

Summary of ET science so far and new problems

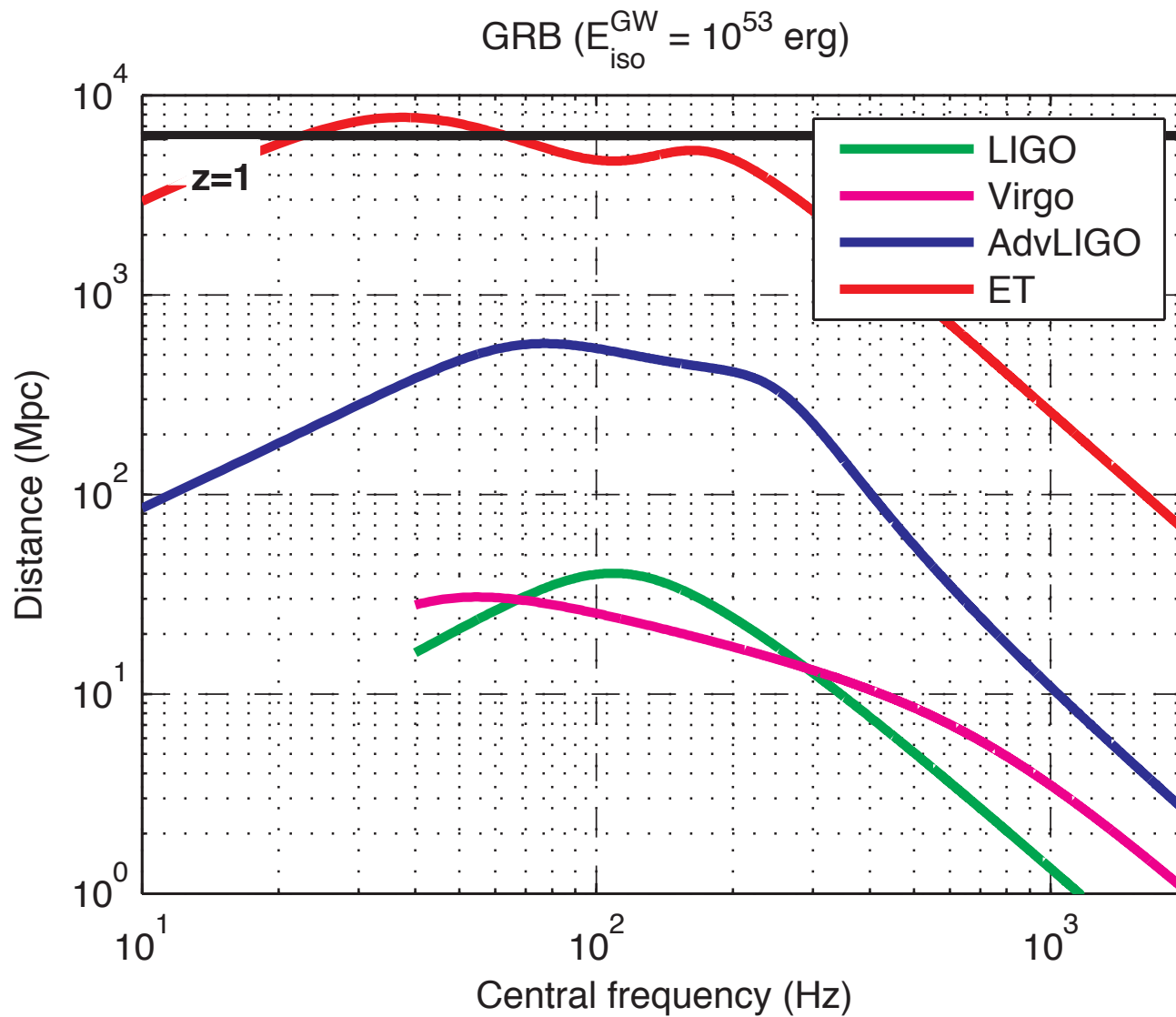
B.S. Sathyaprakash



