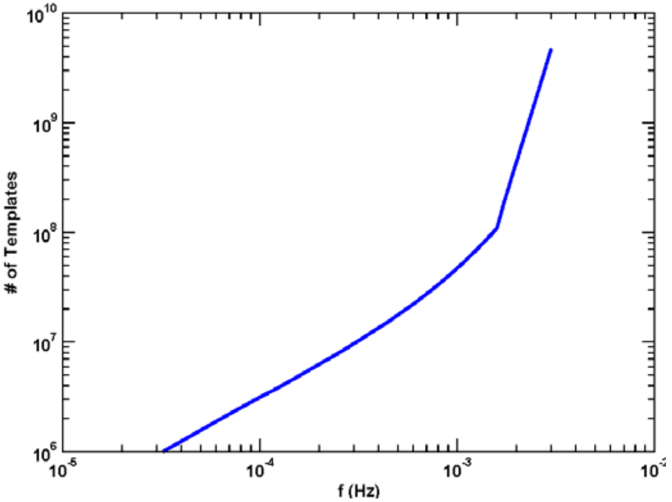
LISA Data Analysis & Sources

Porter: Detecting Galactic Binaries with LISA

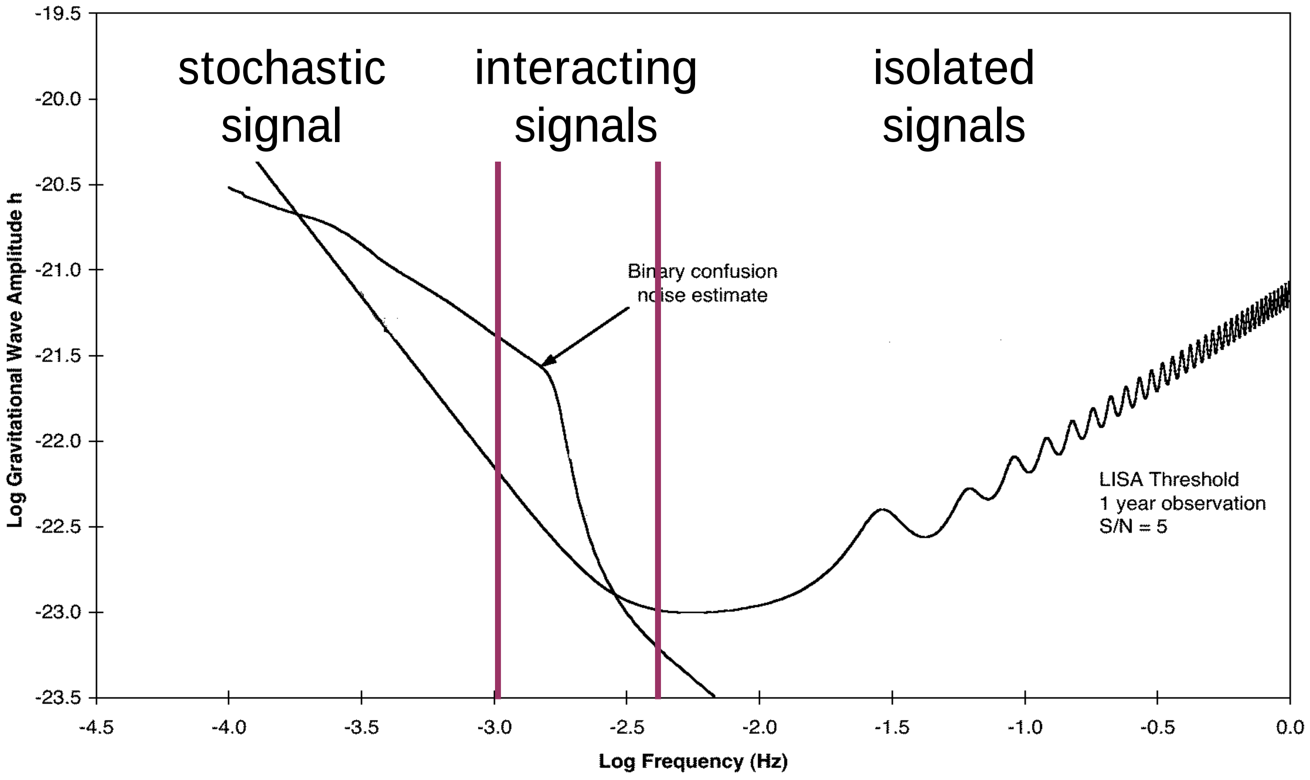
- Goal: Calculate number of templates for galactic binaries in the long-wavelength approx for LISA.

