Which CBs Could be Transformed in the Known Sources of GWs
or
On the Possible Progenitors of GW Sources

Nino Kochiashvili

Senior Scientist of the Abastumani Observatory

Observatoire de la Côte d’Azur, Nice, May 30, 2022

Unexpected things...

- Persons may have unfulfilled dreams and sometimes vice versa ...
- February 11, 2016 …
- I could not imagine that I could do any aspect of studying gravitational waves, I just noticed that quite massive black holes had merged. But in this millennium, events in the world and in science are moving in an unexpected direction
- GRANDMA

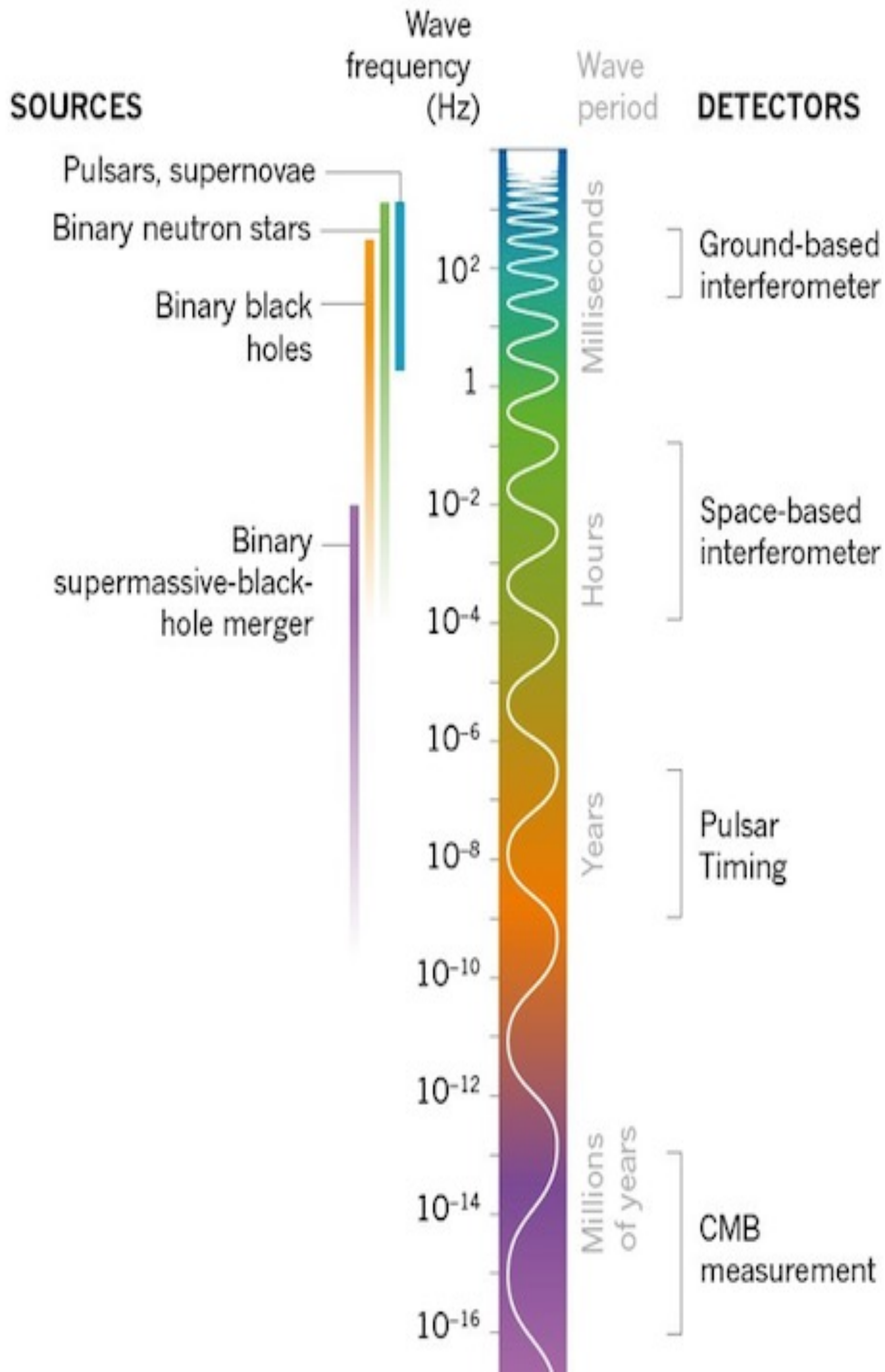
- My presentation today is dedicated to the incredible high masses of massive Close Binaries (CBs) and mergers that actually exist in the Universe...

