Summary and Outcomes of A+ session

Dave Reitze
LIGO Laboratory, Caltech

Five presentations

1) Reaching Advanced LIGO Detector Design Sensitivity (Sigg)

2) Post-detection GW Astrophysics: What We Know and Don't Know About the GW Sky (But Really Want To!) (Vitale)

3) Getting an A+: Sensitivity Enhancements Beyond the Advanced LIGO Design — Plans, Timelines, and Costs (Zucker)

4) Progress and Plans in Optical Coating Research (Fejer)

5) LIGO Voyager: What It Might Look Like (Adhikari)

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Commissioning

- Plans for Commissioning for pre- and post-O3
  - Pre-O2 → double the laser power for O2 to 50W, in-vac work @LLO
    - Problems with Livingston laser; O2 will operate at 25W for at least first 1/2
  - Mystery noise at low frequency – investigations ongoing, but causes remain elusive
  - Post-O2
    - Replace reaction masses at both sites, install squeezing at one or both sites

- Discussion:
  - Goal of Design Sensitivity still achievable by 2019? A: Not unrealistic
  - What is most important for commissioning? Salvo: “Low-frequency should be the priority. It will be a win-win, we'll get more cycles for NSNS. Think of how much better PE we had for GW151226 compared to GW150914. (Can the Virgo curve improve at low frequency below 30Hz?)

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Post-detection Science

- We learned about BH masses, spins in O1; we tested GR in the dynamical strong field regime
- About BHs, still want to know: spin-precession, formation channels, EM counterparts (if they exist)
- Post O2 or O3 or O4: CBC formation channels, intrinsic masses, NS EOS (new facility?), CW emitters, CCSNe, stochastic (O4)

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A+

- A+: frequency-dependent squeezing, TMs with lower thermal noise coatings, balanced homodyne readout
- Factor of 5 increase in volume/event rate over aLIGO design
  - » Need CTN reduced by 2X to 4X to achieve mid-band improvement
- Operational in 2023 (if funded in 2018)
- Preliminary Cost: $29M
  - » Challenge: fitting this into the Physics Mid-scale funding envelope
  - » Can be phased, eg, deploy squeezing and balanced homodyne detection, and do TM replacement with better coatings later.

- Question for this group: do we endorse this plan?

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Coating Thermal Noise

- ***This is the bottleneck in improving detector sensitivity***
- What we (think we) know: Loss mechanisms (distribution of two level systems), T-dependence, empirical role of doping
- Good Progress in MD many atom simulations
- Where from here: ultrastable glasses, ideal glasses, nanolayers, heated substrate deposition, better characterization
  - » Crystalline coatings, too
- Should try to maintain other coating 'goodness' – low absorption, low scatter, uniformity

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What a Voyager Might Look Like

- Exploits the LIGO facility limits (~ 3x aLIGO design)
  - » Rana points out that technical noises are always important
- Refrigeration, 200 kg silicon TMs, 1.5 – 2 um lasers
- Technologies look within hand, but R&D needed
- Plans to prototype at Caltech 40 m

Near Term Need: Coordinated R&D Among the Projects

- R&D themes are common for Voyager and ET/Cosmic Explorer
  - Lower loss coatings
  - Si test masses
  - Longer wavelength stabilized lasers
  - Cryogenics
  - Newtonian Noise
  - Control schemes
  - …
- Currently, the major projects/collaborations do not really 'inter-collaborate' on R&D
  - LSC, Virgo, KAGRA each have separate R&D programs; some cross-talk, but little to no coordination
- 'Coordination' here is defined as having a common program in which resources (= expertise, person power, funding) are assigned and managed efficiently
  - LSC Instrument Science White Paper is probably the best example of a coordinated R&D effort
- Distinction between 'R' and 'D' in this model?
- Role of GWIC, role of agencies?