Report from the Cosmology / Hubble Constant break-out session

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for Patrick Brady, Hsin-Yu Chen, Ryan Foley,
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Christopher Stubbs, Salvatore Vitale (90% confidence)

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Ways to get at H_0 with GW events

Approach #1: Identify EM counterparts to GW CBC events

Infer distance from GW signal

Measure redshift of host galaxy (if not already known) with optical obs, or try to measure redshift of kilonova itself if it does not have a host

Approach #2: Statistically associate GW CBC events with galaxies

Using pre-existing galaxy catalog,
or using galaxy catalog generated on demand for that region
(maybe using survey data that has already been collected)

Measure redshifts of possible host galaxies (if not already known) with optical obs

Infer distance from GW signal, with each galaxy as hypothetical host

Issues for approach #1

Assumes that you have an unambiguous counterpart, and that its redshift is measured

Issues for approach #2 (statistical)

To do this, need to know 3D distrib. of possible source locations

- Not just a matter of having a catalog of galaxies and their luminosities
- It's nontrivial to go from galaxy types and colors to stellar mass; consider age too
- There likely are, or can be, better catalogs than the current public ones
- Would LVC need to negotiate for this, or is it enough to just point out that it would be valuable?

In principle, being able to include BBH mergers is an advantage, but in practice, most of them are so far away that there are lots of galaxies they could be associated with ➔ little or no information about the BBH's actual redshift

- Even if you know the redshifts of all those galaxies
- So distant events have negligible impact in the statistical analysis

Issues for both approaches

Major uncertainty in measuring distance from GW is due to degeneracy with inclination angle

- GW data cannot determine inclination if it's anywhere near face-on, regardless of how many GW detectors are in the network
- (Has to be inclined ~45-60 deg before polarization deviates from circular by a measurable amount)

One way to break degeneracy: take advantage of precession

- From black hole spin; precession modulates GW signal

Another way to break degeneracy: use EM counterpart data

- Requires modeling of light curves as a function of inclination, other params ➔ expertise is essential. Internal or external to LVC?
- Could combine that properly with GW-derived likelihood on inclination, before marginalizing
- Can combine likelihoods from many EM data sets

Who does what?

There are likely to be multiple papers with H_0 determinations from a given data set

- Some from using preliminary GW distance, but also different analyses (with modeling) of same final data sets?
- Invite everyone to contribute to one joint paper?
  Has downsides (big machinery, long author list), but equitable

What is the main objective of LVC? To deliver $h(t)$ or $H_0(t)$?

What motivates astronomers? Is it enough to identify counterpart and obtain light curves which are used (and cited) by others?

What's best for the science is for people with deep knowledge of the inputs and systematics to do the analysis

- Is kilonova modeling in scope for the LVC?
- OK for LVC to want to do science that it doesn't (currently, at least) have the expertise to do fully? Well, didn't know how to do GW data analysis
- Maybe write a white paper describing what it takes to do this science well