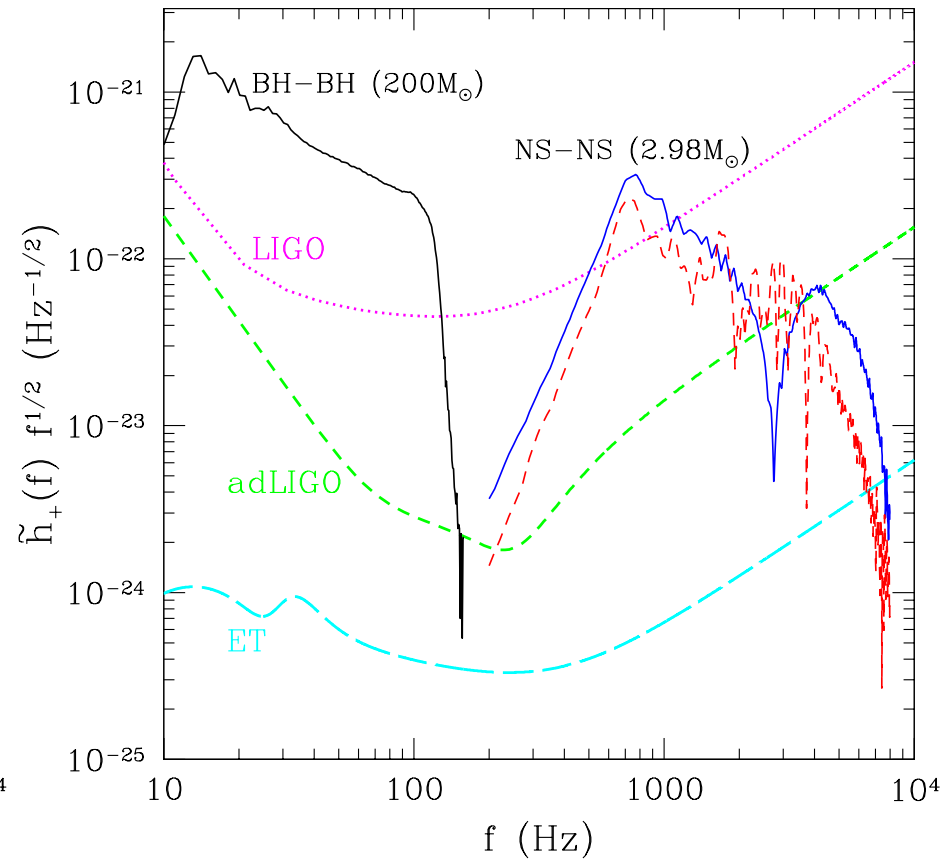
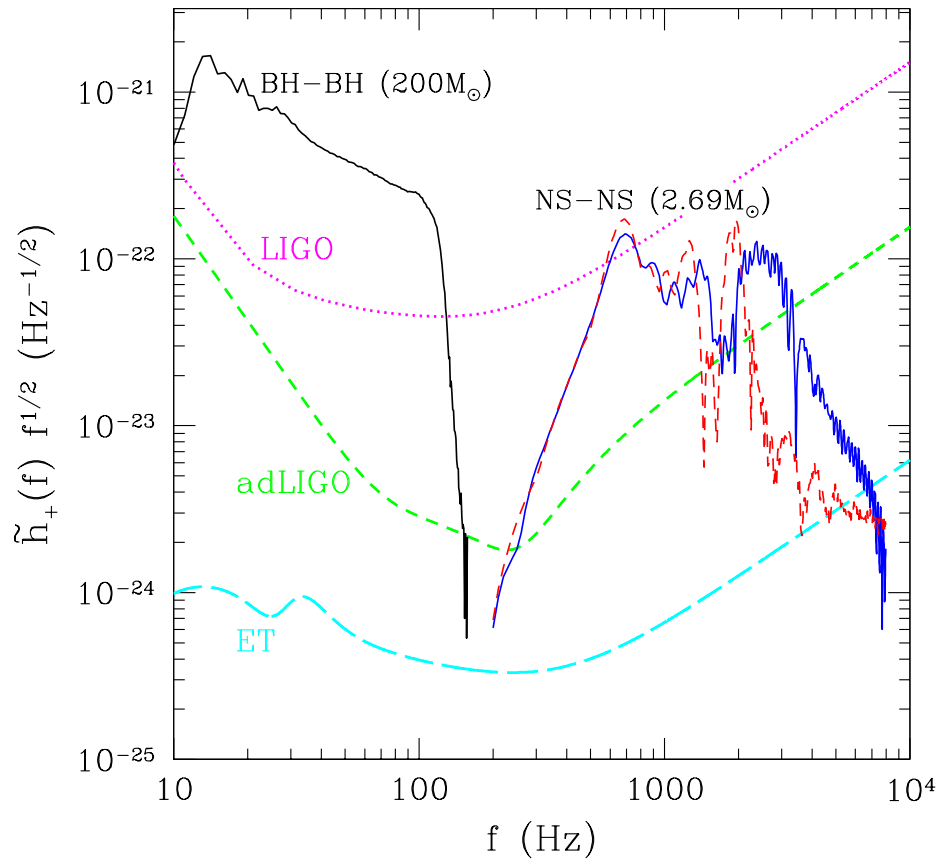
Summary of ET Science