GWs and some of the Universe's deepest mysteries...

April, 2018 – a year before O3

- insight into the origins of the Universe’s black holes;
- the extreme conditions inside neutron stars;
- a chronicle of how the Universe structured itself into galaxies;
- and the most-strictest tests yet of Albert Einstein’s general theory of relativity.
- Gravitational waves might even provide a window into what happened in the first few moments after the Big Bang.
- + expectations on accelerating expansion… +…

- Lack of black holes at the low-mass end… And at the high end — around 50 times the mass of the Sun — researchers expect to see another cut-off. “(Castelvecchi, D.; Nature, 2018, v 556, p. 164)



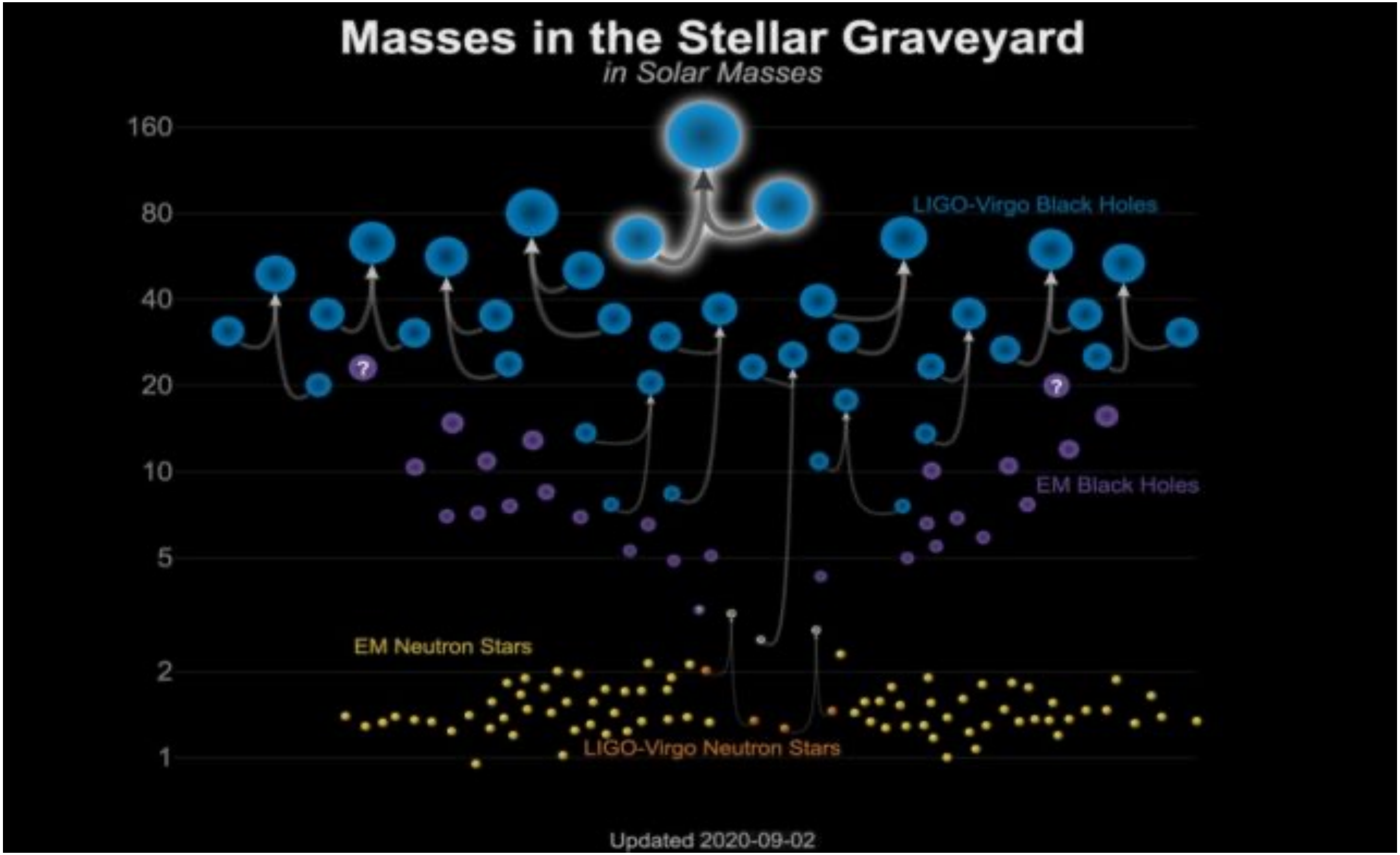
Future generations of ground-based gravitational-wave observatories may allow researchers to determine the equation-of-state of the highest density matter, to detect dark matter around black holes, and to test modified theories of gravity.

