Highlights from the Pulsar Timing Array (PTA) session

Chairs: Vicky Kaspi, Michael Kramer

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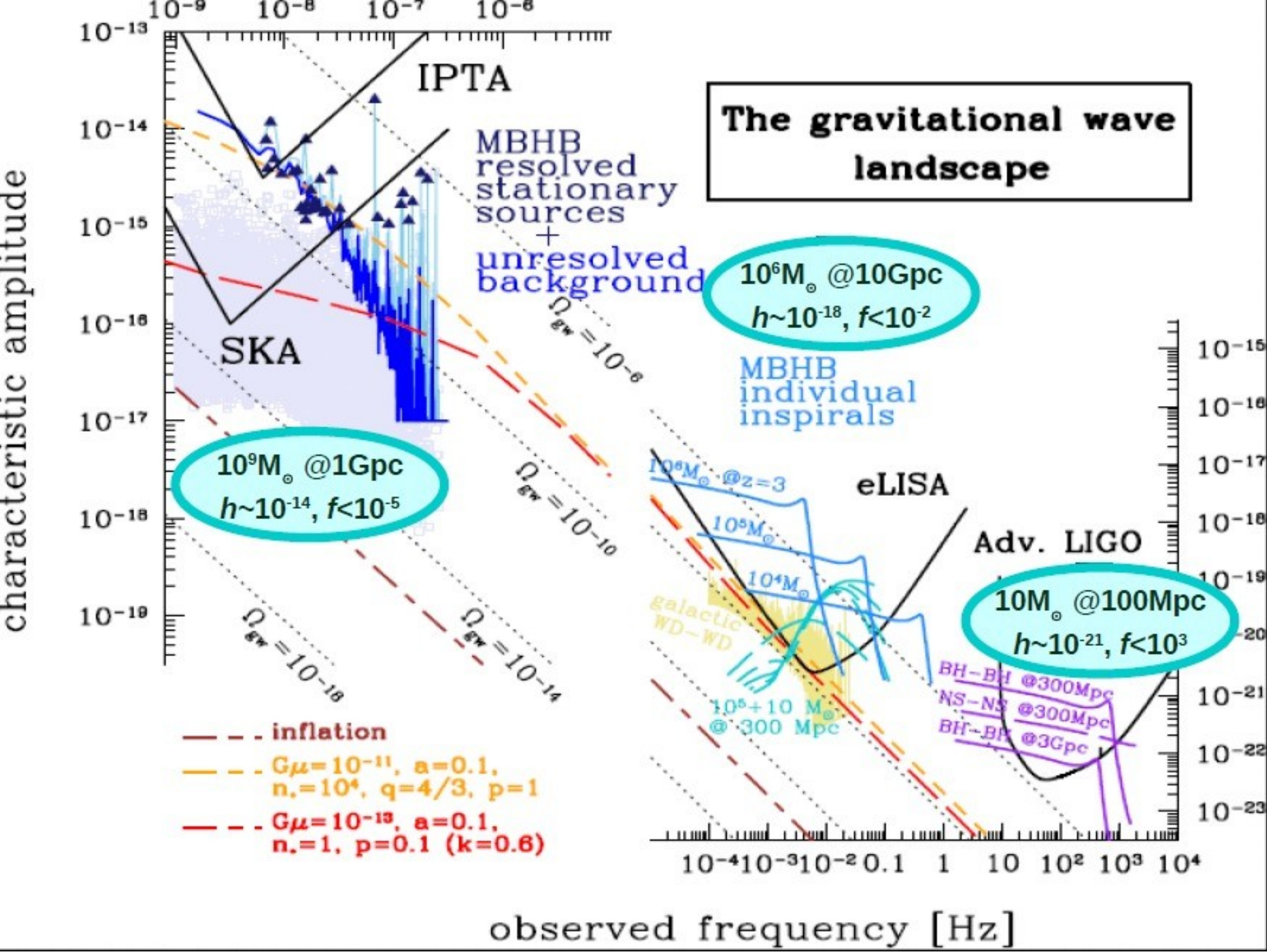
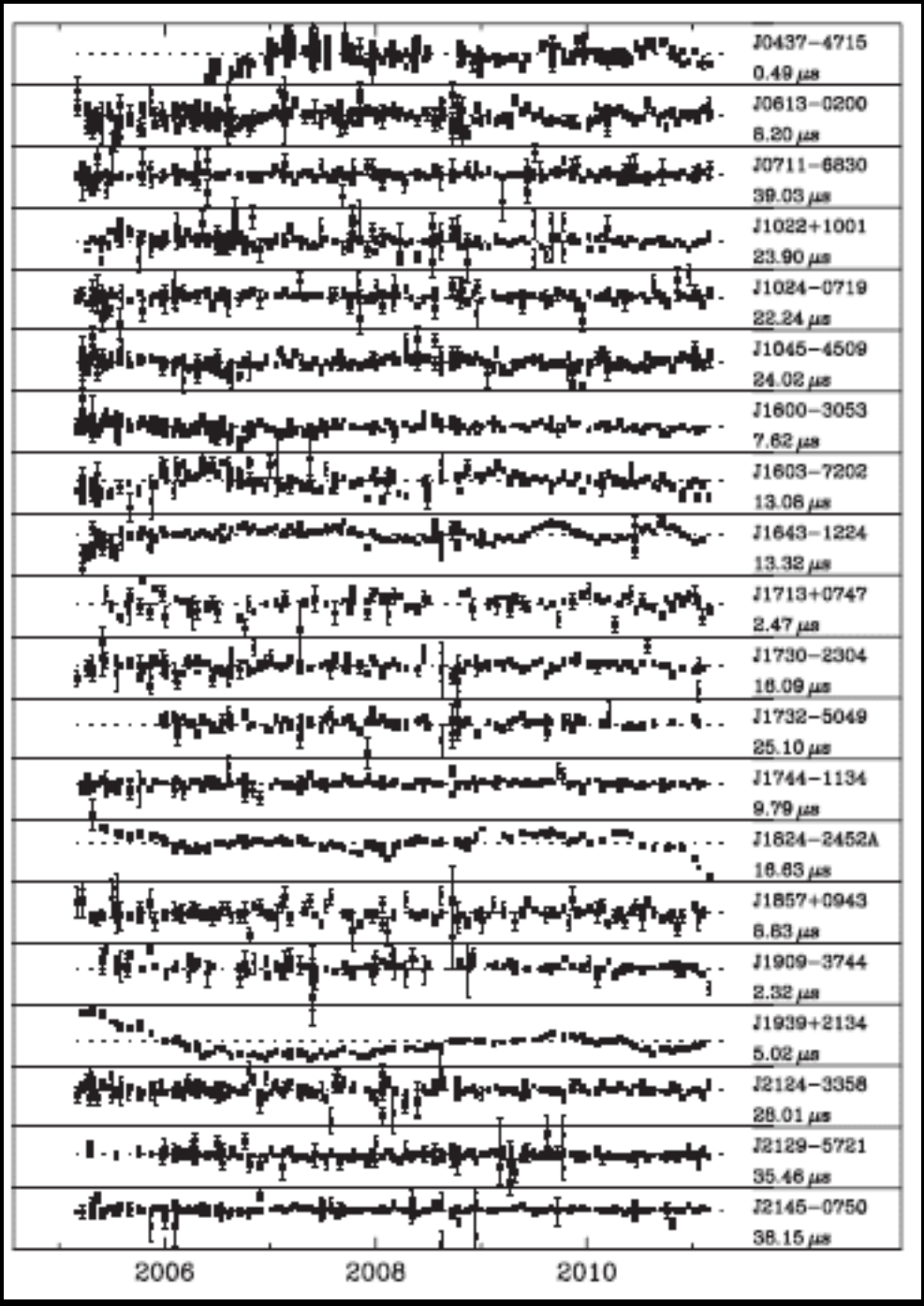
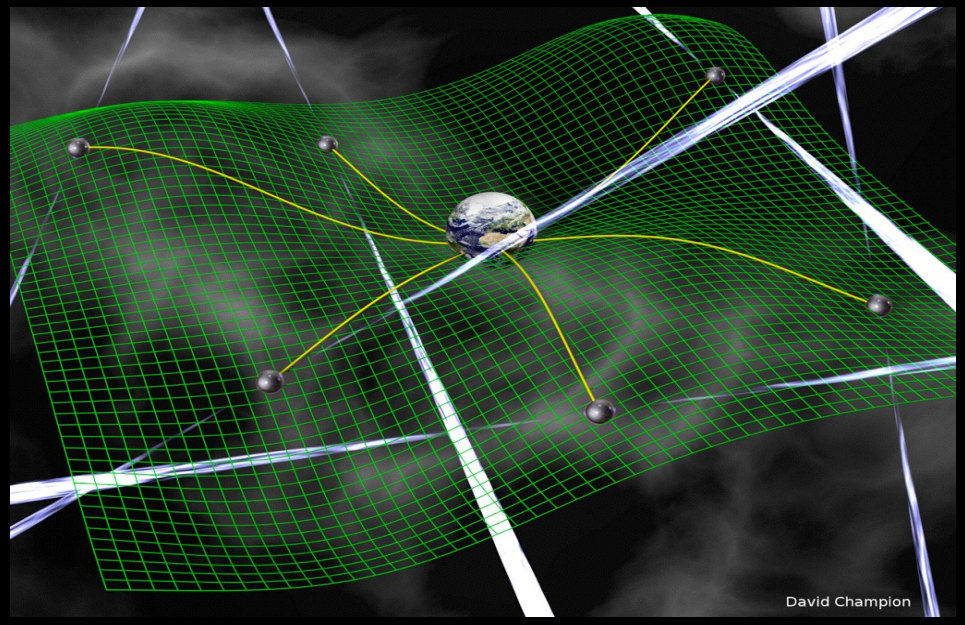
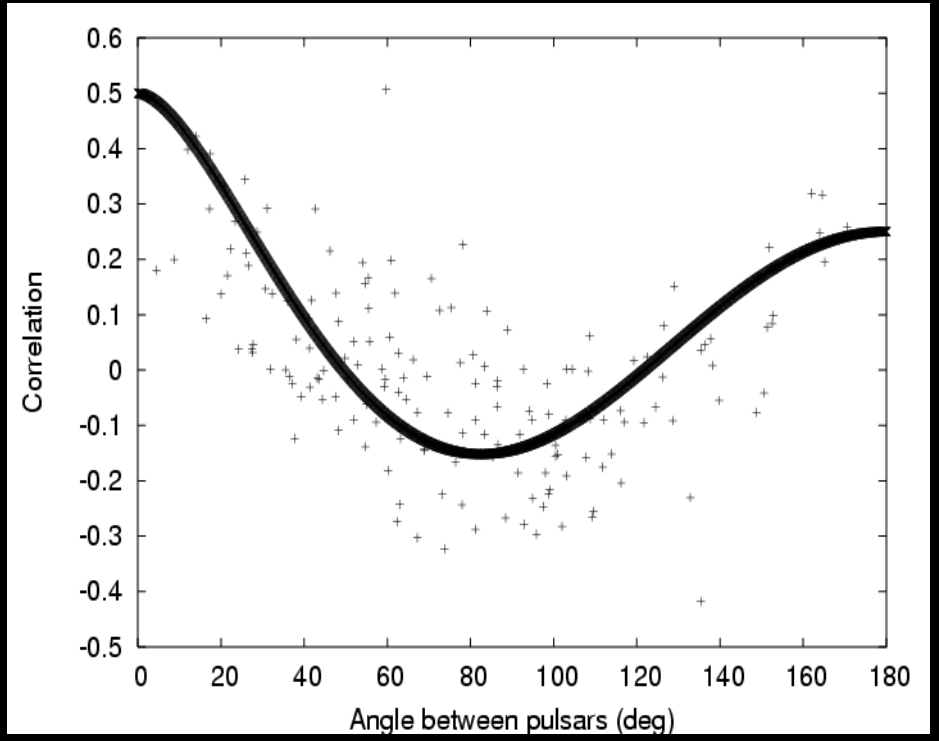

