Contribution ID: **13** Type: **Contributed Talk**

Potential biases and prospects for the Hubble constant estimation from a joint EM and GW analysis of neutron star merger

Thursday, 5 October 2023 15:30 (15 minutes)

GW170817 is an outstanding event as it paved the way for multi-messenger astrophysics. It is a binary neutron stars merger, that saw the detection of a gravitational wave (GW), a gamma ray burst (GRB) and an afterglow. Such events are interesting also from a cosmological point of view, as we can derive an Hubble constant (H_0) measurement (the current expansion rate of the Universe), independently from any cosmic distance ladder. In this work we estimate H_0 using the broad band afterglow emission and the relativistic jet centroid motion from the very-large-baseline interferometry (VLBI) and HST images of GW170817. Compared to previous attempts, we join these two messengers with the GW in a simultaneous Bayesian fit. We focus on the H_0 estimation robustness depending on the unknown jet structure and the possible presence of a late time flux excess. We find $H_0 = 70.1^{+4.6}_{-4.4}\ km/s/Mpc$, a viewing angle of 18 deg and a distance of 44 Mpc, fitting the complete data set. This H_0 measure is about 3 times more precise than a GW-only estimation. Not including the jet motion in the analysis, the H_0 posterior peaks above 90 $km/s/Mpc$, because of the preference for high viewing angles, caused by the possible presence of a late-time excess in the afterglow flux. In general, the afterglow, no matter the jet structure, tends to prefer high viewing angles, leading to an unreliable H_0 measurements. Therefore, careful modeling of the afterglow is needed. Moreover, the larger the number of counterparts included in the analysis, the more robust and reliable is H_0.

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Session Classification: Multimessenger view of neutron stars: from pulsars to GRBs