However, Earth-based instruments available for the O4 season will still use the GW spectrum from ∼ 10Hz to ∼ 10 kHz, which is consistent with compact objects with stellar masses (Bailes, et.al, 2021).

The mergers before merging

Obviously, during the preparation of the LIGO project, for to "recognize" the mergers from the interferometer data, the possible parameters, and corresponding models of the last stages of the compact binaries' evolution of any mass are pre-processed and taken into account (see e.g. Abbott, et.al, Phys.Rev.Lett., 125, 101102, 2020)

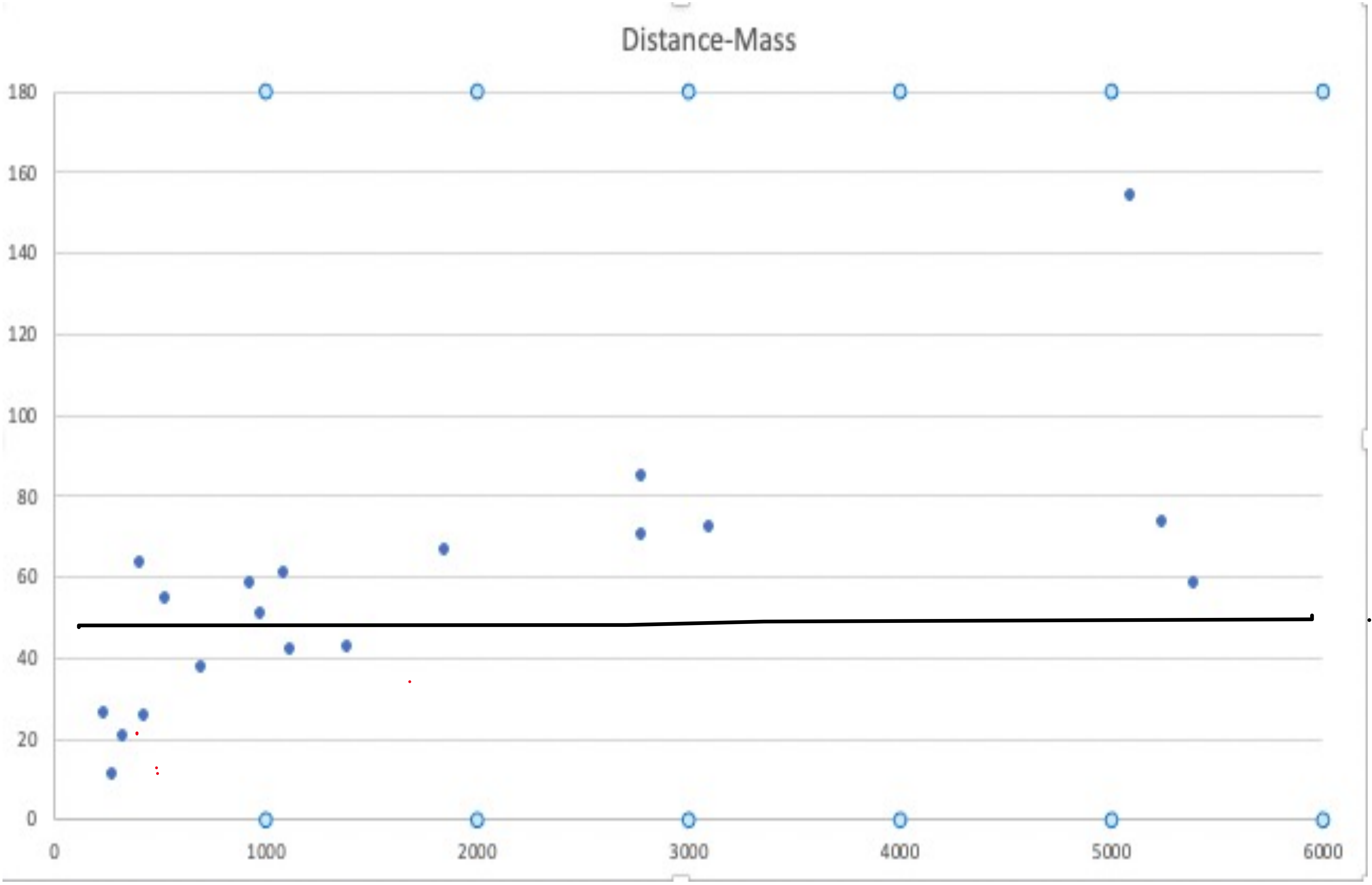
Here they are – the LIGO-Virgo mergers after the O3



After LIGO-Virgo O3 run we have at least 12 mergers with higher then 50 solar masses…

- "most of the compact binary mergers detected by LIGO and Virgo are expected to consist of firstgeneration black holes formed from the collapse of stars, others might instead be of second (or higher) generation, containing the remnants of previous black-hole mergers.
- Such a subpopulation of hierarchically assembled black holes presents distinctive gravitational-wave signatures, namely higher masses, possibly within the pair-instability mass gap, and dimensionless spins clustered at the characteristic value of ∼ 0.7. In order to produce hierarchical mergers, astrophysical environments need to overcome the relativistic recoils imparted to black-hole merger remnants, a condition which prefers hosts with escape speeds ~ 100 km/s.
- Promising locations for efficient production of hierarchical mergers include nuclear star clusters and accretion disks surrounding active galactic nuclei, though environments that are less efficient at retaining merger products such as globular clusters may still contribute significantly to the detectable population of repeated mergers. While GW190521 is the single most promising hierarchical-merger candidate to date, constraints coming from large population analyses are becoming increasingly more powerful." (Gerosa & Fishbach, 2021 and list of literature there).
- We can see the most massive stars in our galaxy and in Magellanic Clouds exactly in the clusters like this.

