Communications and Interactions across MMA Observatories

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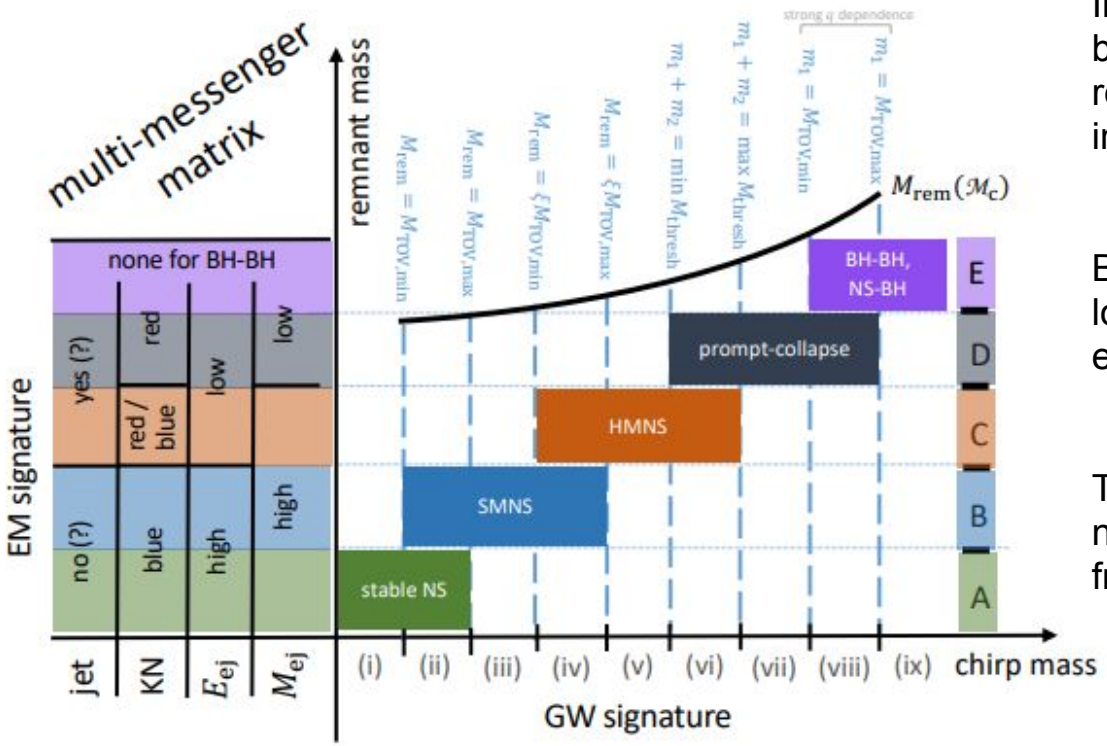
Why we need more (and better) inter-Observatory comms.

1. Sharing adequate classification information in real-time is extremely helpful for follow-up teams trying to efficiently allocate telescope resources.
    a. chirp mass-->Multi-messenger Matrix : Margalit + Metzger (2019)
2. Localization regions of GRBs and GWs are often very large and thus require coordination and information sharing between follow-up groups to search efficiently and effectively.
    a. GCN ---> TACH (?)
    b. Gravitational Wave Treasure Map
    c. Scalable Cyberinfrastructure to support Multi-Messenger Astrophysics (SCIMMA)
3. Due to the differing instrumental horizons as well as intrinsic luminosities of events across messengers, the expected yield of joint sub-threshold searches is extremely promising. These types of searches require sharing of data, and cooperation, at scales not currently the norm.
    a. Astrophysical Multimessenger Observatory Network (AMON)
    b. LVC/Fermi/Swift joint-subthreshold MoU



Margalit, Metzger (2019)

