



Multi-band GW astrophysics

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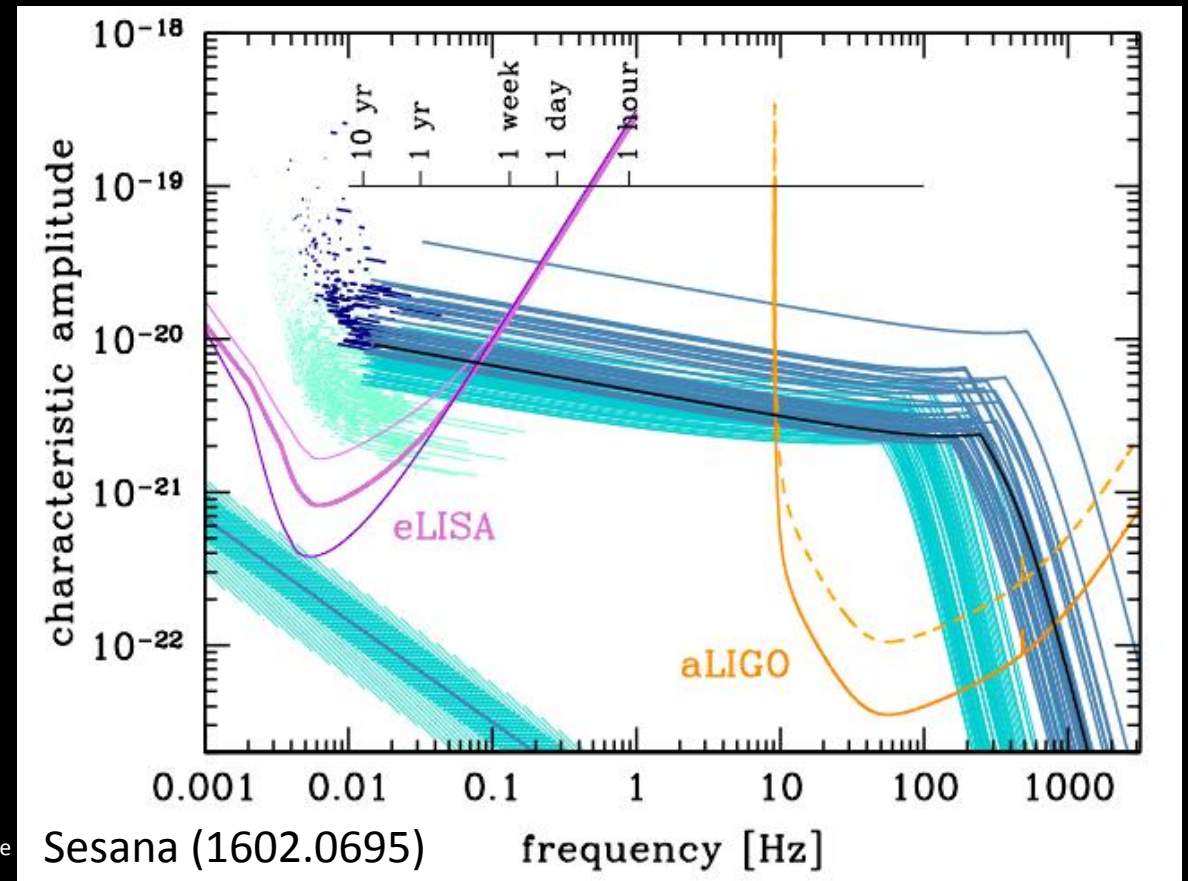
Reporting on others' work too

GWDAW, May 26th 2016



What GW sources are multi-band?