- Fundamental physics
 - Upper limits on the graviton mass, dark energy equation of state, polarization states of GW, black hole no-hair theorem, signature of string theory
- Astrophysics
 - GRB progenitors, mass function of NS, history of star formation rate, NS normal modes (glitching pulsars, flaring magnetars), NS equation-of-state from mergers
- Cosmology
 - Cosmological parameters, seed black holes, intermediate-mass black holes,

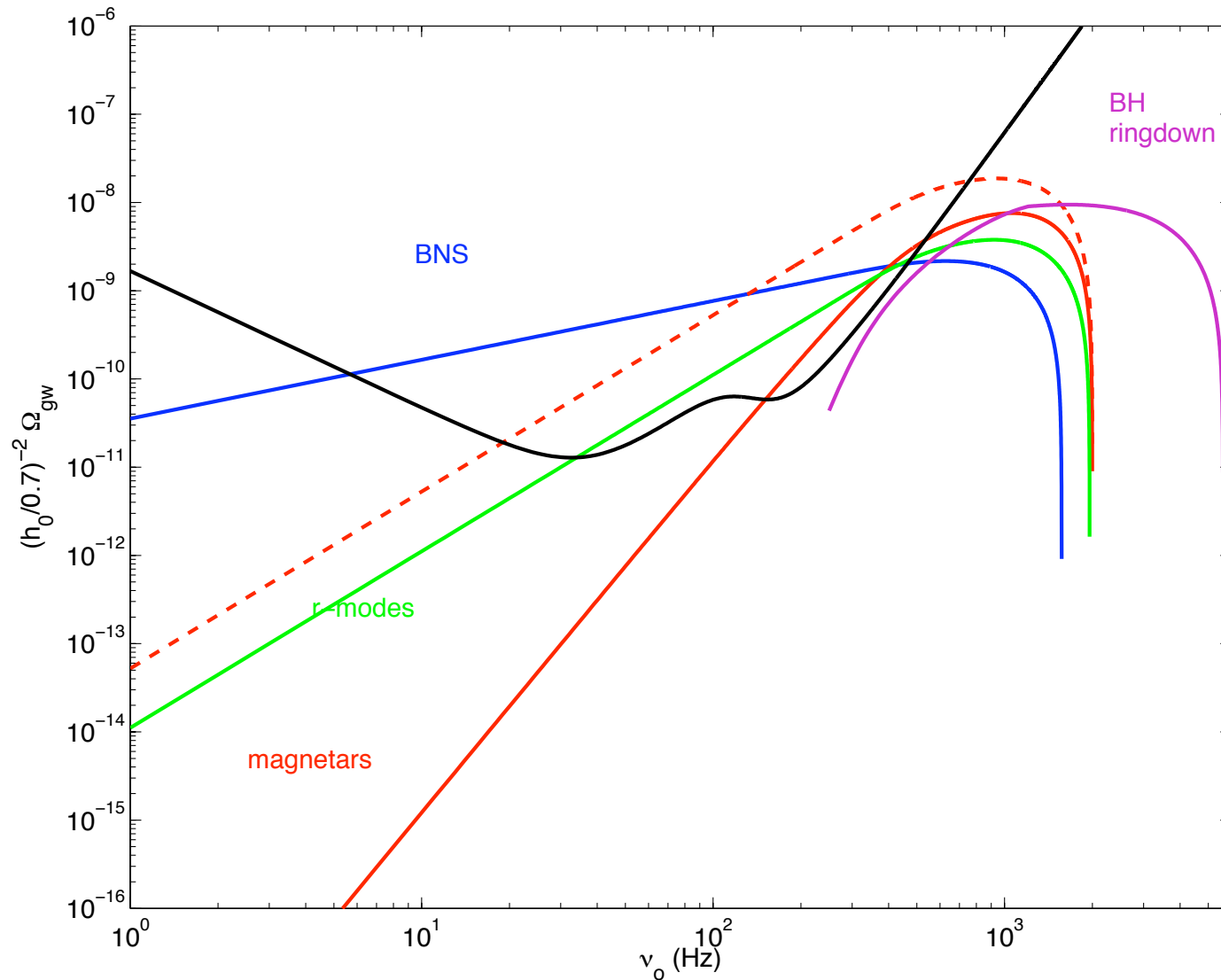
Gamma-ray bursts



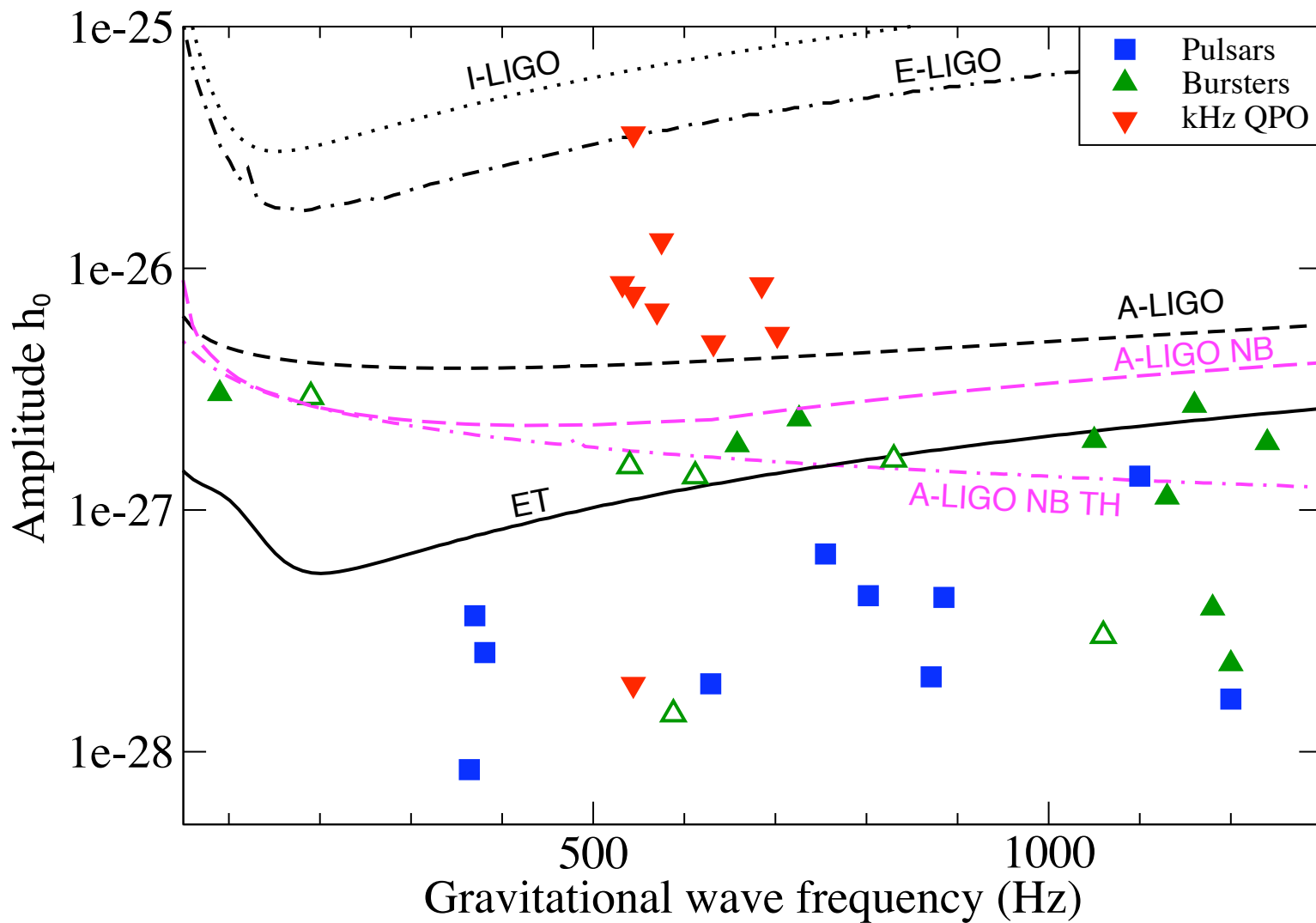
Double Neutron Star Mergers



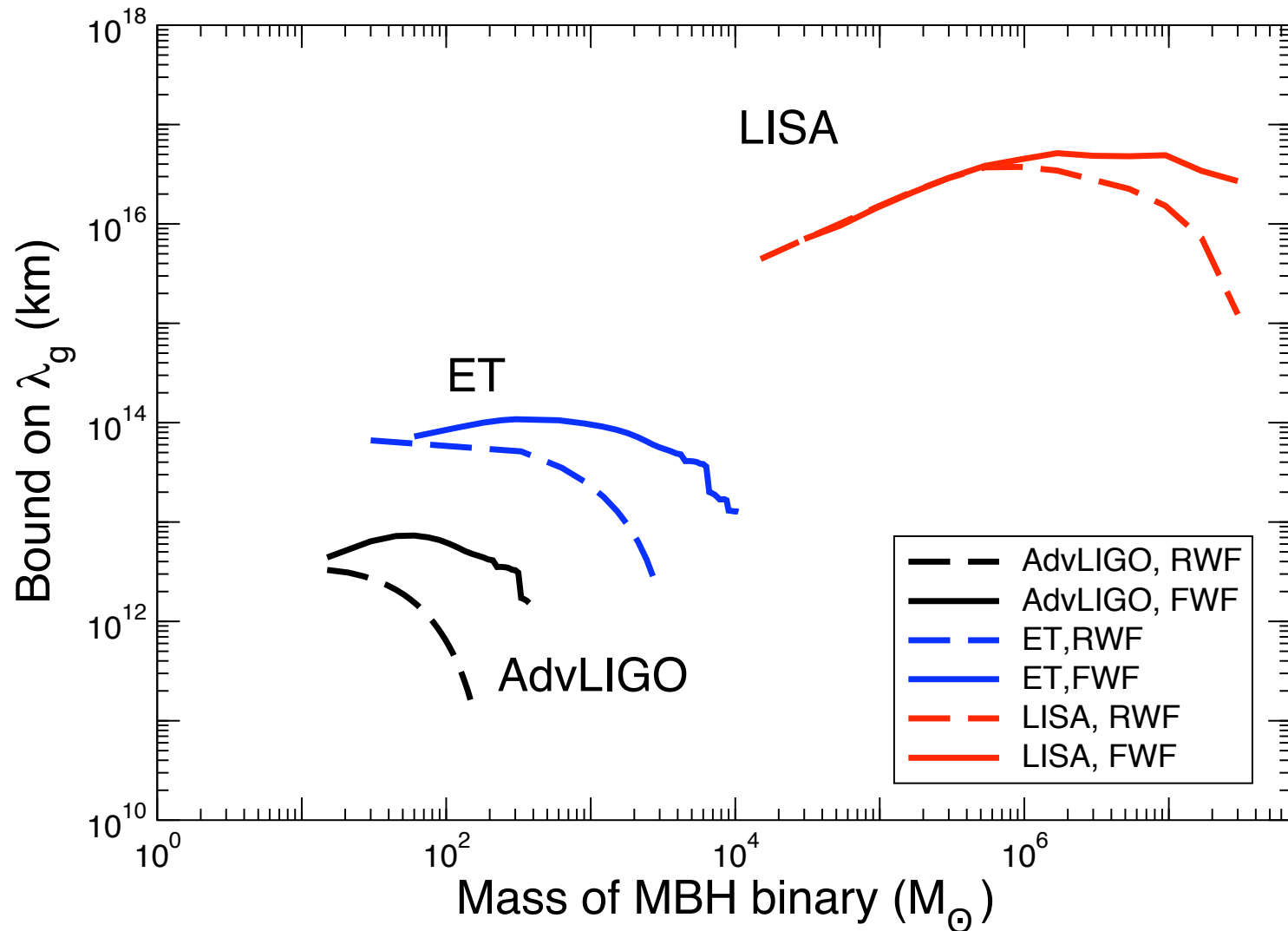
Astrophysical Backgrounds



Accreting Neutron Stars

