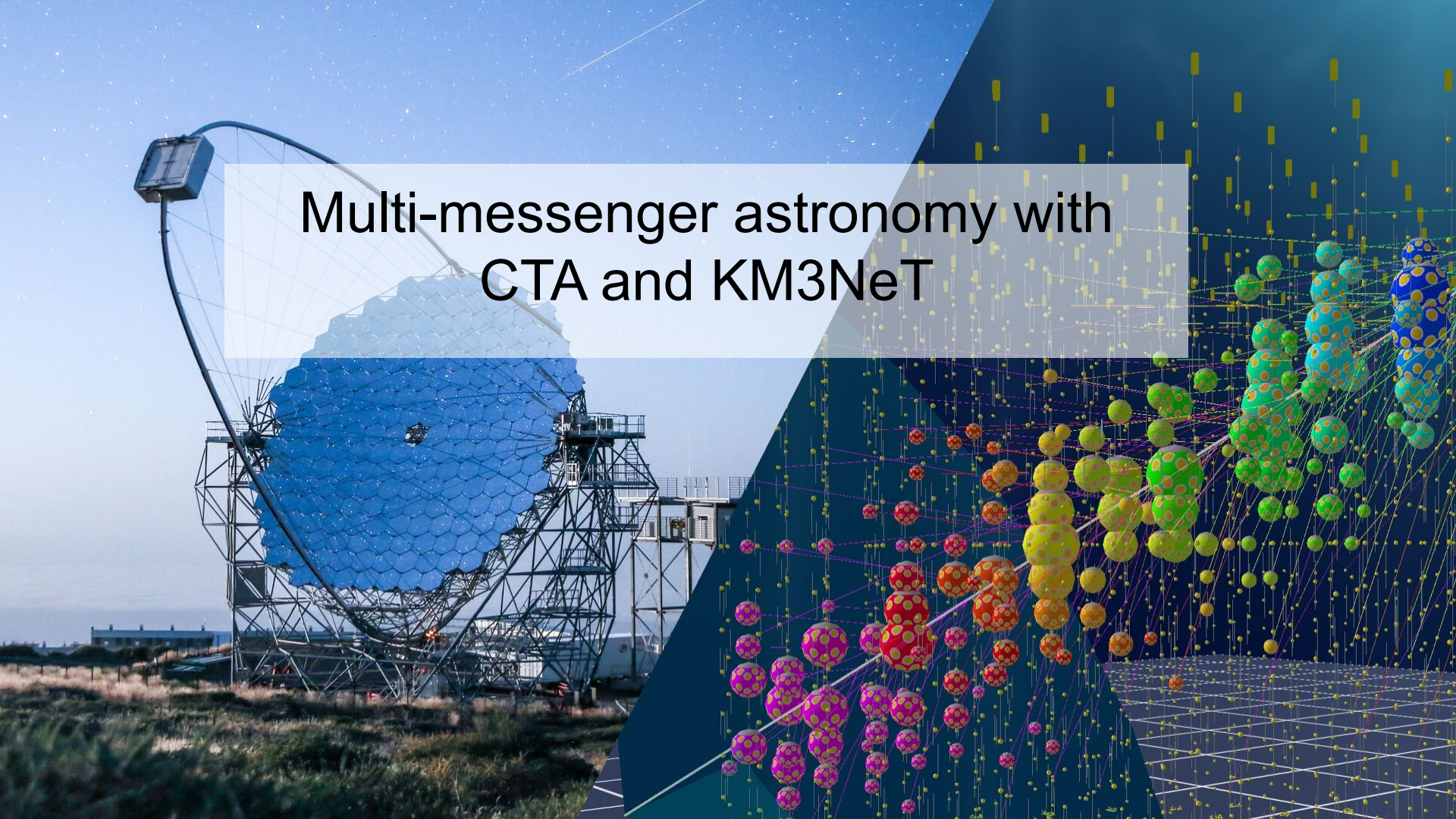
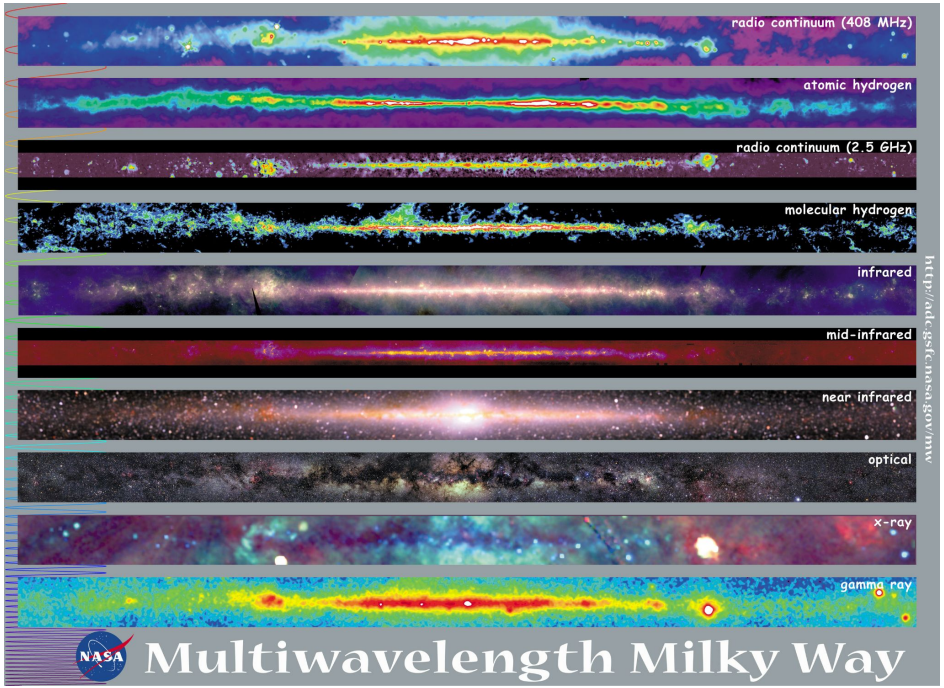
Multi-messenger astronomy with CTA and KM3NeT