- Each binary has 8 params:
  - » nuisance: A, ι, ϕ_0, ψ
  - » templates for: θ, ϕ, f, f'



- Define metric for overlap of two signals, use to est. number of templates needed.
  - » Need 10^7 (10^{10}) templates for f<$3\text{x}10^{-4}$Hz ($3\text{x}10^{-3}$Hz).

Christensen: Bayesian modeling of source confusion in LISA data.

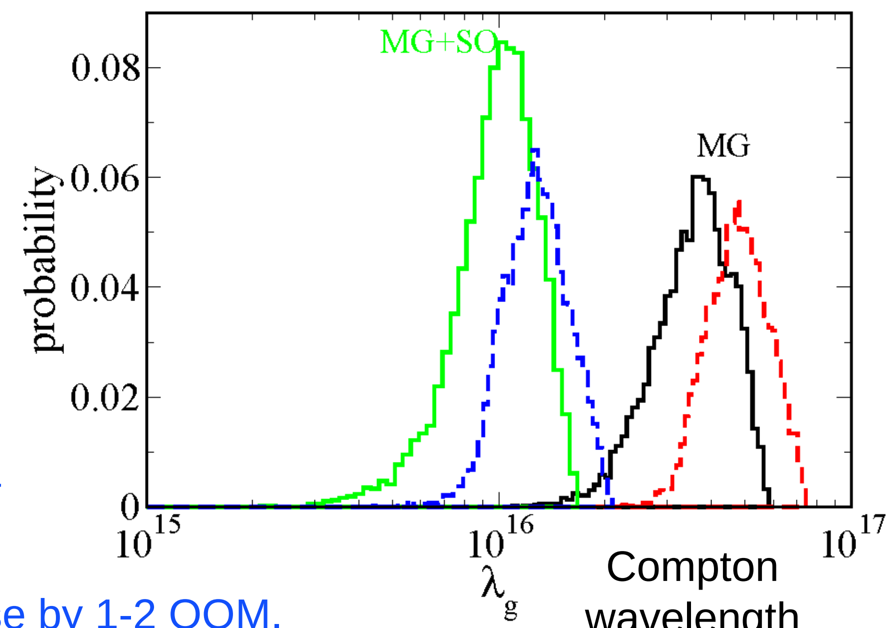


Christensen: Bayesian modeling of source confusion in LISA data.

- Problem: 1-5mHz band there will be ~10^5 WD binaries to be resolved.
- Developed Bayesian MCMC technique (*simulated annealing?*) to extract number of binaries, system parameters, and estimate noise spectrum.
  - » Uses "reversible jump" MCMC which can create/destroy/split/merge signals.
  - » Showed performance with 100 sinusoidal injections, error estimates.
- Next step: realistic numbers and types of signals.