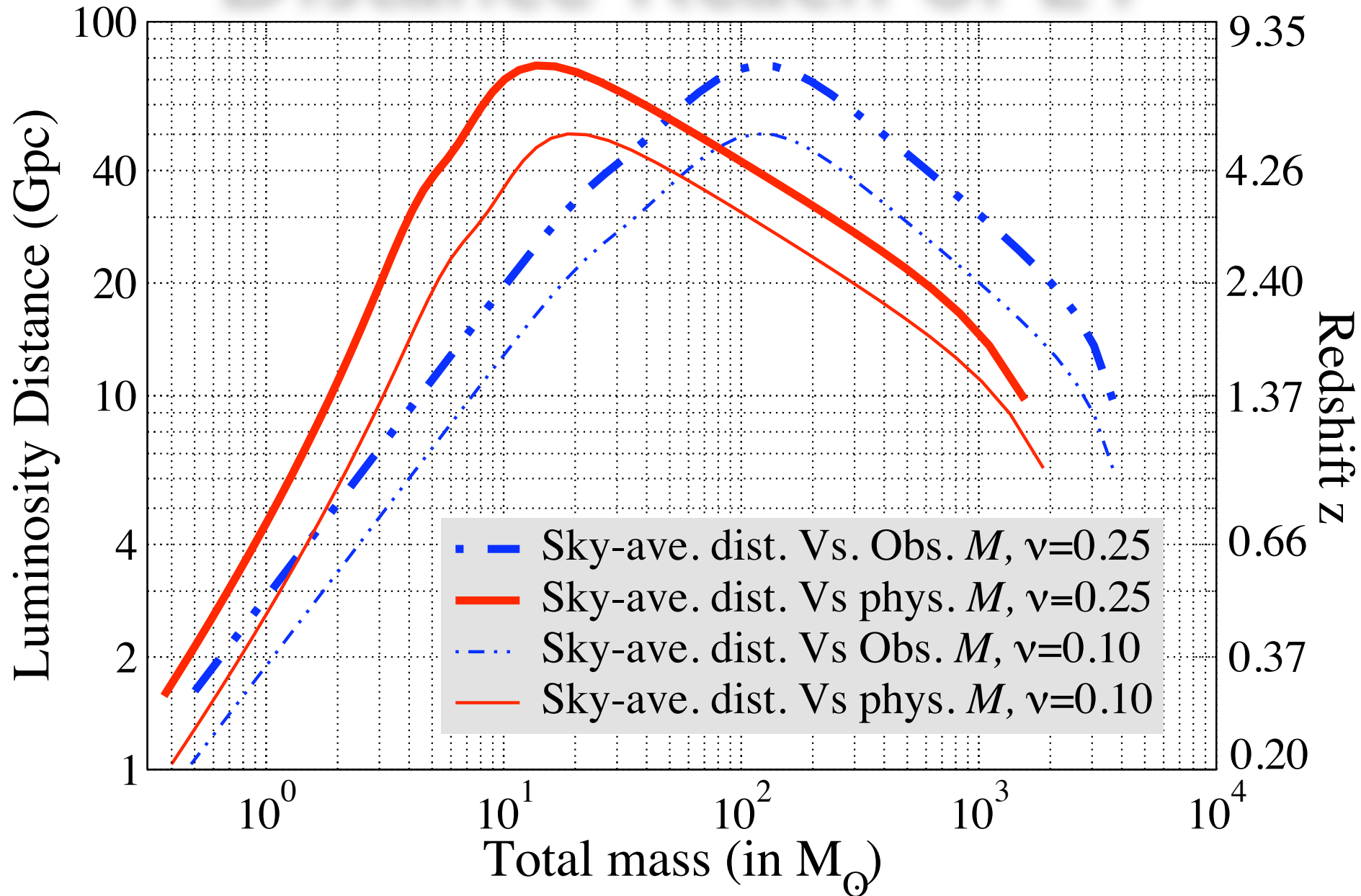


Bounds on Graviton Mass



Arun and Will (2009)

Distance Reach of ET



Problems that need your attention

Science with BBH mergers

- ET should be able to see thousands of BBH mergers at $z \sim 1$ with an SNR of 100 or more
- Within $z \sim 5-8$, ET should detect millions of these sources
- Challenges:
 - Can we disentangle these sources from everything else
 - Not looked at the science potential of such a large number of events
- Obvious things to do
 - Mass function of black hole binaries, star formation rate, strong field tests of GR
 - How well can we determine cosmological parameters statistically?

Open but easy problems