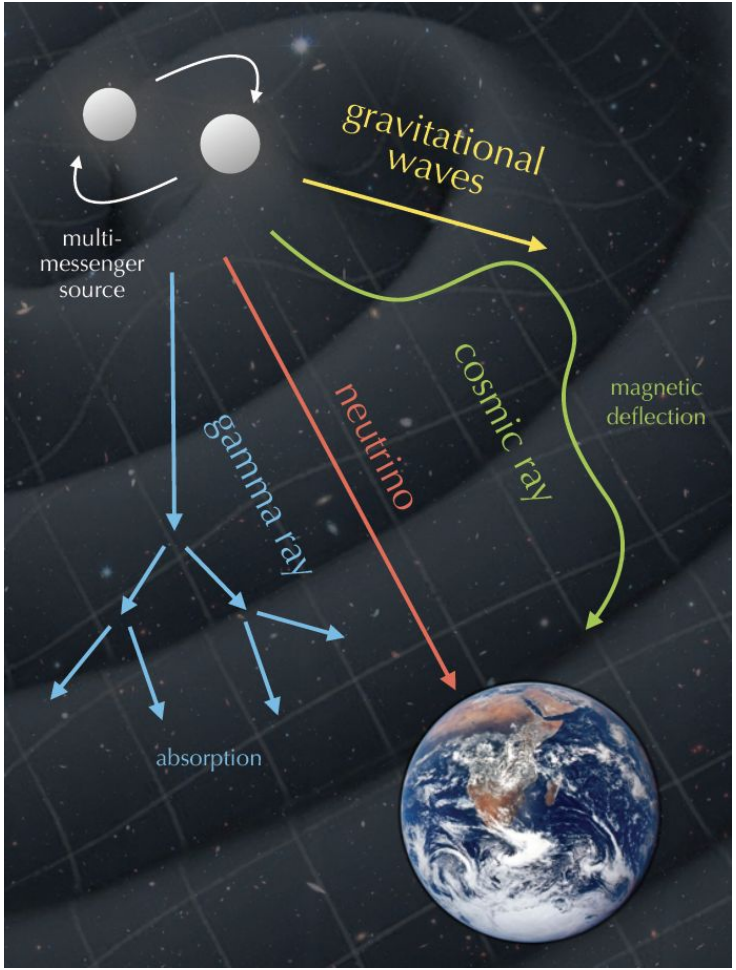
Multi-wavelength astronomy



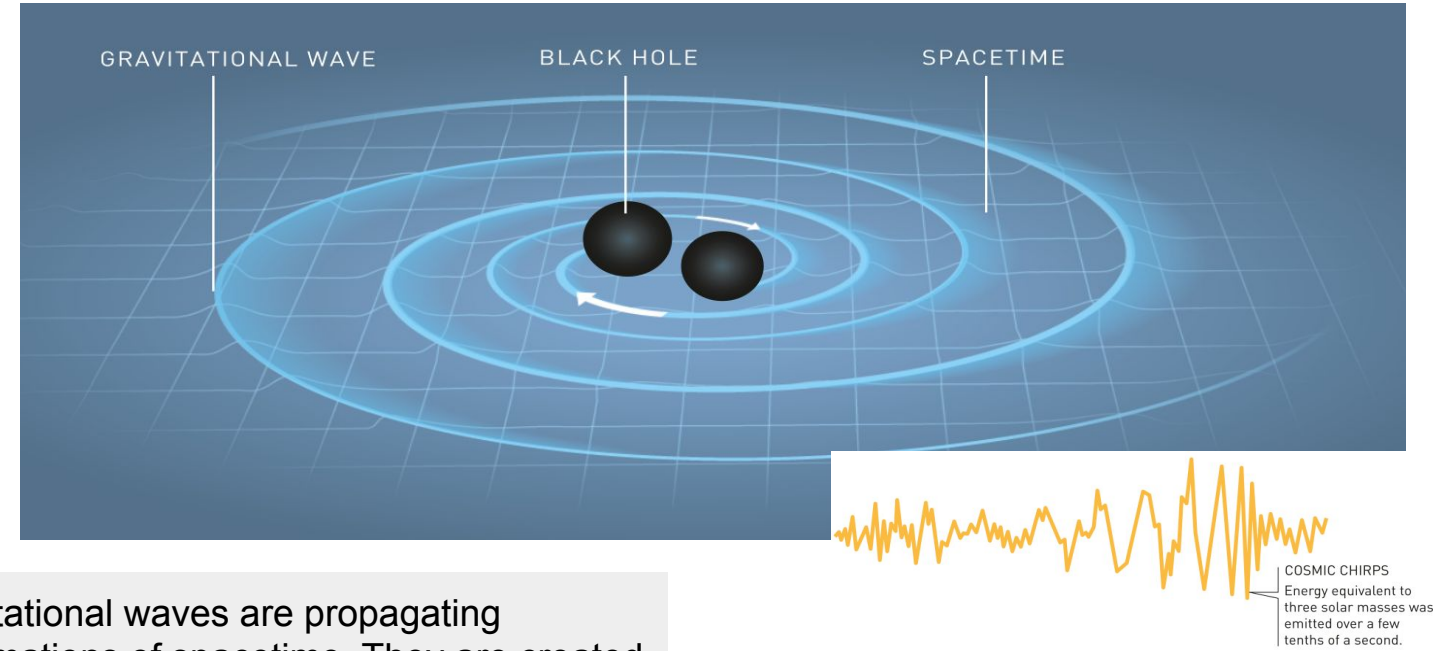
Observing celestial objects with different wavelengths gives a more complete view of all the different physical processes involved (mostly electromagnetic).

Multi-messenger astronomy

By combining observed light with other messengers (cosmic rays, gravitational waves, neutrinos), an even more complete understanding of celestial objects is available. This also allows to probe processes linked to other interactions (gravitational, strong and weak).