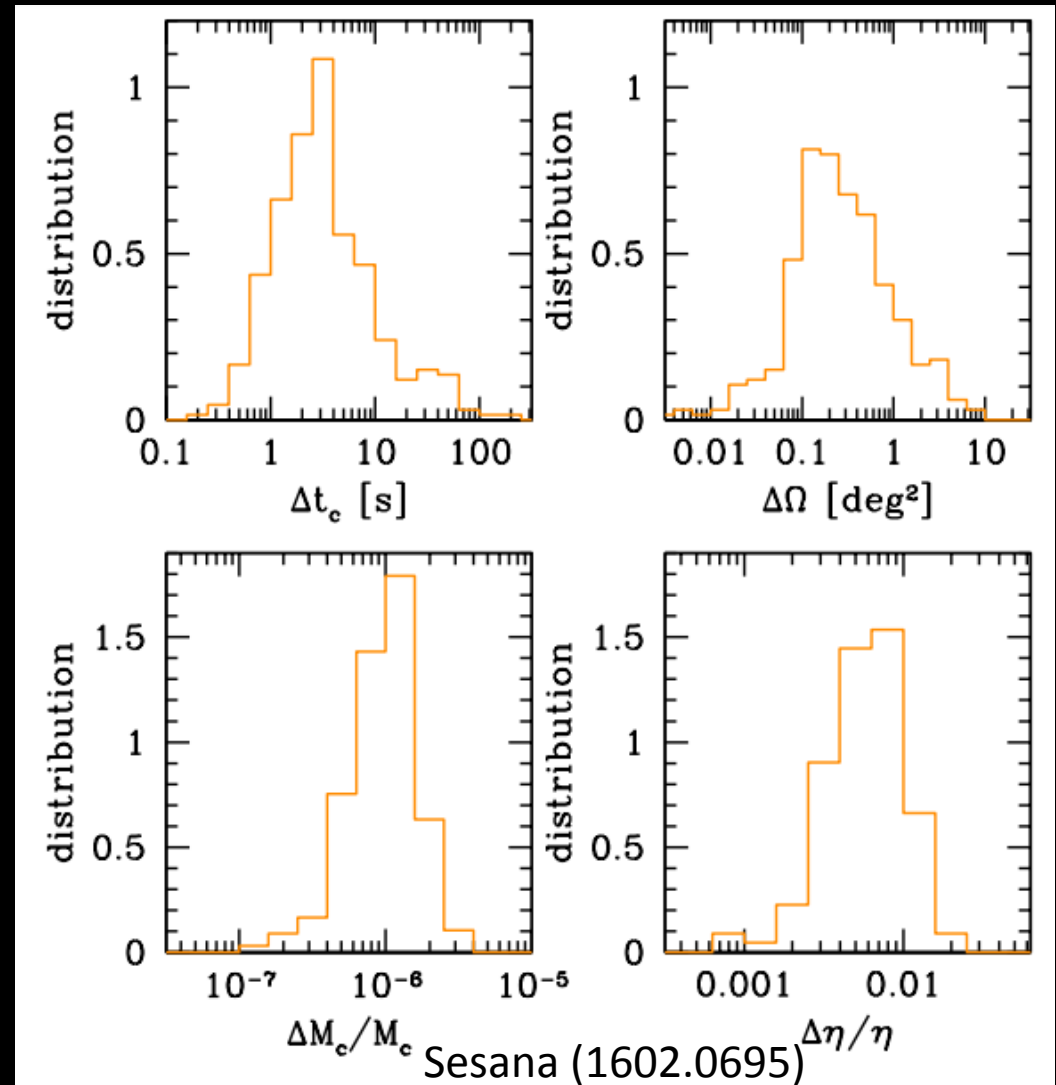
- Recently realized by Sesana (1602.0695) that heavy BBH such as GW150914, and louder would be visible in eLISA band weeks to years before they coalesce in the band of ground based detectors





Why is that useful?

- Pre-merger alerts!
- eLISA would provide coalescence time and sky position well before merger
- Telescopes will know when and where to look
- Ground based detectors will be on science mode