- A systematic and well-document study of the angular resolution of ET for BNS, BBH, NSBH
- A systematic study of the error in luminosity distance with red-shift
- The number of galaxies within the error box of ET on the sky
- Trade studies with different ET designs
 - A single site triangle versus multiple site L-shaped detectors
- Can ET operate usefully in coincidence with advanced detectors? What about BBO/DECIGO?

Multi-messengers and ET

- What optical, radio, x-ray, gamma-ray, neutrino telescopes/detectors will be operating on the 2025 time scale that are capable of good sky-coverage
- If we want to follow-up ET BNS/BBH coalescences what sort of optical telescopes would we need, how many of them to cover the entire globe, etc.
- Create a database of “small” (3 m class) telescopes around the world
- Record all the necessary information about every potential telescope that could be useful for us

Large scale structure of the Universe

- From a large sample of measurements of the Hubble parameter it should be possible to deduce large-scale anisotropy
- Dipole anisotropy can be measured to an accuracy of fraction of a percent
- Residuals can be used to test anisotropic Bianchi Type I models

Sensitivity to Stochastic Background

- Can ET's sensitivity to SBG improved beyond the standard cross-correlation-based values
- Can one construct “noise-only” channels from ET's three detectors?
- How well can we subtract the noise to improve sensitivity to SBG?
- What lessons have been learned from H1-H2 common noise?

Future of the Vision Document

- ET Vision Document is more than 70 pages long
- Many interesting problems in fundamental physics, astrophysics and cosmology
- However, we need more quantitative evaluation of the science ET can do
- The document also lacks clarity on the most important scientific problems ET can solve and what theoretical progress is necessary to take advantage of ET
- Should we aim at producing a glossy, shorter version that could be used for outreach and lobbying?