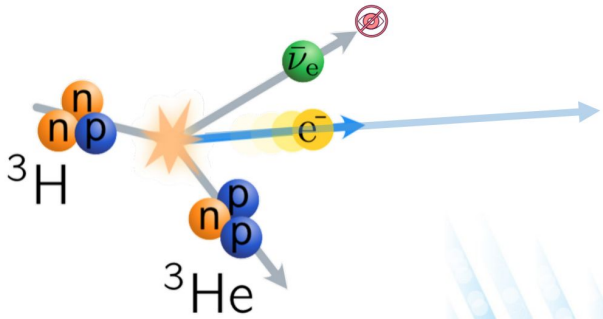
What are gravitational waves?



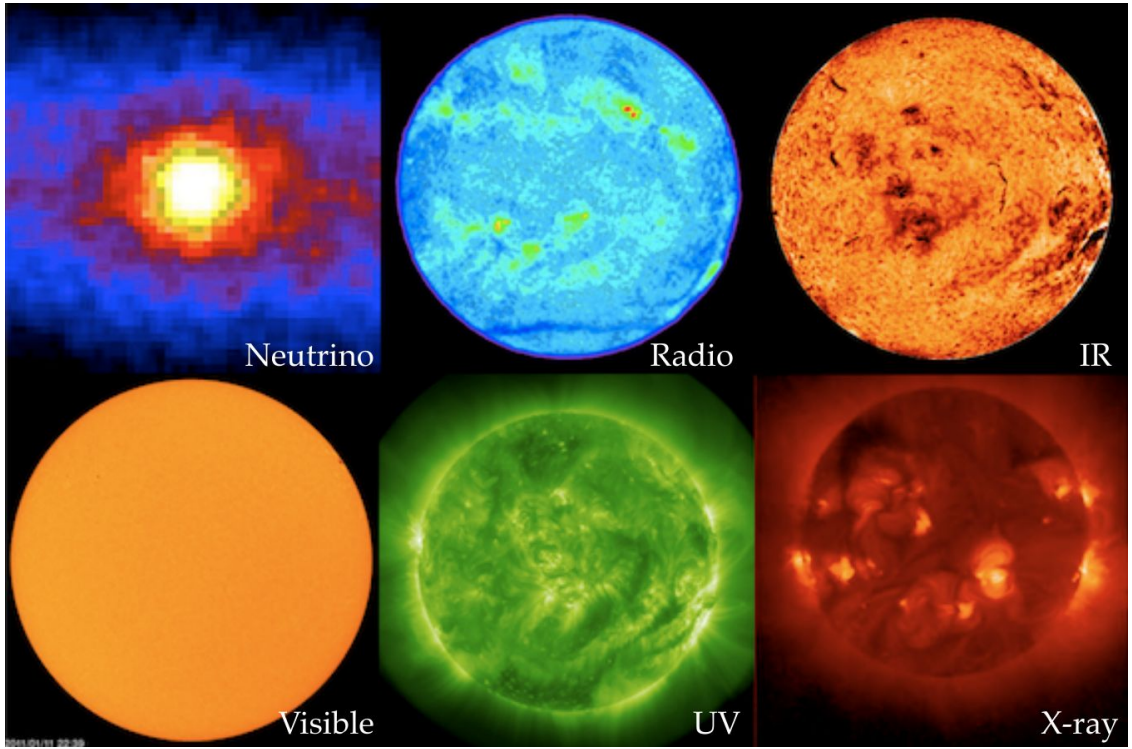
Gravitational waves are propagating deformations of spacetime. They are created when very heavy objects move in a non symmetrical manner. They give information about the released gravitational energy.

What are neutrinos?

Neutrinos are fundamental particles which only interact weakly. This means that they can go through matter, making them difficult to detect. But they are also good to probe the heart of celestial objects.

