High Frequency

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Why listen to higher frequency ?

Higher frequencies: shorter wavelength,

more details from the source

But: size of a compact source ~ *2GM*

If surface rotates at *c*

Max frequency f ~ $1/4\pi GM \sim 10^4 M_{\odot}/M$ Hz

Going higher will avoid eventually astrophysical sources

Cosmological red shift pushes source frequency down

Listening further away increases the number of sources leading to an astrophysical background (Olbers…)

D Blair et al, V Ferrari et al, K Postnov, Owen et al

Astrophysical sources

Subject covered here

by Sam Finn, Fred Rasio

Talk by Bernard Schutz

Picked up for you:

NS torn away by BH field

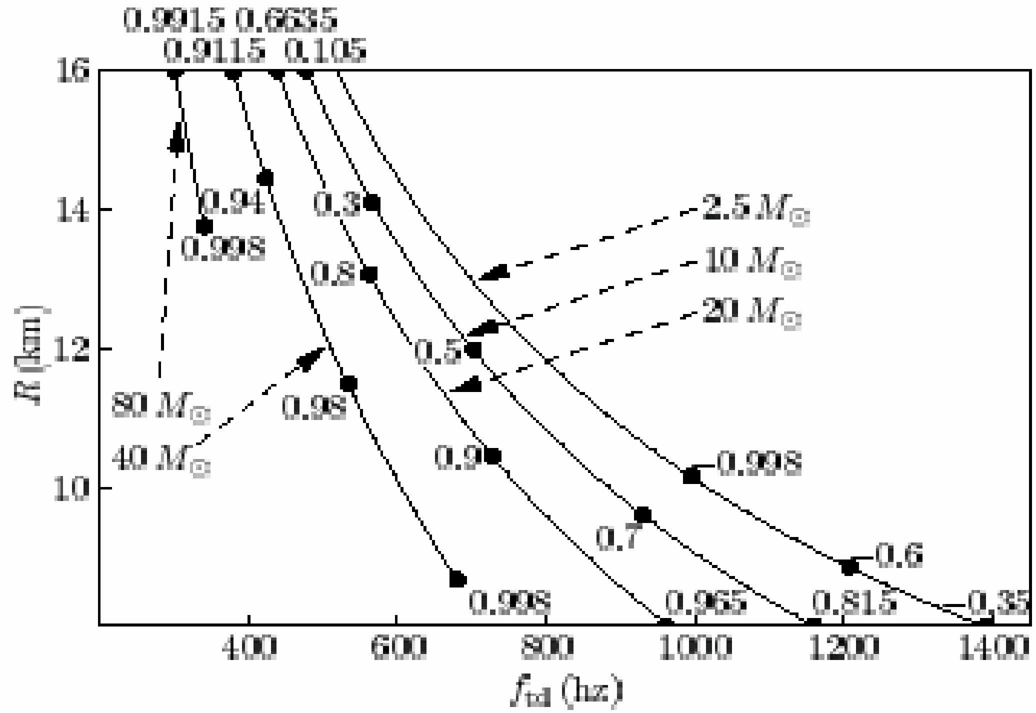
M Vallisneri + refs therein

Frequency depends on EOS

But also on BH spin

Data analysis for this phase will not be based on templates, need low noise

May apply steep bandpass filter to find last observed *f*



GW frequency at tidal disruption, f(m, R, M, a)

M, a: BH mass and spin

R: NS radius at 15 %, to be related to EOS

NS mass m at 1.4 $M_\odot$

Dots: a/M needed to have disruption at 6M ISCO

Astrophysical sources: Black hole and NS modes

Chandrasekhar-Friedman-Schutz instability

Gravitational waves from hot young NS

BJ Owen, L Lindblom, C Cutler, BF Schutz, A Vecchio, N Andersson

At D=20 MPc :

$$h_c \approx 5.7 \times 10^{-22} \left(\frac{f}{1kHz} \right)^{1/2}$$

Non linear evolution of R-modes

L Lindblom, J E Tohline, M Vallisneri

Saturation of the R-mode instability

P Arras, E E Flanagan, S M Morsink, A Katrin Schenk, S A Teukolsky, I Wasserman

Cosmological background

Physics Report by Maggiore (gr-qc/9909001)

Expressed in terms of $$\Omega_{gw}(f) = \frac{1}{\rho_c}\frac{d\rho_{gw}}{d\log f}$$

where $$\rho_c = \frac{3H_0^2}{8\pi G}$$

$$h_c(f) \simeq 1.263 \times 10^{-18} \left(\frac{1\mathrm{Hz}}{f}\right)\sqrt{h_0^2\Omega_{gw}(f)}\,.$$

h_c : characteristic value of the amplitude per unit ln *f*

Assuming a narrow band Δf

$$h_c(f,\Delta f) \simeq 2.249 \times 10^{-25} \left(\frac{1\mathrm{Hz}}{f}\right)^{3/2}\left(\frac{h_0^2\Omega_{gw}(f)}{10^{-6}}\right)^{1/2}\left(\frac{\Delta f}{3.17\times 10^{-8}\,\mathrm{Hz}}\right)^{1/2}$$