The gravitational wave landscape
IPTA
SKA
MBHB resolved stationary sources + unresolved background
$10^9 M_\odot$ @1Gpc
h~10^{-14}, f<10^{-5}
$10^6 M_\odot$ @10Gpc
h~10^{-18}, f<10^{-2}
MBHB individual inspirals
eLISA
Adv. LIGO
$10M_\odot$ @100Mpc
h~10^{-21}, f<10^{3}
$10^6 M_\odot$ @z=3
$10^5 M_\odot$
$10^4 M_\odot$
galactic WD-WD
$10^5+10\ M_\odot$ @ 300 Mpc
BH-BH @300Mpc
NS-NS @300Mpc
BH-BH @3Gpc
$\Omega_{gw}=10^{-6}$
$\Omega_{gw}=10^{-10}$
$\Omega_{gw}=10^{-14}$
$\Omega_{gw}=10^{-18}$
inflation
$G\mu=10^{-11}$, a=0.1, $n_*=10^4$, q=4/3, p=1
$G\mu=10^{-13}$, a=0.1, $n_*=1$, p=0.1 (k=0.6)
characteristic amplitude
observed frequency [Hz]

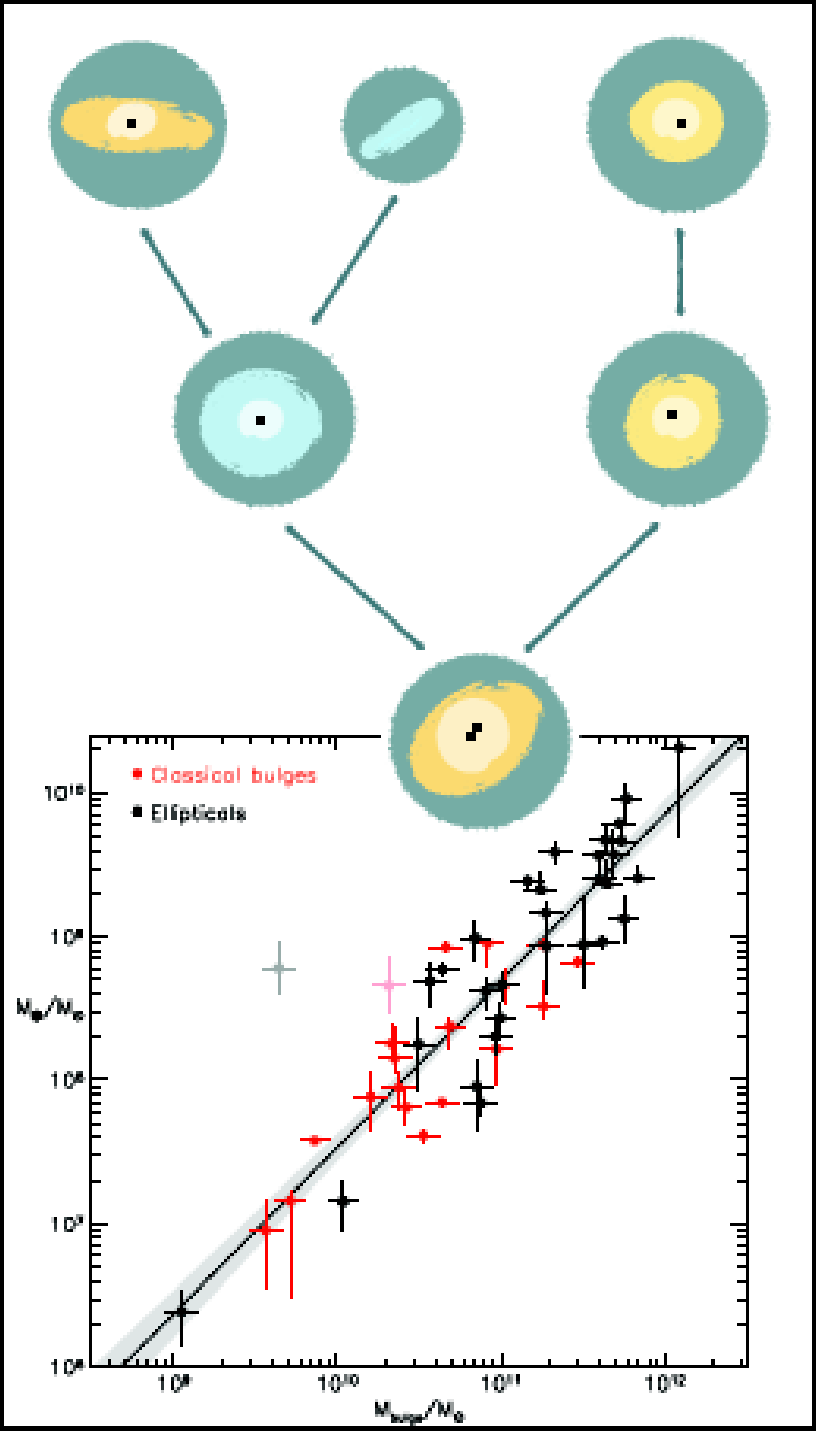
PTAs: looking for correlations in timing residuals