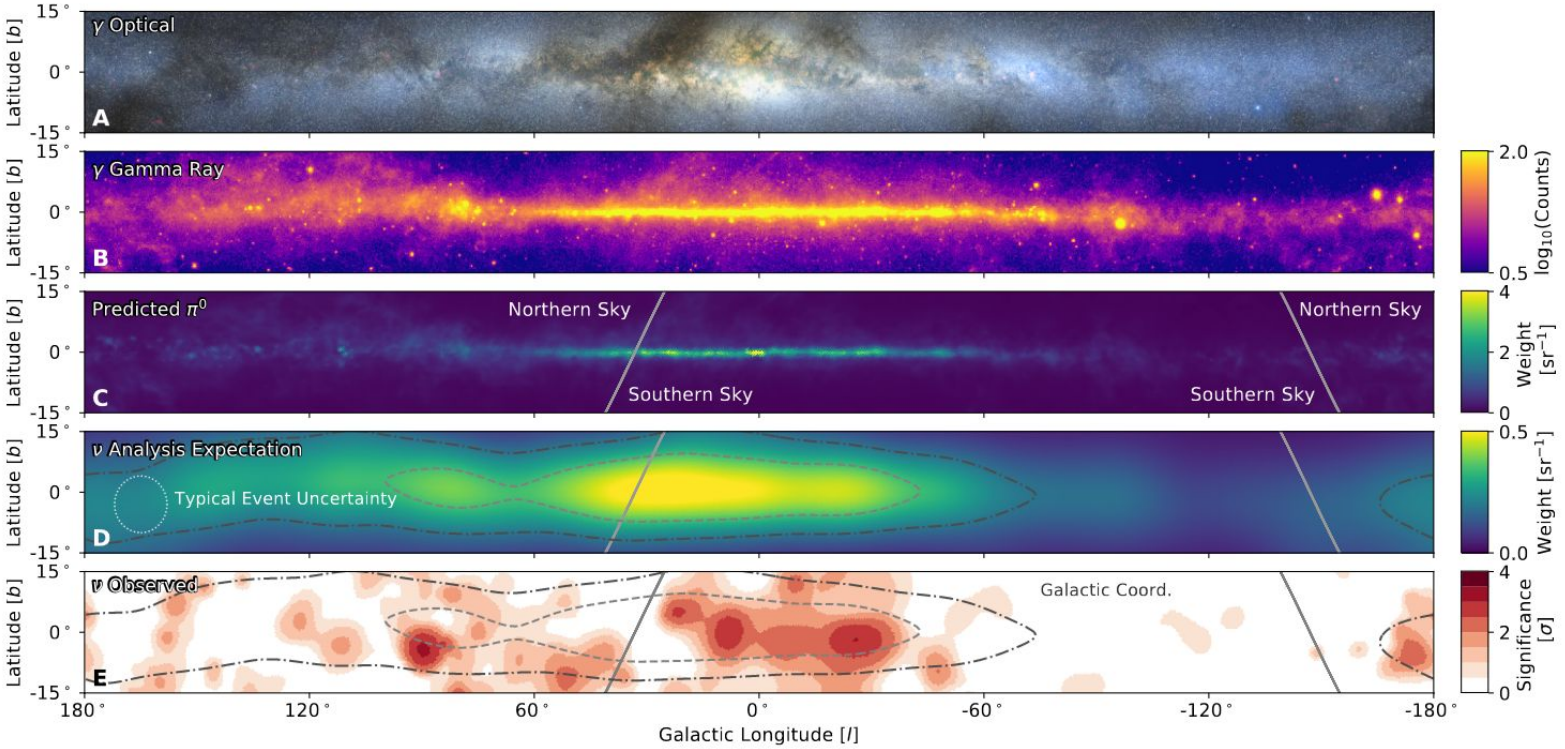


Multi-messenger observation of the Sun



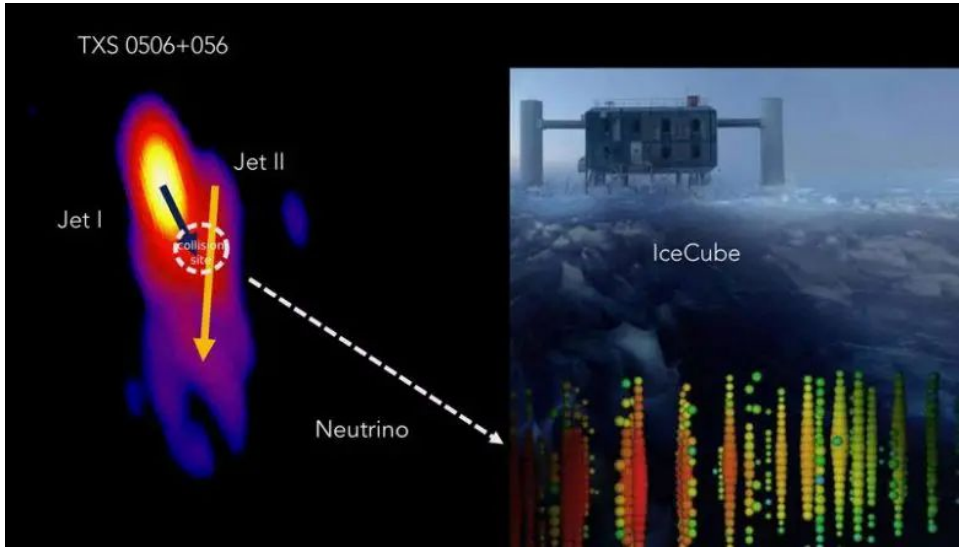
Light created in the core of the Sun takes millions of year to be able to escape, due to the high density inside. Neutrinos give a clear picture of the core, and confirm the hypothesis of the nuclear reactions powering it.