Let us look at the distance-mass relation

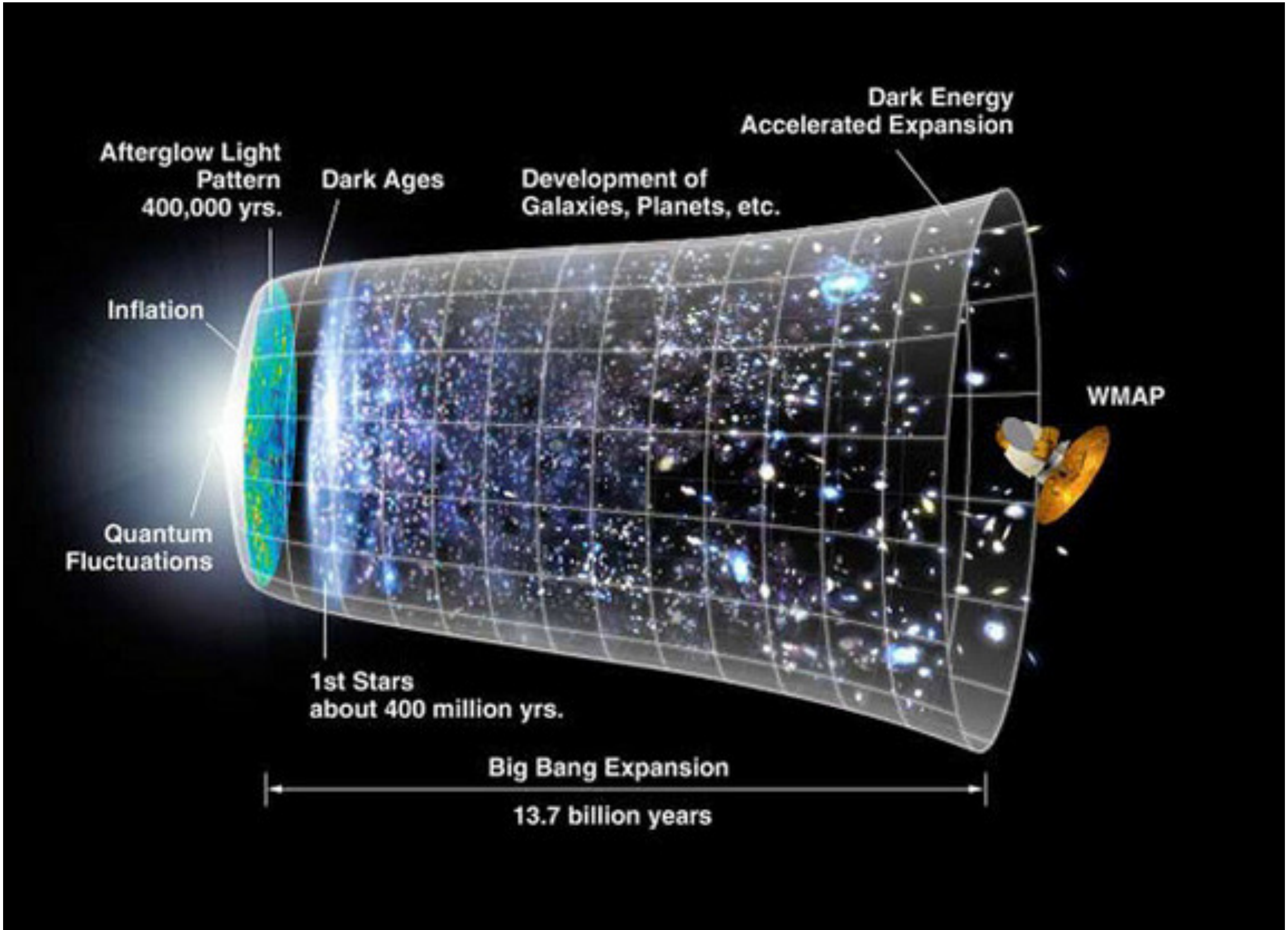


These high mass BHs initially was one more unexpected thing in the science, but…

- Because of the Eddington Limit, we could not have imagined (until the beginning of this millennium) that a star more massive than 120 solar masses could exist in the universe, except for the so-called "Primordial" III population Stars. Until we found stars 300 of solar masses in the Tarantula Nebula (LMC) and even in MW.
- There are a few groups who are working on evolutionary models of the most massive stars using chemical abundances lower than the solar one.
- And I could not find any new models about progenitors of so massive BHs, though they are publishing some new works dedicated to GWs…

- I think now is a time to speculate on the bigginning point of the Big Bang…

Instead of this….



Let’s imagine…

Thank you for your attention!

☺