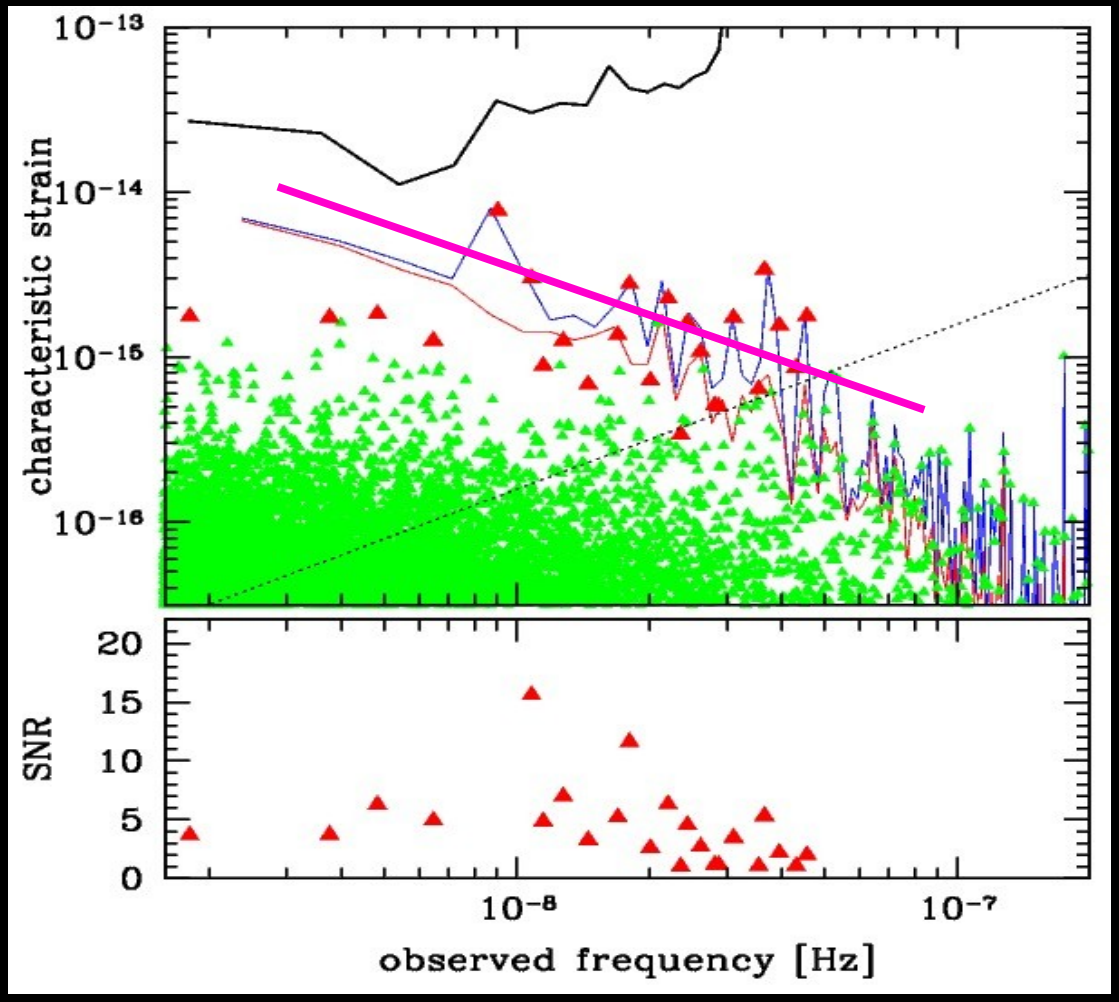






The nature of the signal

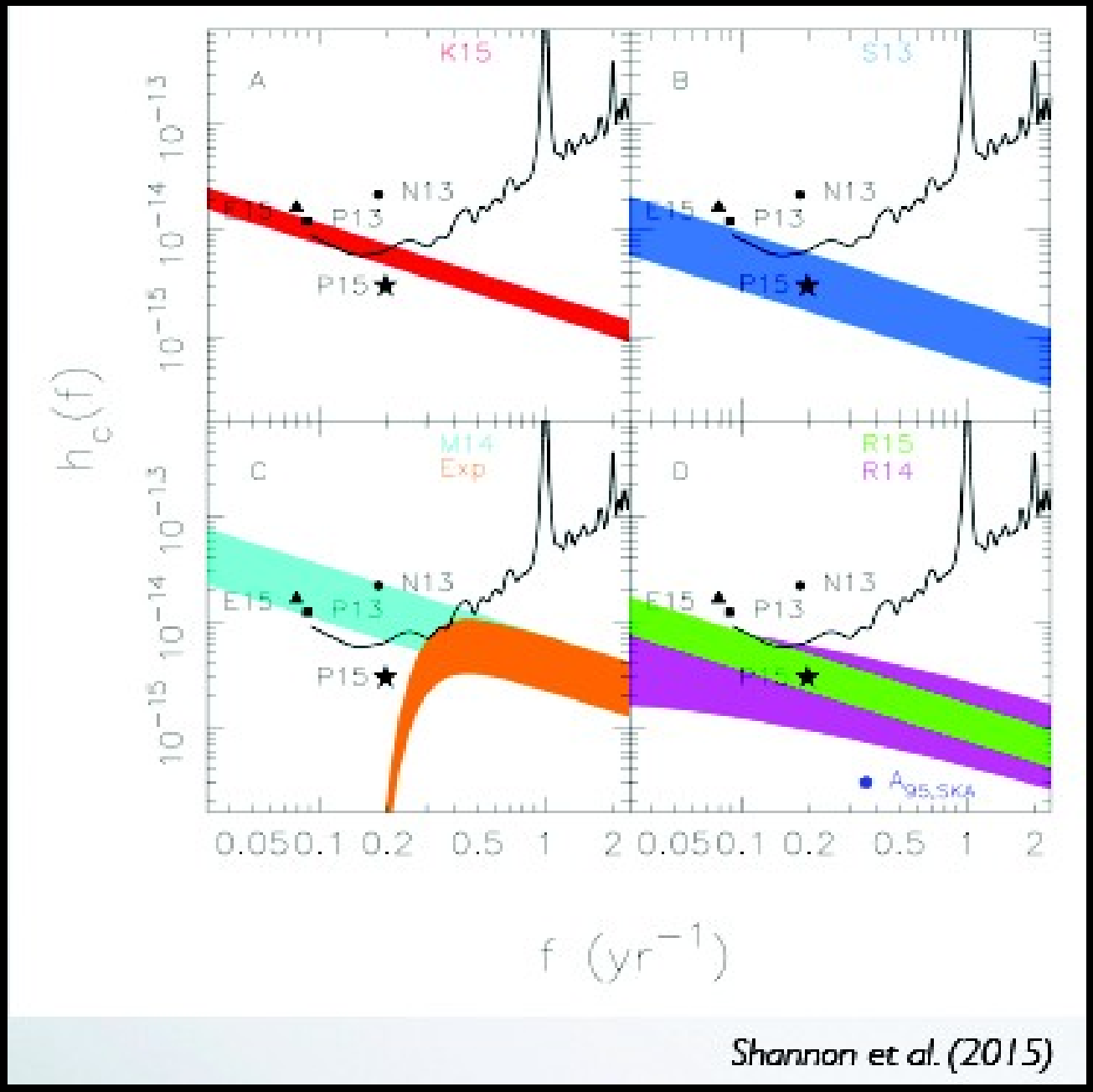




*It is not smooth
*It is not Gaussian
*Single sources might pop-up
*The distribution of the brightest sources might well be anisotropic

Limits on isotropic stochastic backgrounds

(Talk by Oslowski)