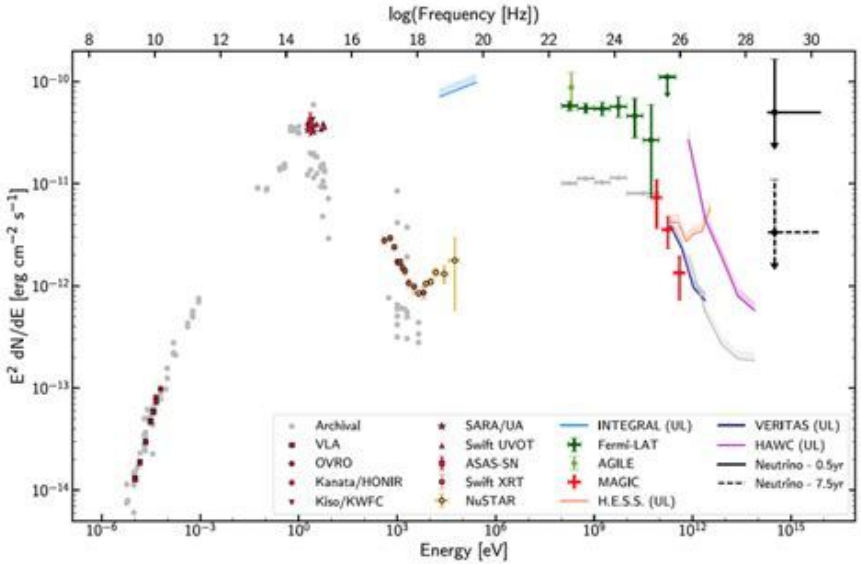
Multi-messenger observation of the Milky Way



Multi-messenger observation of TXS 0506+056

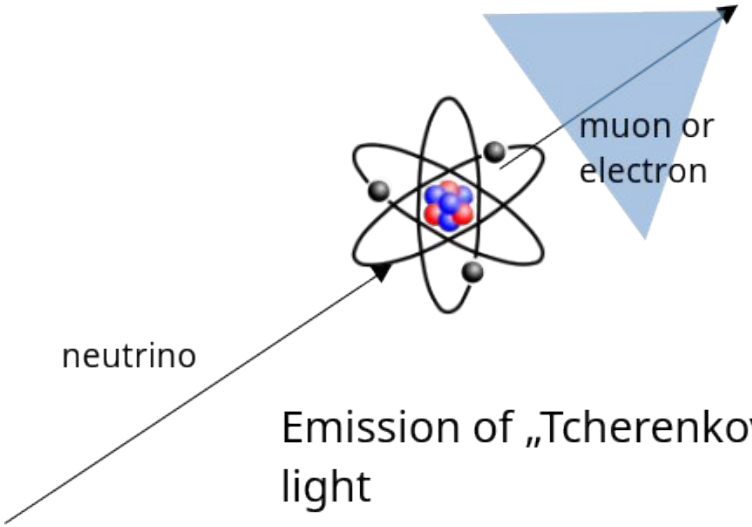
TXS 0506+056 is a very high energy blazar (very massive black hole in the center of a galaxy with its jet pointing toward us).
On September 2017, detection of an high energy neutrino with a gamma-ray flare.