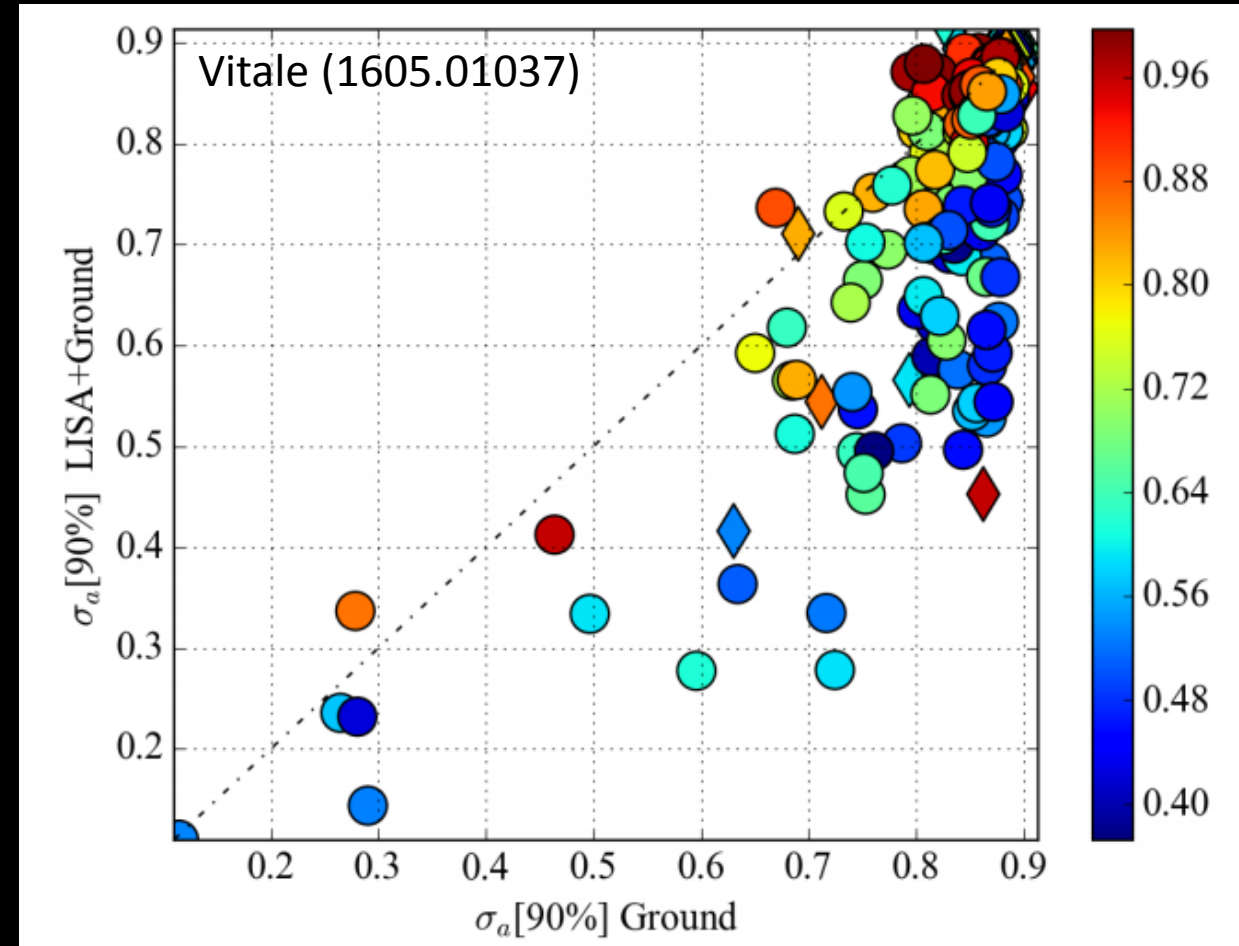
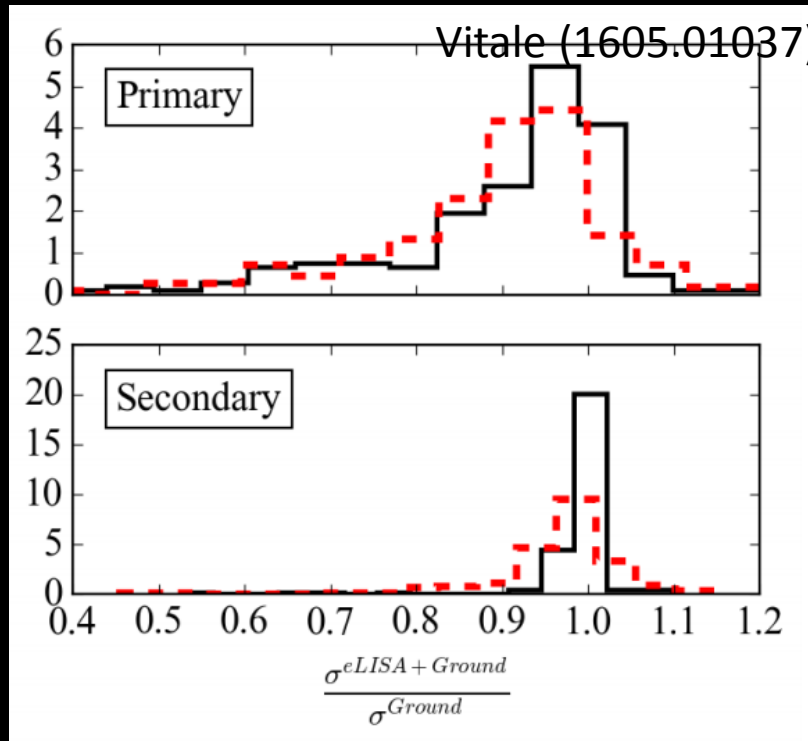
Multi-band parameter estimation

- But we can do more! (Also, not yet sure BBH are EM bright)
- Use parameter estimation from eLISA as prior for ground based analysis
- In Vitale (1605.01037) it is shown how that can significantly improve source characterization
 - Assume eLISA gives estimates of mass ratio and chirp mass estimates with uncertainties above
 - Assume eLISA won't give any spin constraints



Spin estimates

- Using prior eLISA mass estimates can reduce spin magnitude uncertainties by up to a factor of 2
- Large improvement for large mass ratios





Mass estimates

- Mass estimate is so good with eLISA that ground based will not be able to improve it
- But since eLISA provides mass estimates while ground based hear the last few cycles, we get much better characterization of the *final* black hole
 - Mass estimate of the final BH 1 order of magnitude better than with ground based alone
 - Spin estimates of the final BH factor 2 better
- Note: eLISA's mass estimates can be much better than ground based

Tests of GR

- Barausse+ (1603.04075) shows how some specific tests of GR (dipole GW emission) can be improved by orders of magnitude relative to *current constraints*, and factor of few relative to eLISA alone
- Vitale (1605.01037) shows how Post-Newtonian tests with eLISA+ground would be a few tens of percent better than with ground based alone
- eLISA: early inspiral, ground-based: merger+ringdown
 - Ideal for inspiral-merger-ringdown consistency tests
- eLISA+ground will lead to exquisite characterization of the final black hole
 - Can test some non-GR theories like axions clouds

Conclusions

- Heavy BBH have to potential to start multi band GW astrophysics
 - Improves estimates of spins and final BH properties
 - Improves test of GR
- Nishizawa+ (1605.01341) shows how eccentricity could also be measurable with eLISA for those systems
- Need the best eLISA possible
- Considered eLISA+2G, but similar conclusions apply to >2G and new facilities.