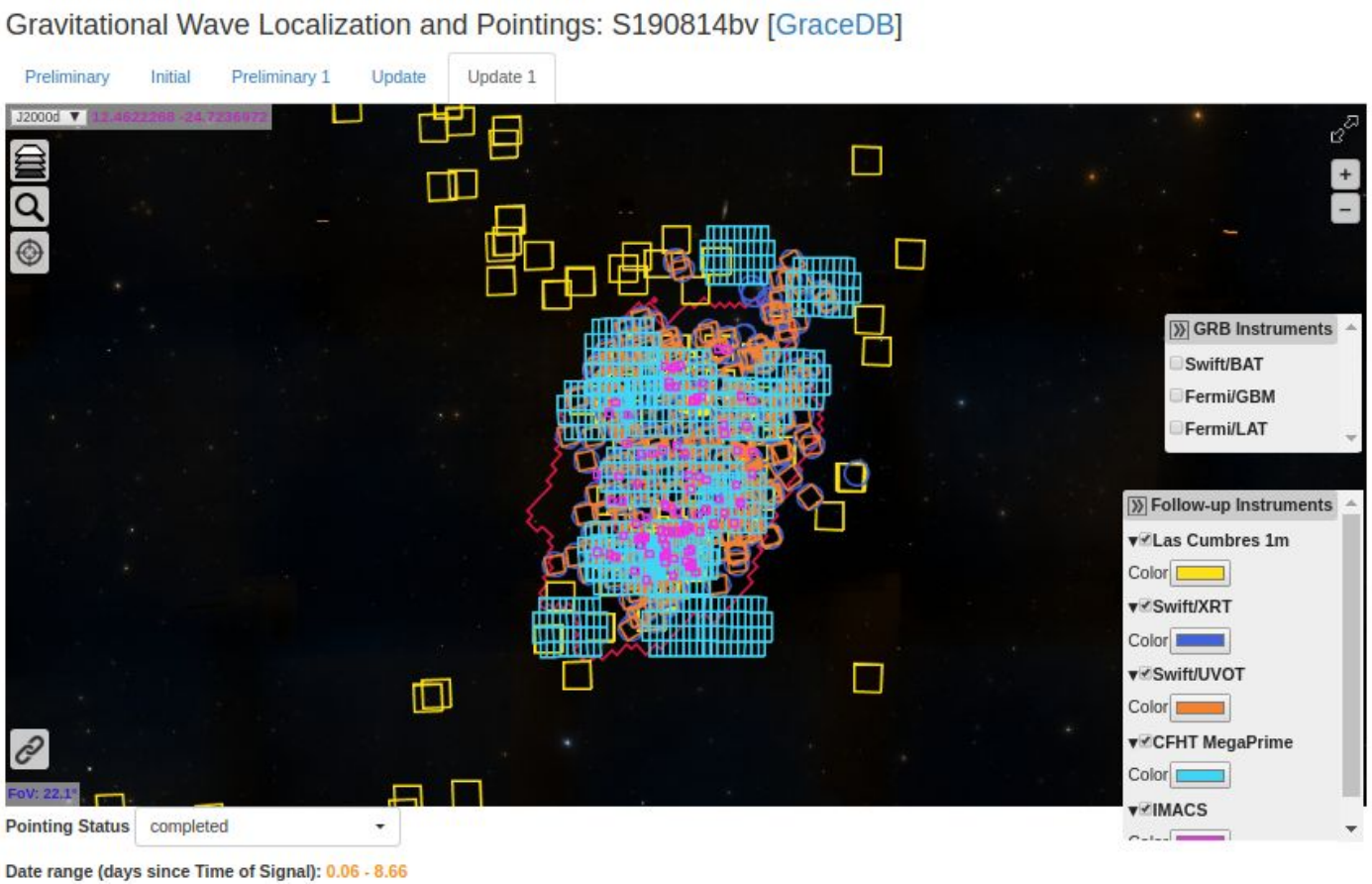
In the O4 ++ era, BNS/NSBH detections will begin to overwhelm our available follow-up resources. Hence require more distinguishing info (eg chirp mass) for promising candidates.

Biscoveanu (2019) demonstrated that low-latency parameter estimation is accurate enough to enable this type of decision making.

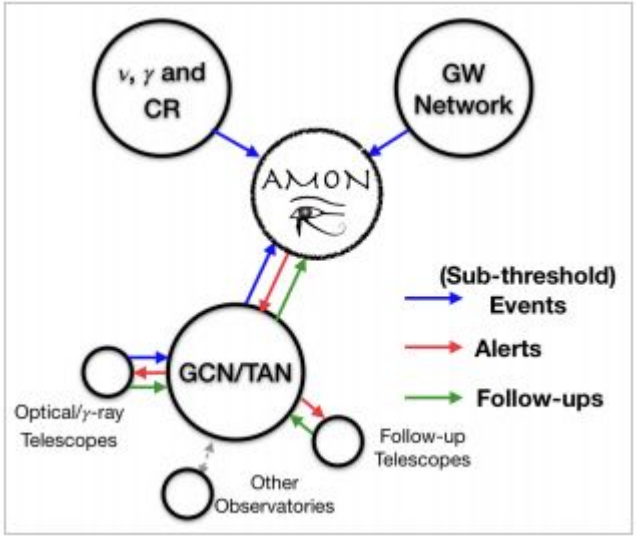
Trigger instruments will need to release necessary information. This requires pressure from the follow-up community.

