, **active galactic nuclei**, and **neutron star collisions**) produce one or more “**messengers**” which give information about the processes that created them.





There are **four extrasolar messengers** in astronomy: electromagnetic radiation (**photons**), **gravitational waves**, **neutrinos**, and **cosmic rays**.

Observations of a neutron star collision in the **galaxy NGC 4993** marked a new milestone for **multi-messenger astronomy** because they were the first detections of a **gravitational wave** event with an **electromagnetic** counterpart.

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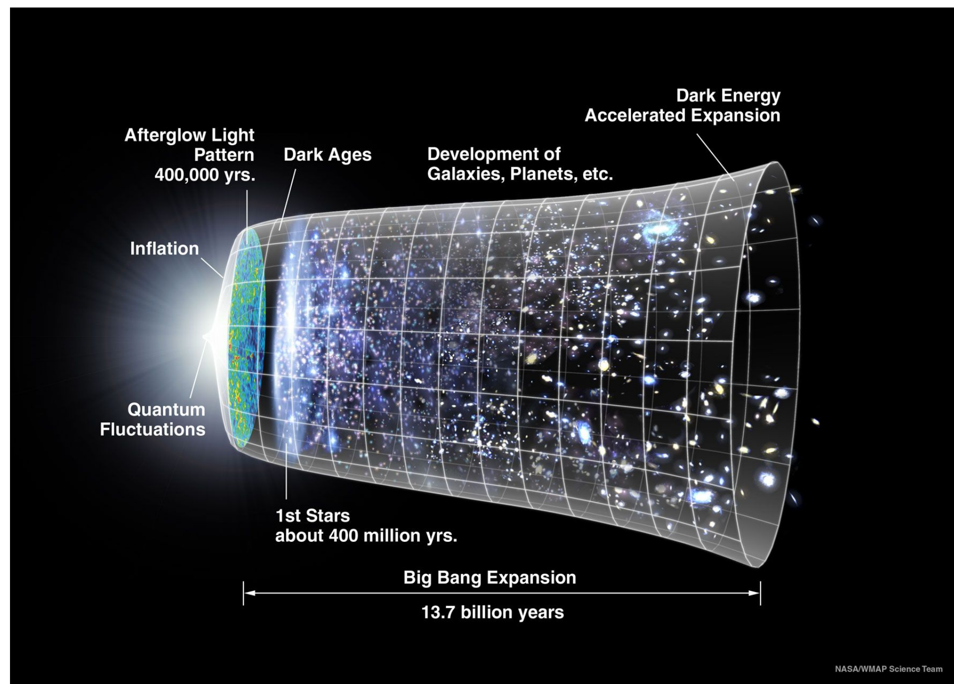
The **Dark Energy Survey** (DES) is an international collaboration that aims to understand the **properties of dark energy** using observations from the **Dark Energy Camera** (DEcam).

Soares-Santos contributed to the construction of DEcam which has been used to observe distant **galaxies** and **supernovae**.

By combining these observations with **gravitational lensing** and **galaxy clusters**, DES can constrain changes in dark energy over the course of **cosmic time**.



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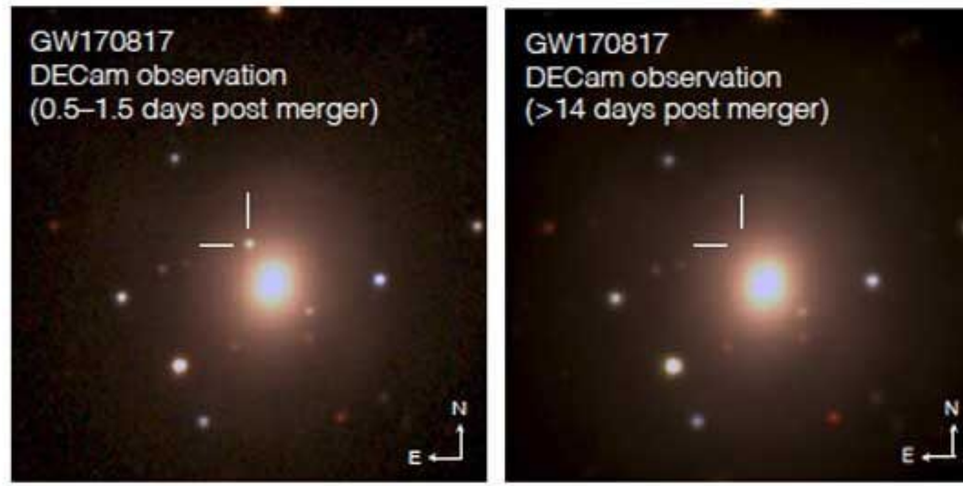
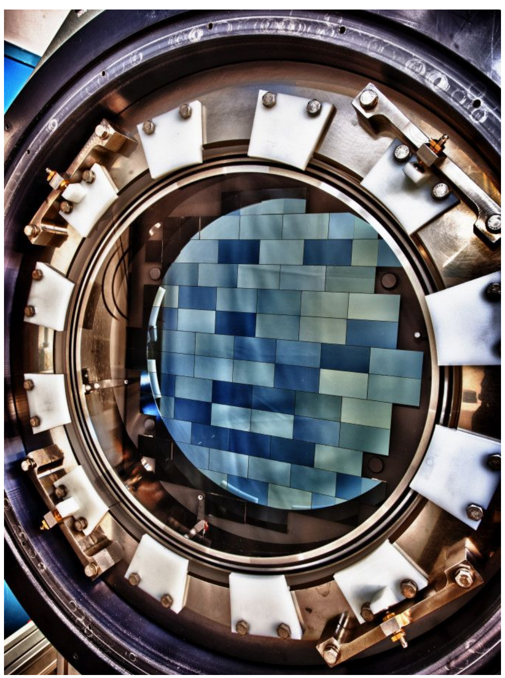
Soares-Santos had to adapt **DEcam** to search for the **electromagnetic counterparts to gravitational waves** (in addition to the original goal of searching for supernovae).





In 2017, she and her collaborators detected the EM counterparts to the **gravitational wave event GW170817** due to **two neutron stars colliding** over 100 million years ago.

These observations will contribute to furthering the understanding of the **accelerating expansion of the Universe**.