

Do you know how fast the universe is expanding ?

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1. The Hubble constant

- fundamental constant (H)
- **describes the universe expansion**
- predicted by Planck

2. Estimation of the Hubble constant

There are two successful techniques based on the observation of :

- 1) **the cosmic microwave background**
(Planck's model)
- 2) **exploding stars** (Type supernovae model)



They give **two different results** !

The measure of model 2 is bigger than expected, so model 1 seems better ?!

⇒ **We need a third independent check**

3. The merger of 2 neutron stars

Energetic event in which **two massive stars** whip around each other hundred of time per seconds before merging in a **collision** that flings out a burst of **gravitational waves**.

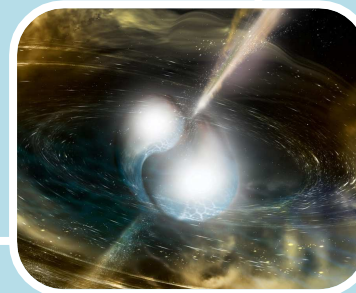
4. Which neutron stars ?

Name : **GW170817**

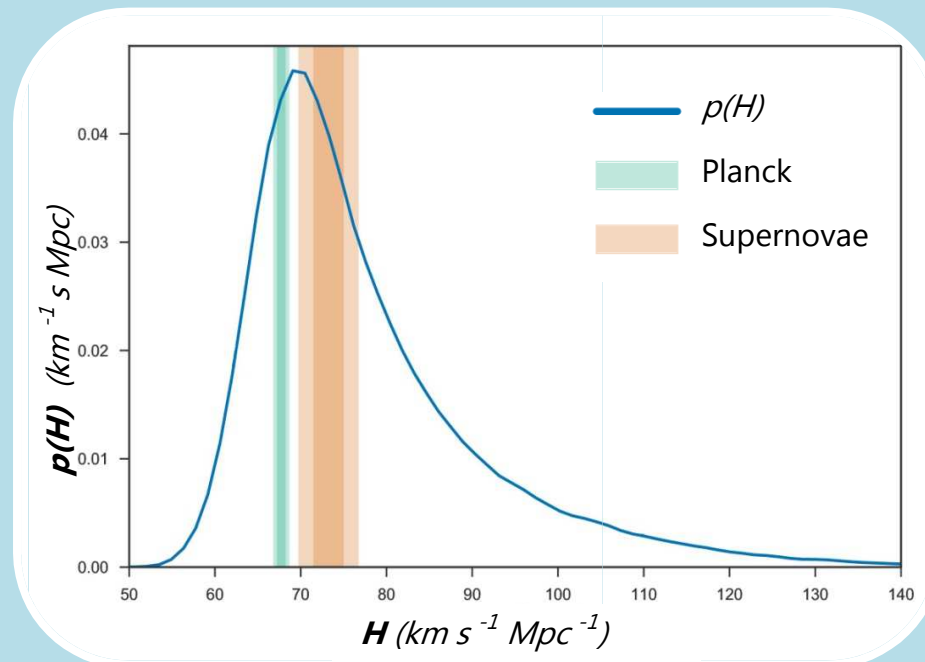
Detected on : August 17th, 2017

Size : As big as Manhattan

Weigh : Twice as heavy as the sun



Posterior probability distribution for the Hubble constant (H) inferred from GW170817



5. A new speed ?

Before : between 66 and 90 km/s/Mpc

Now : **between 65.3 and 75.6 km/s/Mpc**

Improvement : three times more precise

6. How was the merger measured

- Astrophysicists can calculate how strong the **gravitational waves signal** is.
- Then, they **compare** it with known measures.
- They need supercomputers and optical cameras to **determine the orientation** of the merger stars.
- This process allows scientists to determine the **speed of the universe expansion**.

7. Remarks

- This third figure does not confirm any model...
- It would need **15 more collisions** to refine the Hubble constant and be able to agree with one model.

8. Sources

<https://www.sciencedaily.com/releases/2019/07/190709110202.htm>

https://www.nsf.gov/news/mmg/mmg_disp.jsp?med_id=132963&from=

<https://christopherplberry.files.wordpress.com/2017/10/h0-inference.png>