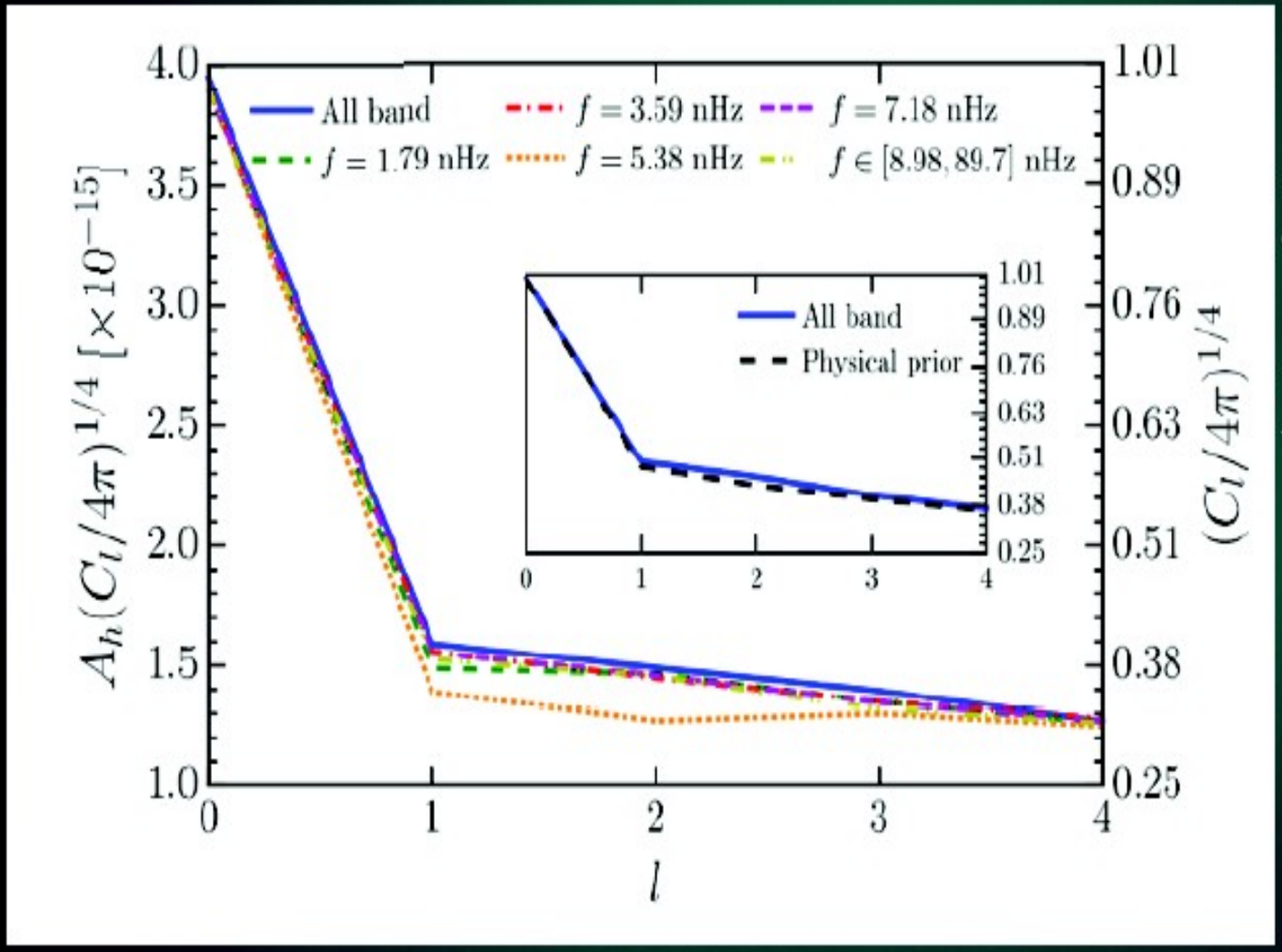
***It rules out some very optimistic models**

***It starts to constrain more conservative vanilla models (circular GW driven binaries)**

***It is consistent with more sophisticated models including environmental effects**

First search for anisotropic backgrounds

(Talk by Lentati)



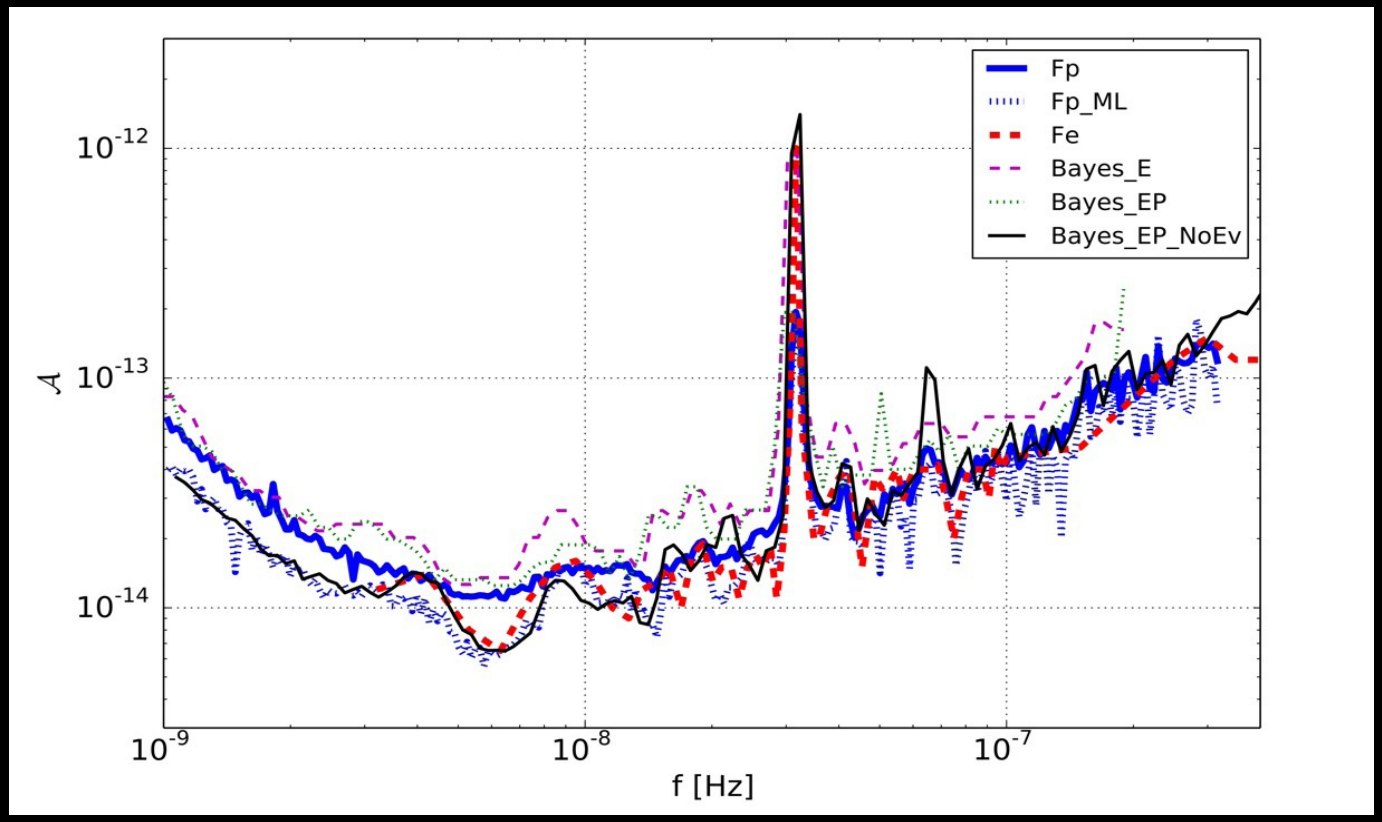
Data provides no constraints on anisotropy (yet!).

Upper limits at each scale the result of physical prior.