Buonanno: Determining spinning binary parameters with LISA

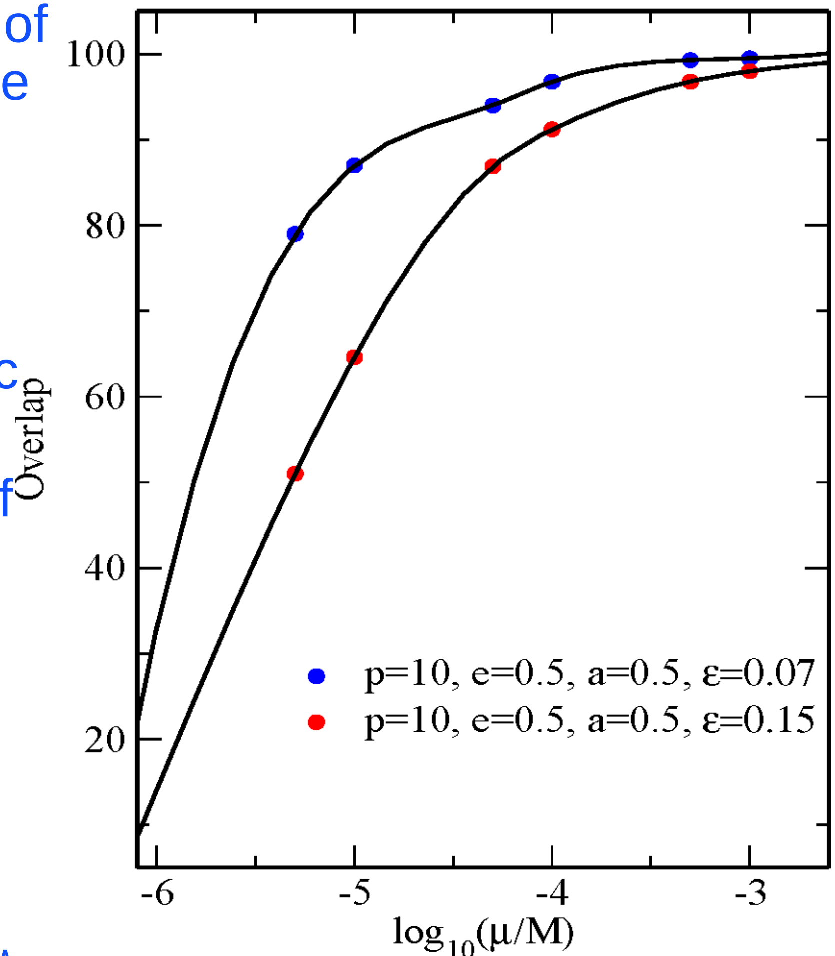
- Goal: Investigate effect of spin-orbit and spin-spin couplings in est of params for LISA inspirals.
  - » Study case where spins normal to the orbital plane.
  - » For GR, scalar-tensor, and massive-graviton theories.
- Find: Params in GW phase are highly correlated, so fitting extra params dilutes info per param.
  - » GR: Uncertainty in chirp mass worse by 1-2 OOM.
  - » Scalar-tensor: Bound on coupling worse by 1-2 OOM.
  - » Graviton-mass bound worse by <1 OOM.
- Little effect on angular resolution or distance est.



Compton wavelength of graviton

Babak: Geod. motion & GWs from test mass + 'quasi-Kerr' object

- Goal: Extracting multipole structure of spacetime of compact object from the GW extreme-mass-ratio-inspiral signal.
  - » Test if CO in galaxy cores are SMBH or, eg, boson star.
- Assume body's exterior = Kerr metric + small quadrupole perturbation.
- Study equatorial orbits. Measures of perturbation:
  - » periastron shift
  - » overlap of "kludge" waveforms in quadrupole approx, with and without perturbation.
- (Not demonstrated: ability to determine perturbation.)



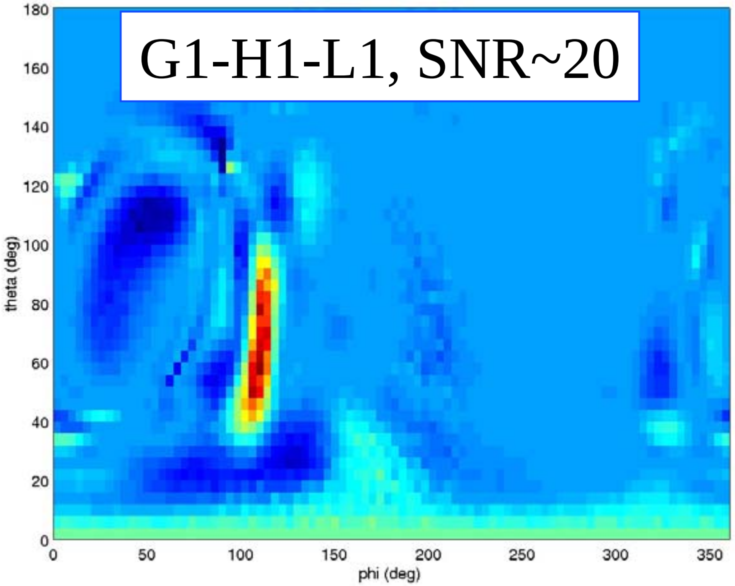
Multi-Detector Analyses, New Methods

Klimenko: Coherent analysis of signals from multiple IFOs

- Variation on Gursel-Tinto method to detect GWBs & determine sky position, waveform with 3 IFOs.