Cosmological background (2)

Two co-located detectors

$$h_{\rm min}^{\rm 2d}(f) \simeq \frac{1}{(\frac{1}{2}T\Delta f)^{1/4}} \frac{1}{\sqrt{2}} h_{\rm min}^{\rm 1d}(f) \simeq 1.12 \times 10^{-2} h_{\rm min}^{\rm 1d}(f) \left(\frac{1\,{\rm Hz}}{\Delta f}\right)^{1/4} \left(\frac{1\,{\rm yr}}{T}\right)^{1/4}$$

Two Virgo

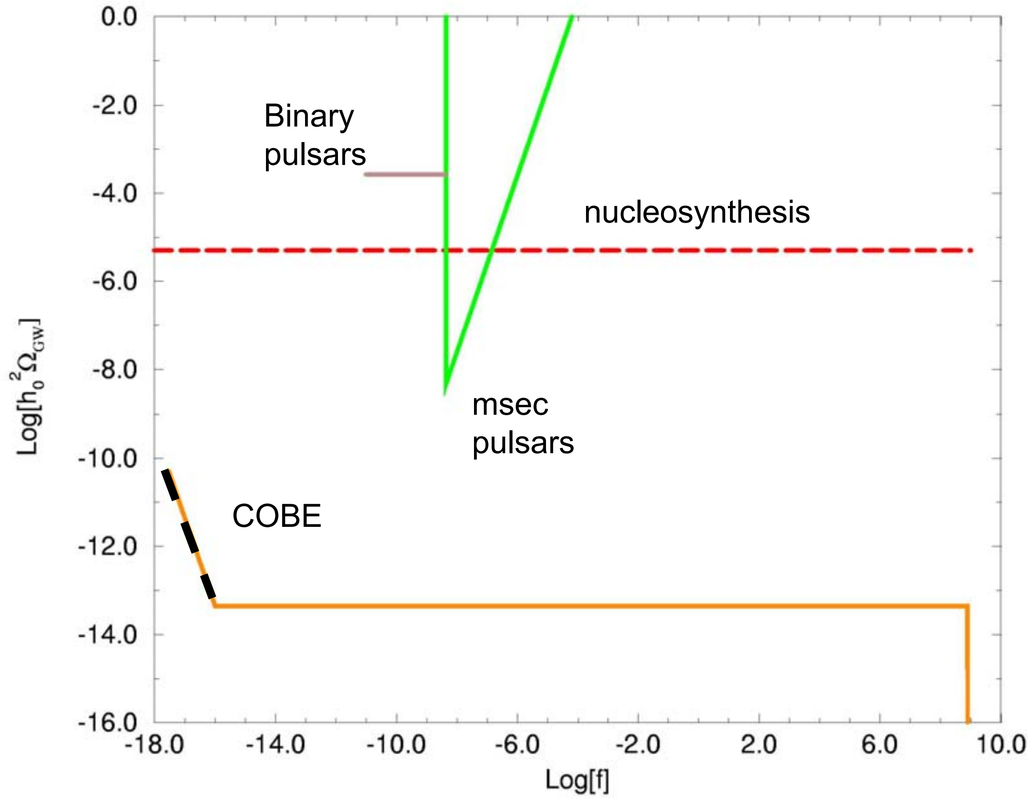
$$h_0^2 \Omega_{\rm gw}^{\rm min}(f) \sim 3 \times 10^{-7} \left(\frac{f}{100{\rm Hz}}\right)^3 \left(\frac{\tilde{h}_f}{10^{-22}{\rm Hz}^{-1/2}}\right)^2$$