How to detect neutrinos? (an example)

Indirect detection:



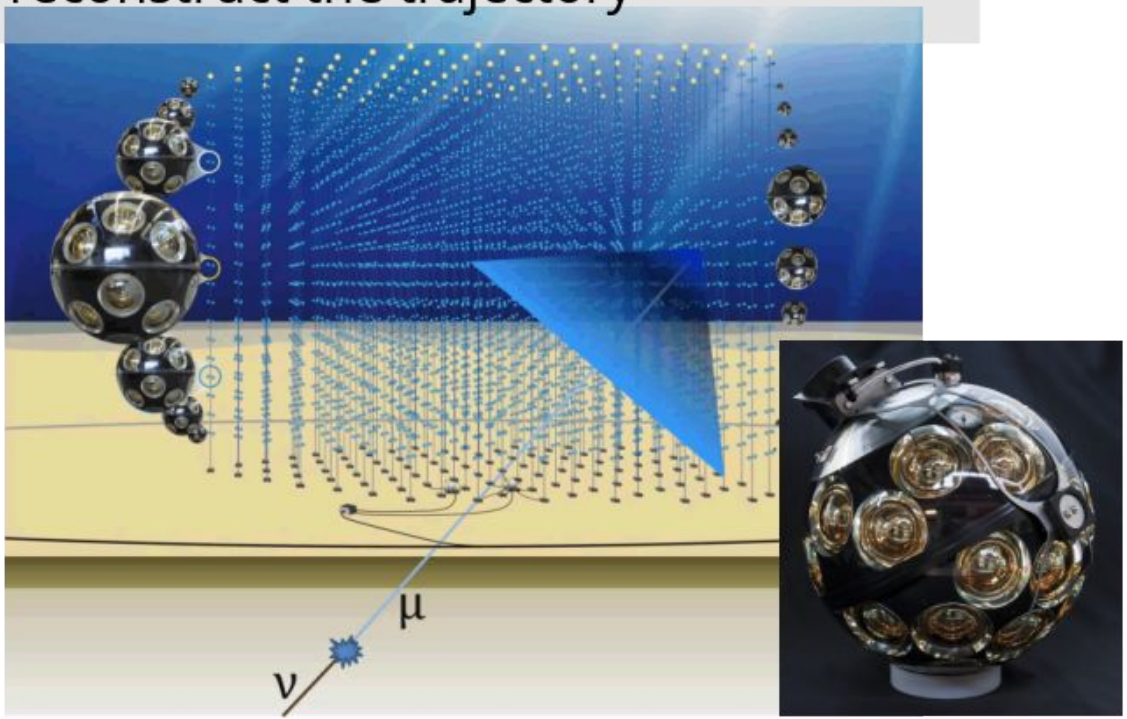
Emission of „Tcherenkov“ light

Weak interaction : we need a big volume, so we use the sea

We use Earth as a filter that only let neutrino pass

Neutrino detection with KM3NeT

3D grid of light detectors to reconstruct the trajectory



2 detectors planned:

115 lines (200 m) in front of Toulon at a 2500 m depth (ORCA)

230 lines (800 m) in front of Sicily at a 3500 m depth (ARCA)

Every line contains 18 „optical modules“

How to build underwater?

Pros of a detector in the sea :
- Easy to have a big volume
- Transparent medium
- At this depth, obscurity

Cons:
- 250 to 350 bars of pressure
- Corrosion due to the salt
- Sea currents
- Need for a wave-less sea to deploy