Figure:
Taylor et. al. 2015

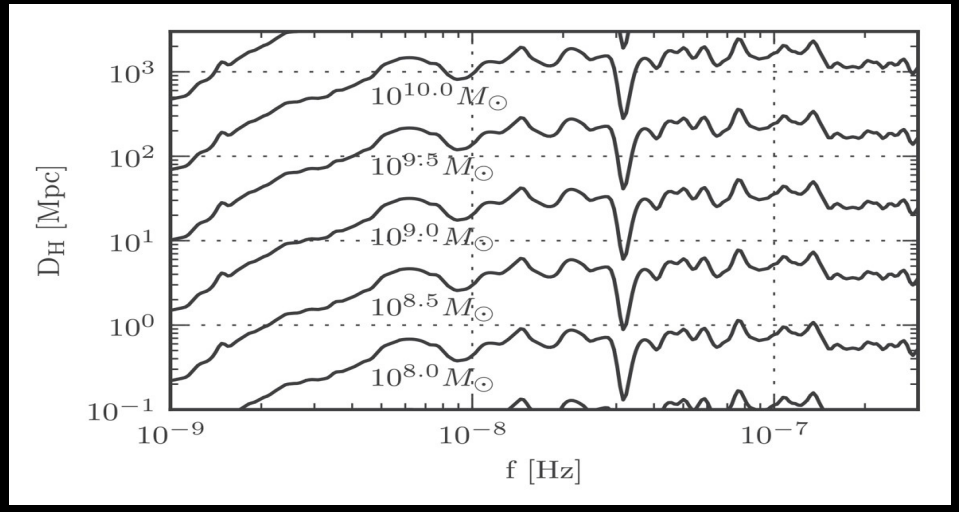
Limits on individual massive black hole binaries

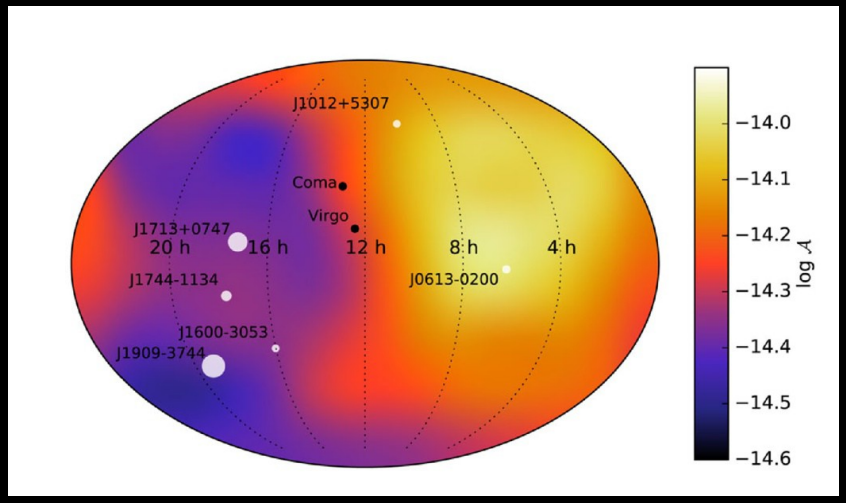
(Talk by Lassus)



*It rules out the existence of massive binaries within few hundred Mpc (in the PTA band)

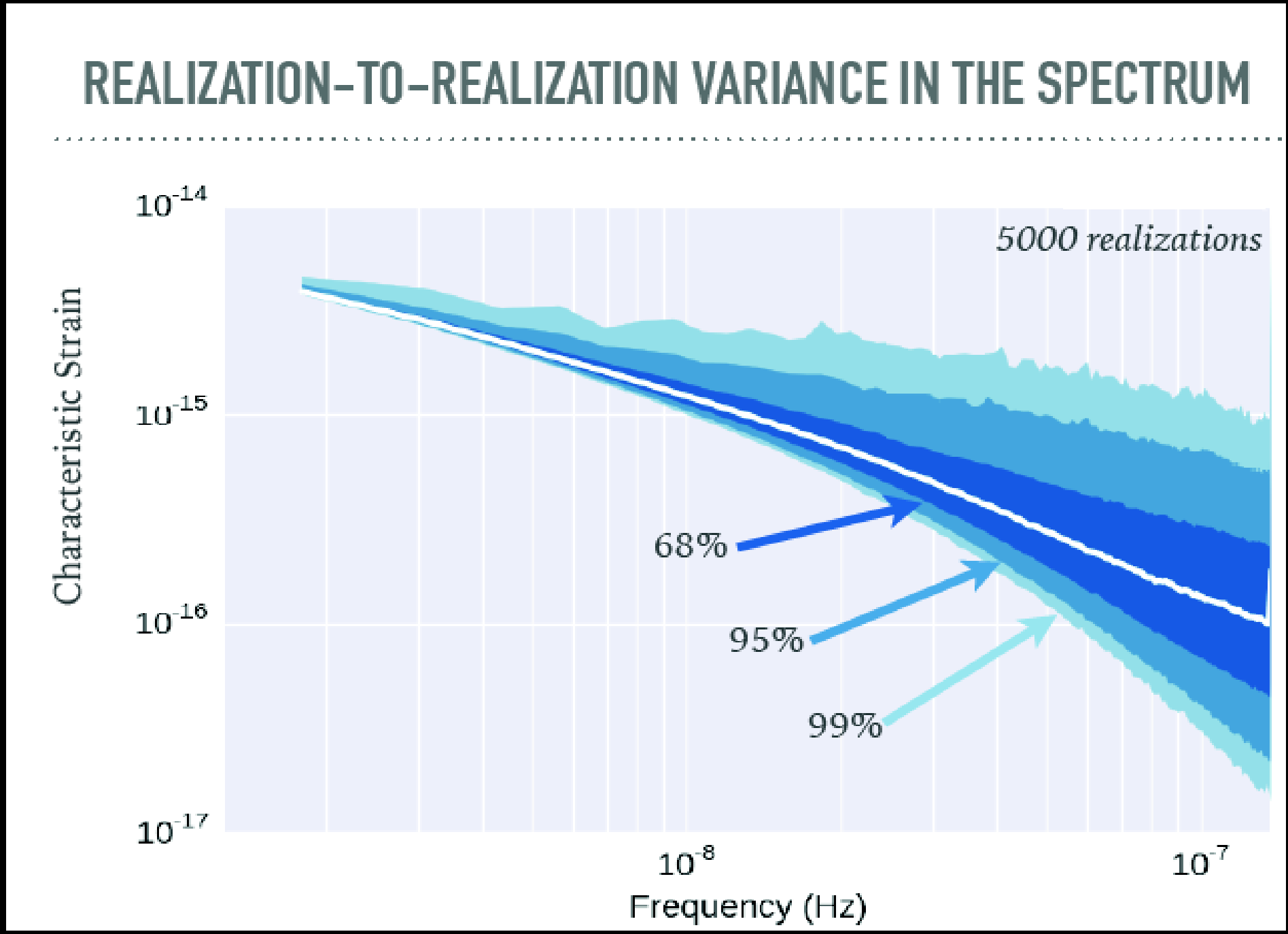
*sensitivity strongly dependent on sky location