Gravitational Wave Treasure Map (http://treasuremap.space)

Wyatt, AT, et al. (arXiv: 2001.00588)



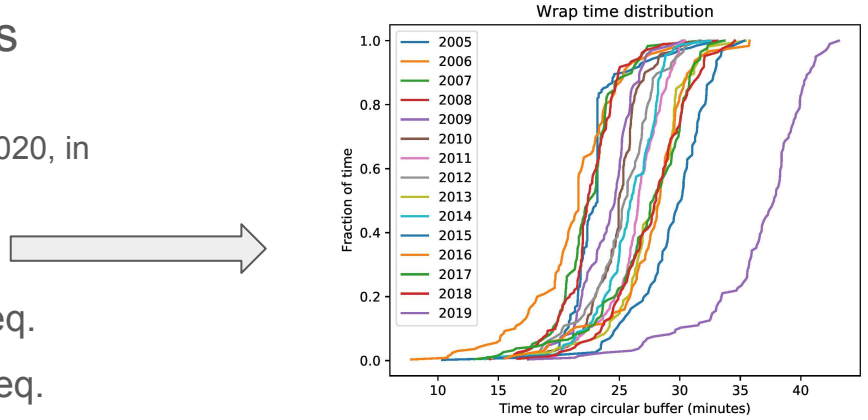
Sharing (more) information!

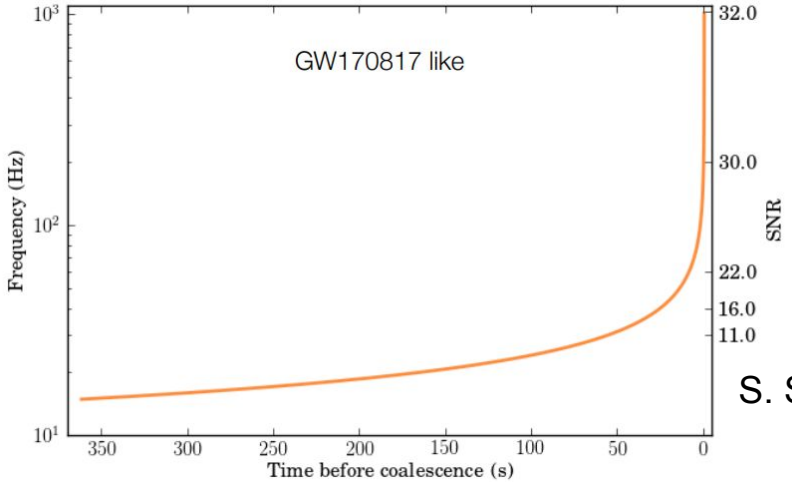


- Joint sub-threshold MM searches
  - GRB/GW searches significantly extend the GW horizon for on-axis sources, and the GRB horizon for off-axis sources
- joint (coherent GRB) searches
  - Coherent GRB searches across multiple missions will dramatically enhance sensitivity: “The network is the Observatory” - K. Thorne
- IPN like localizations across GRB detectors
  - Faster
  - Machine-readable standardized localization format (HEALpix)
- Neutrino localizations in HEALPix

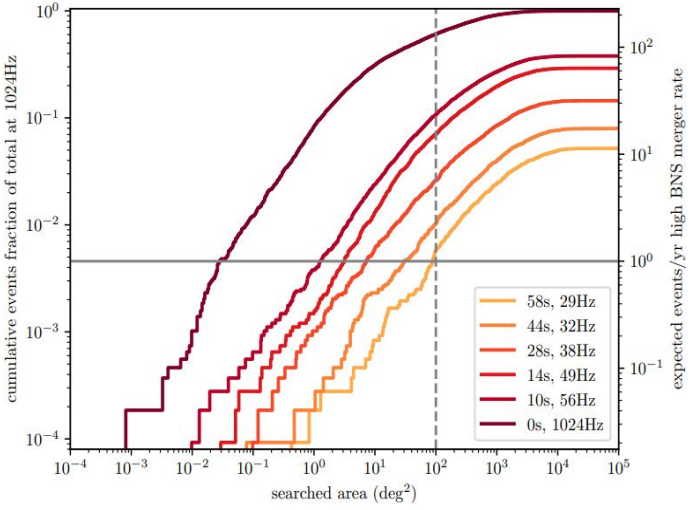
Science cases for lower-latency commanding of spacecraft

