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 (>100Hz)
• 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. spectography
• 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…

Gravitational wave detector with cosmological reach

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