Intrinsic variance of the signal

(Talk by Roebber)



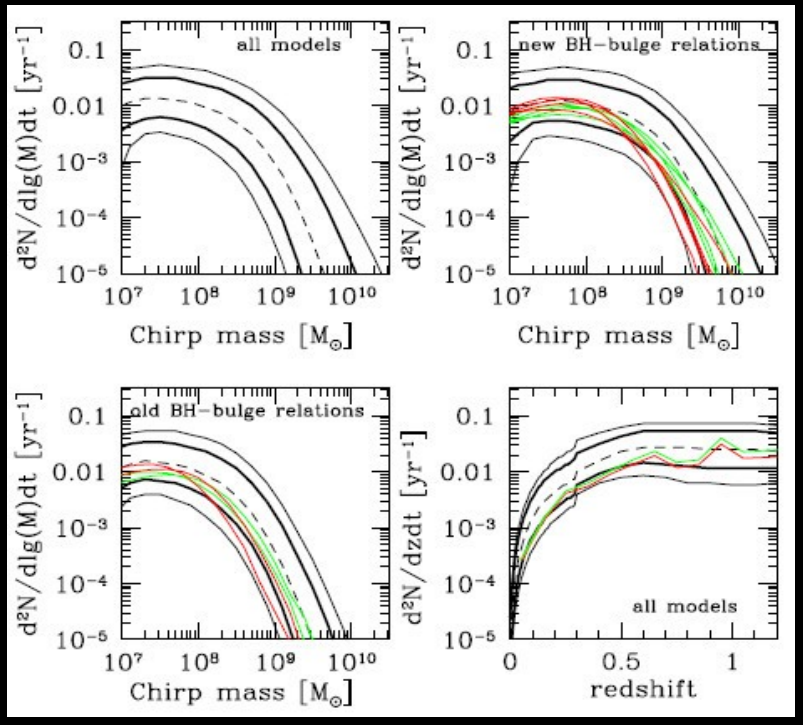
Uncertainties in the normalization

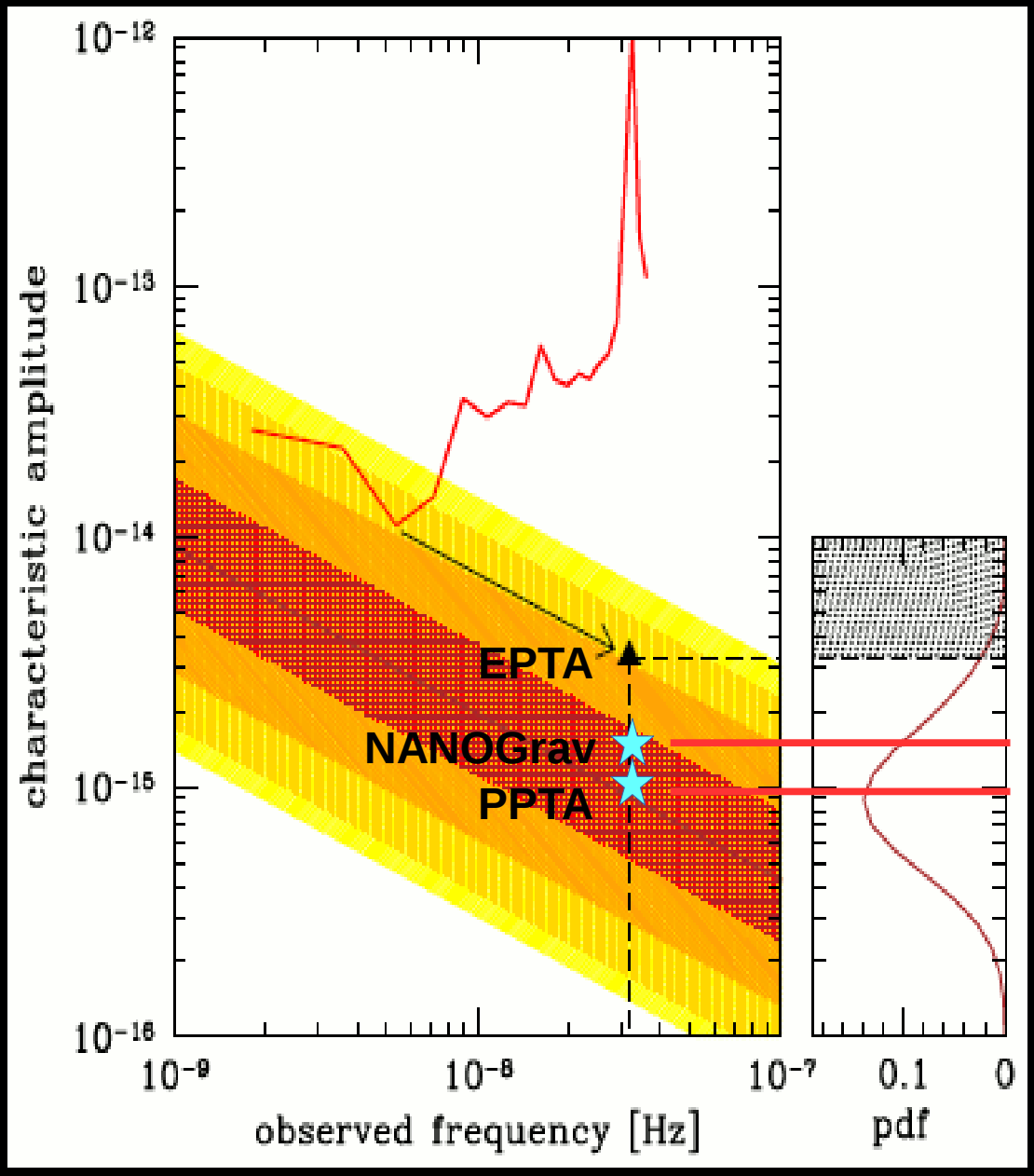
(Talk by Sesana)

The MBHB merger rate is poorly Determined:

