Gravitational waves

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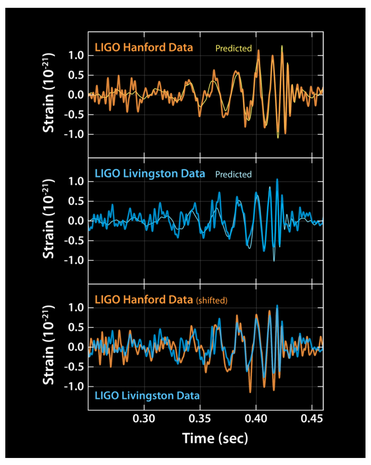
LIGO and the first detections of GW

- 2 detectors (Handford/Washington, Livingston/Louisiana)
- 2-arm-detector on Earth, each arm 4 km long
- Effective in a high-frequency band $f \in [10, 10^4]$ Hz

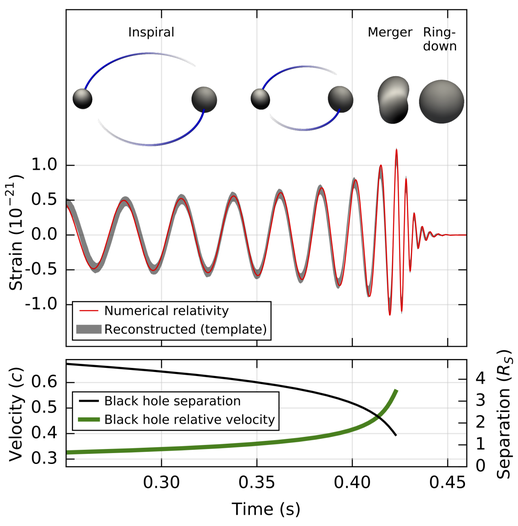
GW150914: First direct detection of GW

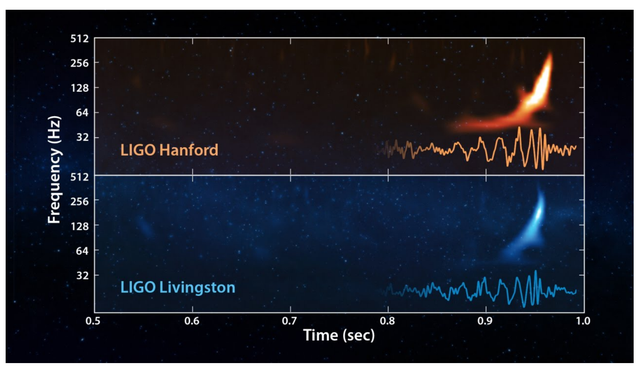
P. Abbott et al., PRL 116, 061102 (2016)

BH merger (36 $M_\odot$ and 29 $M_\odot$ merged into a 62 $M_\odot$ BH, with 3 $M_\odot$ radiated in GW)



The simulated waveforms (fine lines) are in perfect agreement with the measurement (bold lines)



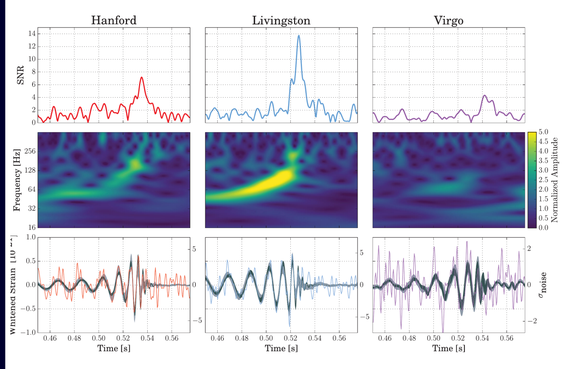


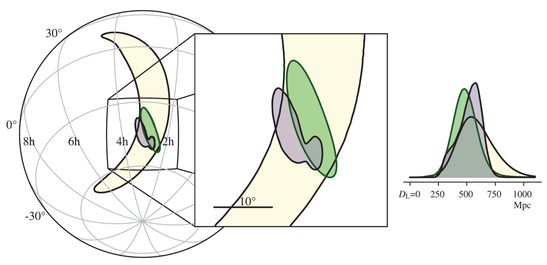
Characteristic chirp from the merger. The signal was detected with a 10ms time intervall between the two sites, due to the propagation time of the GW