Bounds on $h_0^2\Omega_{GW}$ and De Sitter inflation

Nucleosynthesis: integral bound

COBE

Pulsar bound



Pre big bang cosmology

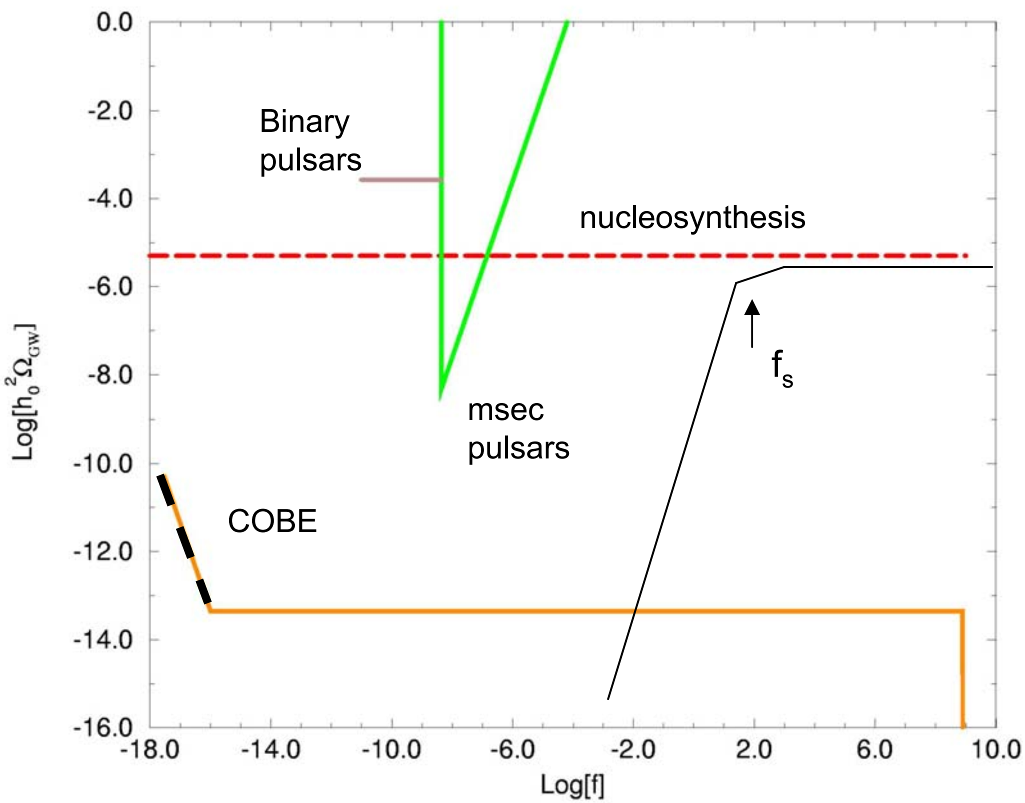
Low energy effective action of string theory (Veneziano 1993)

De Sitter inflation + vacuum amplification fluctuation

Model with two parameters:

$0<f_s<1\text{-}100$ GHz

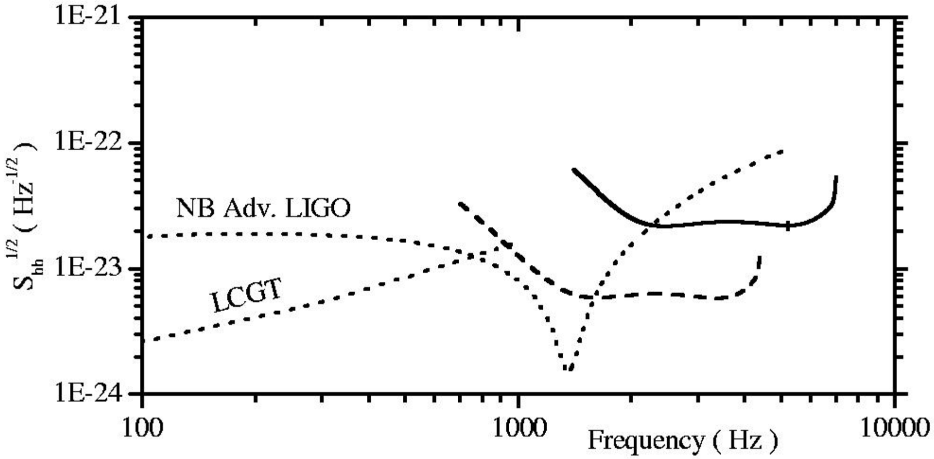
$\mu>0$

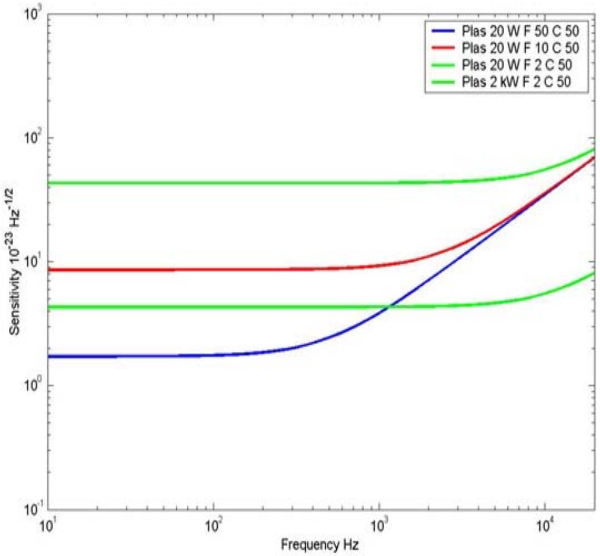


Detection

Detection is difficult

- Interferometers: need to fight shot noise and reduce finesse
- Acoustic detectors: Bonaldi et al, available on gr-qc/0302012





•Microwave/mechanical cavity detectors
Gemme, Chincarini, Picasso et al

5th Edoardo Amaldi Conference on Gravitational Waves

Green Park Resort - Tirrenia (Pisa) - Italy

July 6-11, 2003