$$h_1(t) = f_1^+ h_+(t) + f_1^\times h_\times(t) + n_1(t)$$

  - » Guess sky position, predict signal in IFO3 from IFO1, IFO2.
  - » Cross-correlate data stream with prediction, look for sky position which maximizes correlation.
  - » Repeat for other IFO combinations.



- Showed performance on Gaussian noise, detection efficiency comparable to r-statistic.

Wen: Coherent data analysis using a network of GW detectors

- Also variation on Gursel-Tinto, for 2/3 detectors.
  - » Guess sky position, construct "null" combination of data streams which contains no GW signal.

$$A(\alpha, \delta, t) = A_{23} h_1(t) + A_{31} h_2(t + \tau_{12}) + A_{12} h_3(t + \tau_{13})$$

  - » True sky position minimizes variance of null stream.
  - » If no sky position which makes null stream consistent with background, then not GWB (veto).
- Showed examples of position determination on Gaussian noise for various network combinations.

From Wen:

Three-Detector Case

- Data

$$h_1(t) = f_1^+ h_+(t) + f_1^\times h_\times(t) + n_1(t)$$
$$h_2(t+\tau_{12}) = f_2^+ h_+(t) + f_2^\times h_\times(t) + n_2(t)$$
$$h_3(t+\tau_{13}) = f_3^+ h_+(t) + f_3^\times h_\times(t) + n_3(t).$$

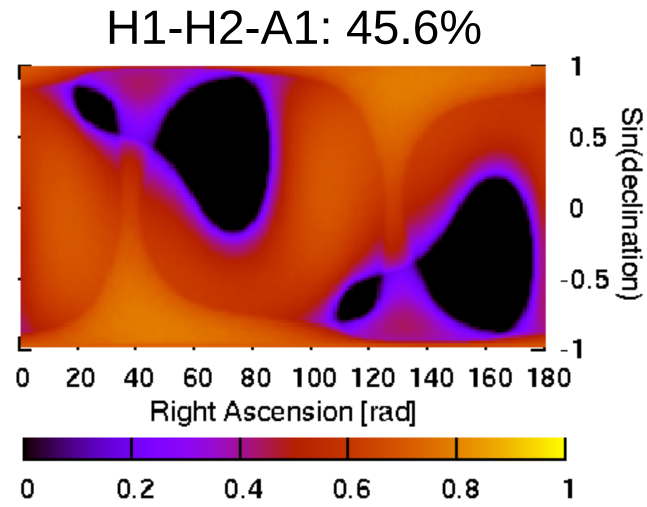
- Null Stream=linear combination of data
  - signal exactly cancelled out (e.g., Guersel & Tinto 1989)
  - coefficients: polarization angle independent

$$A(\alpha,\delta,t) = A_{23}h_1(t) + A_{31}h_2(t+\tau_{12}) + A_{12}h_3(t+\tau_{13})$$

$$A_{ij} = (f_i^+ f_j^\times - f_j^+ f_i^\times).$$

Poggi: Detection of bursts with non-homogeneus GW detectors

- Goal: Expand IGEC-style coincidence to IFO+Bar networks, study sky coverage.
- IGEC coincidence: aligned detectors, assumed sky direction, δ-fn template
- SNR^2 for joint detection ~ $F_1 * F_2$
  - » Studied for linear & circular polarization, for various network choices.
  - » With assumptions on relative sensitivity, computed sky coverage for coincidence and correlation searches.



- Needed: Template-less search - need to make consistent amplitude comparisons between detectors with different bandwidths, sensitivities.