

aLIGO Improvements

What's next for LIGO?

BNS Range is still King

- while this isn't the only relevant metric, detection rate will continue to be our major concern and BNSs are still our most dependable source.
- if detection rate is high, emphasis will move away from BNS range
 - after the first 10s of CBC detections, we will worry more about NS EOS, etc.

Neutron Star Equation of State

- this strongly motivated science target may be within reach of an improved aLIGO
- focus is 500-5kHz
- squeezing is likely the most effective approach
 - narrowband detuning does not give any advantage over squeezing
 - changing SRM transmission has little net effect

Coating Thermal Noise

- is a serious problem for range improvements
- bigger beams are not likely a good answer
 - they will cause alignment stability
 - and would cause a long downtime to change many optics and recommission
- serious financial commitment is required on multiple fronts to address CTN through better materials
 - IBS coating material exploration
 - crystalline coating scaling

EM Follow-Up: Sky Localization

- favors high frequencies ($>100\text{Hz}$)
- rule of thumb: error box determined by 3rd best interferometer
- more and comparable detectors favor sky localization, but improving a single detector may be a viable approach if error box is “good enough”
 - similar to imaging vs. spectrography
- frequency dependent squeezing
 - short filter cavity is good enough for SL and PE

Big Black Holes

- responding to low frequency sources is challenging due to a host of technical noises
- Newtonian noise is likely higher than expected
 - cancellation techniques have been studied
 - relatively cheap, and potentially important for reaching aLIGO sensitivity (e.g., risk mitigation)
 - work here should continue as rapidly as possible

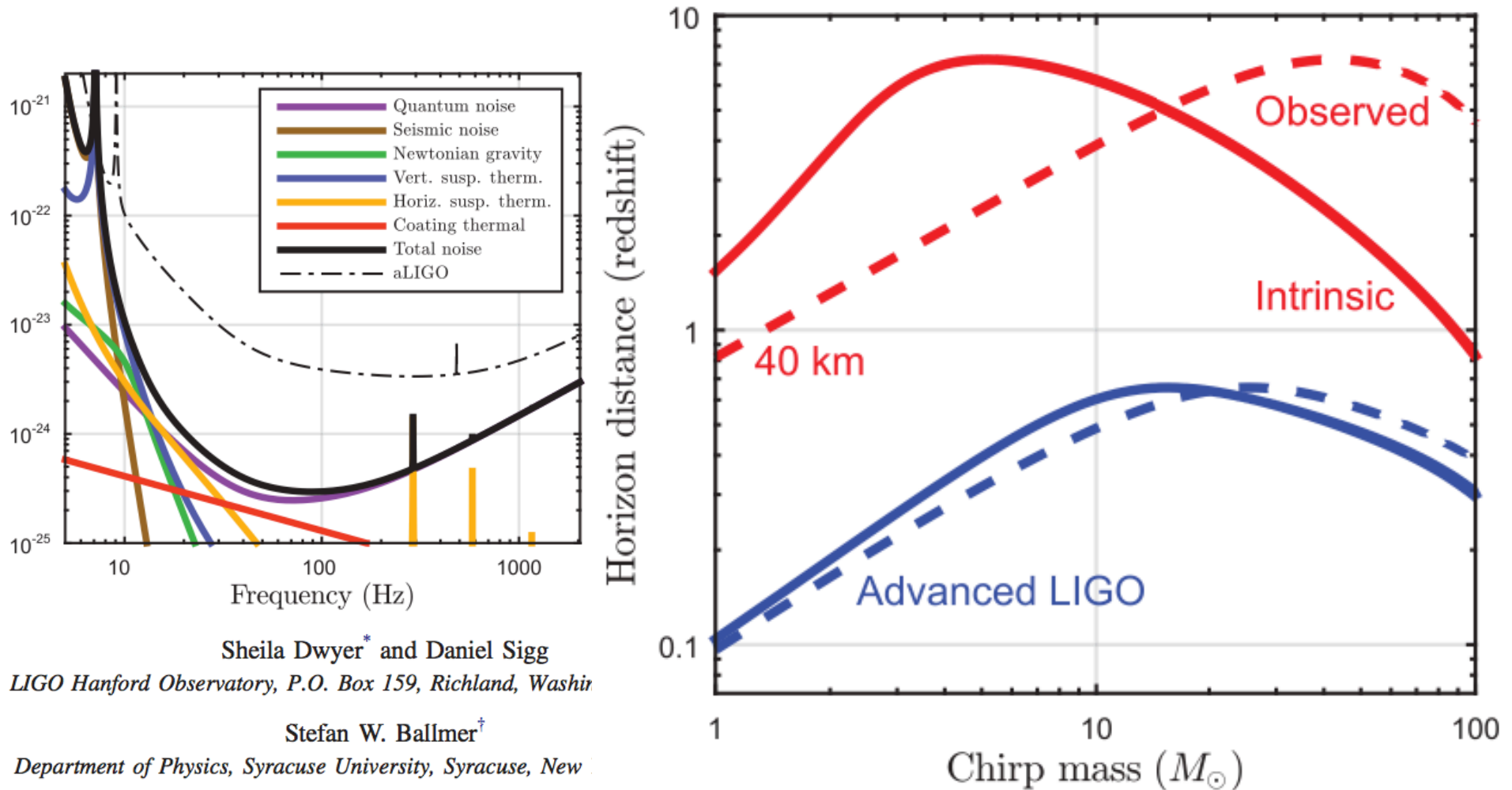
Suspensions and Seismic OK

- in-band seismic noise is good enough for the future (may need mHz improvements for duty-cycle, scatter, upconversion, etc.)
- suspension thermal noise could be improved, but the astrophysical motivation is not high
- technical fixes to the suspensions will be needed, but should not require major redesign
 - reduce gas damping
 - allow for bounce and roll damping, ...

We are planning for the more distant future...

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Gravitational wave detector with cosmological reach



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