GW170814: First detection with 3 detectors

P. Abbott et al., PRL 119, 141101 (2017)

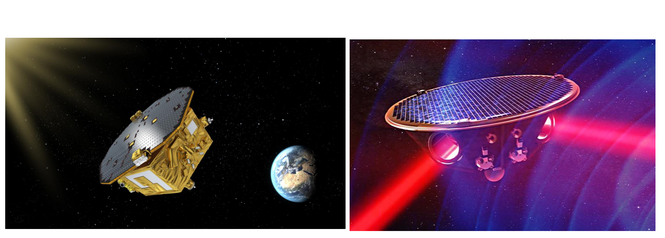
- Network of 3 detectors (LIGO in the USA and VIRGO in Italy)
- Allows to improve the localization of the source



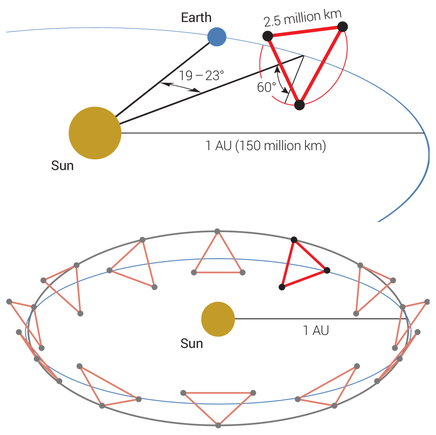


LISA and LISA Pathfinder

- Next ESA L3 mission (~2034)
- Interferometer in space with 3 satellites (3 times 2 laser links)
- Arms of ~2.5 millions km
- Effective in the low-frequency band $f \in [10^{-4}, 10^{-1}]$ Hz

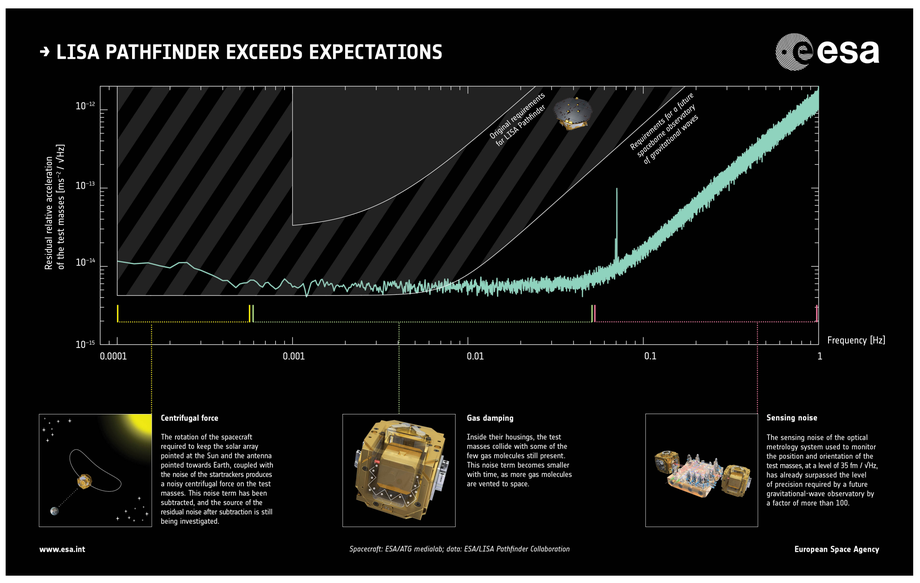


One of the satellites as tested with the LISA Pathfinder mission (left), without the laser links. On the right, satellite concept including the arms of the interferometer.



LISA Pathfinder

- Test the technology of LISA (16 months, until 17.07.17)
- 2 metal cubes in free-fall: shielding
- Relative position of the cubes up to 1pm



Multimessenger astronomy

P. Abbott et al., PRL 119, 161101 (2017)

P. Abbott et al., ApJL 848, L13 (2017)

- GW170817: Binary neutron star
- Detection of GW and the so-called EM counterpart (GRB, etc.)
- Future: combination of GW and EM observations, possibility to predict the merger in advance thanks to GW