- Enabling enhanced data taking modes
  - Gamma-ray Urgent Archiver for Novel Opportunities (GUANO: AT, Kennea, Palmer (2020, in prep)
- Rapid re-pointing for
  - Very fast events (eg FRBs) - O(minutes) req.
  - negative latency GW alerts - O(seconds) req.





S. Sachdev 2019

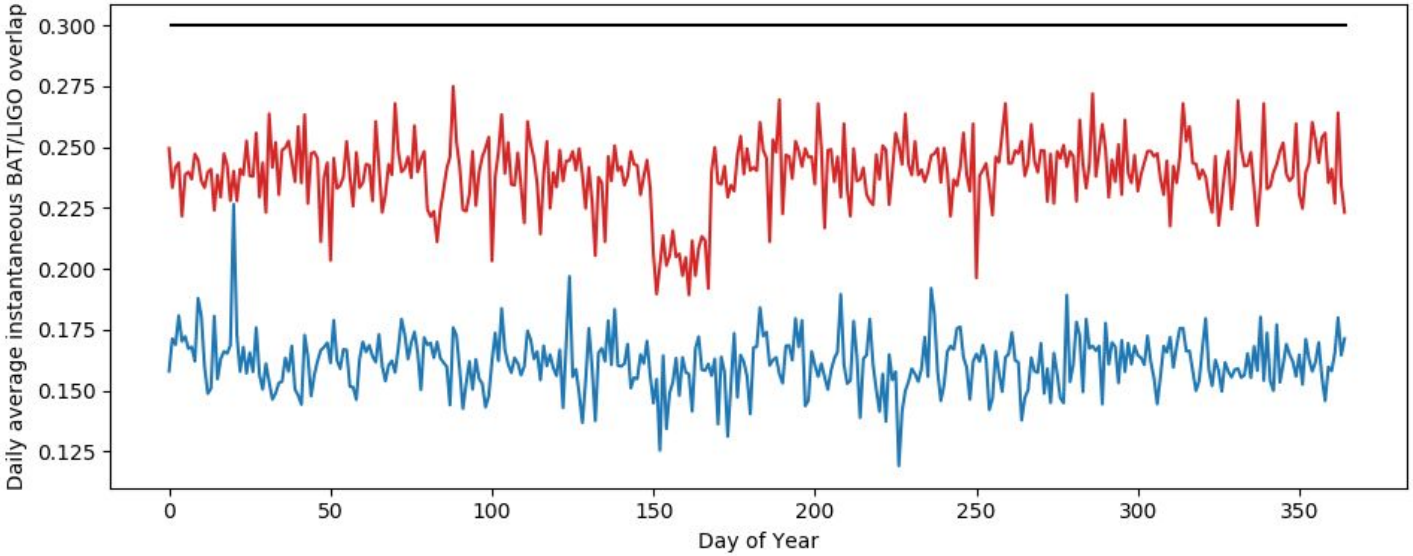


Advantages of sharing scheduling info:

Chasing the LIGO lobes across the sky:

Increasing the Coincident GW/GRB yield with Swift/BAT biasing

(AT 2020, in prep)



Direct quote from me in the conclusions of the Report:

Many of the multi-messenger science cases in space require not only instruments sensitive in particular wavelengths and with sufficient sensitivities, but also operational capabilities such as extremely rapid commanding to enable ultra rapid re-pointing and enhanced data taking modes. Such capabilities require both communications and commanding infrastructure, as well as flexible scheduling of the ground segment, to enable them. It is important that enhancement be made to the autonomous and real-time capabilities of the TDRSS network, and adequate attention be paid to the development of flexible and autonomous observation scheduling software for mission ground segments, to be able to maximally utilize next generation space based observatories.