-The galaxy merger rate is not know very well observationally

-The MBH-galaxy scaling relations have uncertainties and scatter

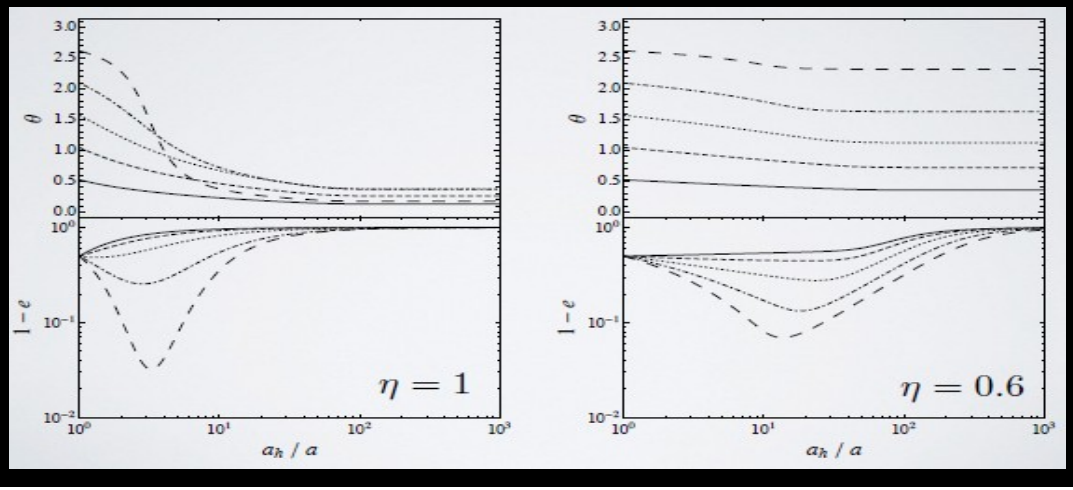




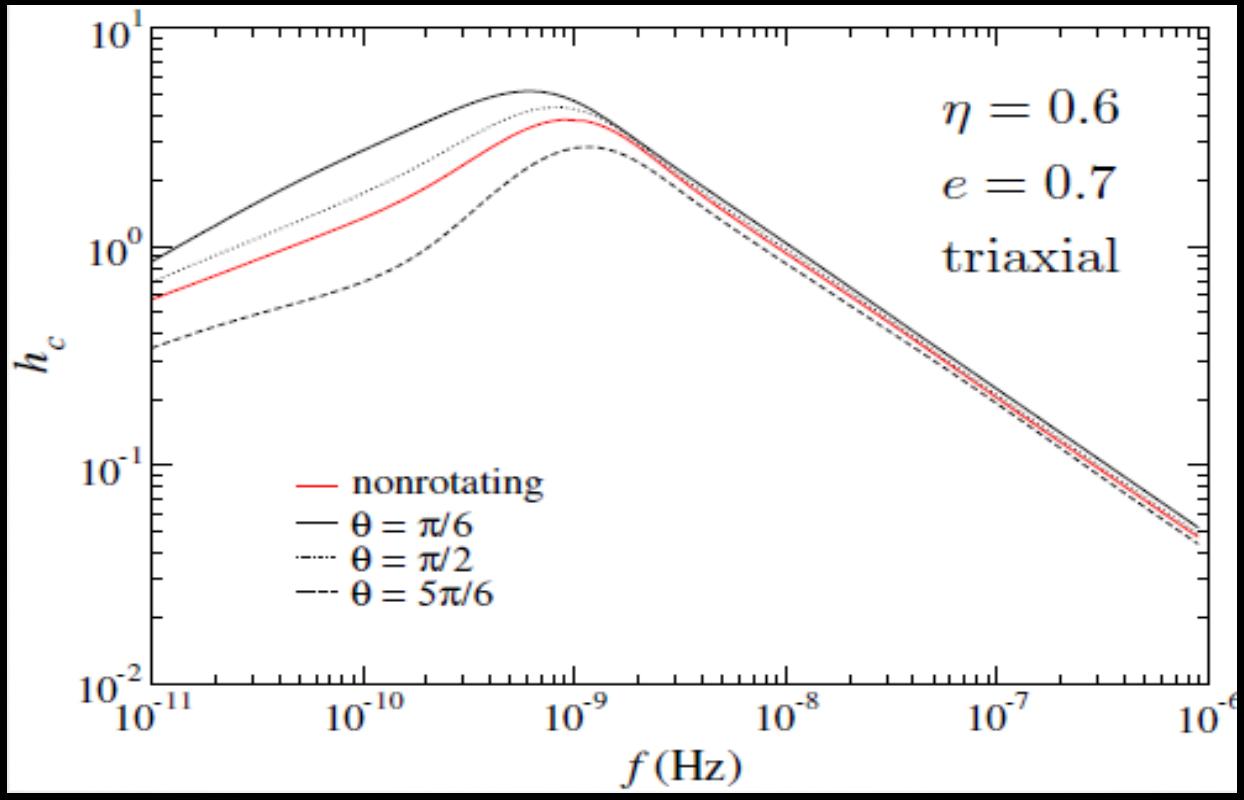
(AS 2008, 2013; Ravi et al. 2012, 2015; Roebber er al. 2015; Kulier et al. 2014; McWilliams et al. 2014)

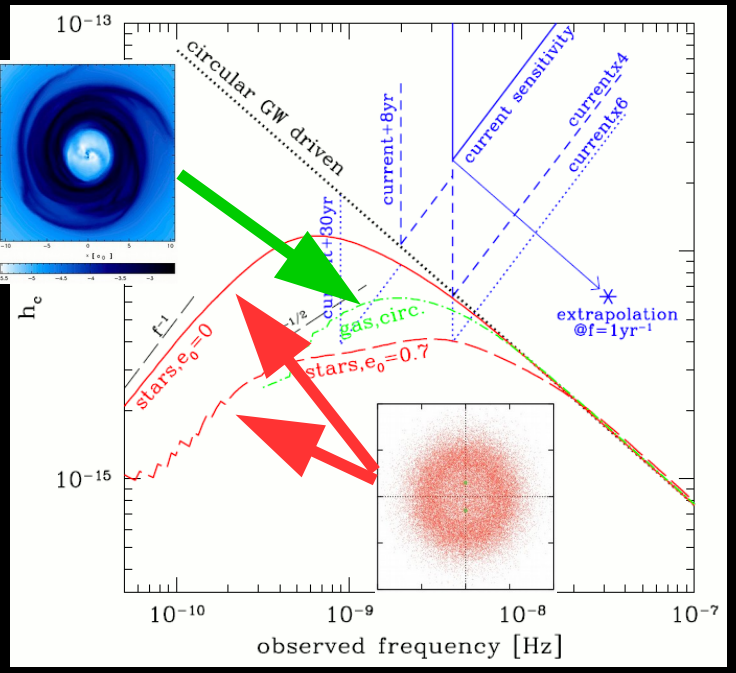
Environmental coupling: uncertainties in the spectral shape

(Talk by Rasskazov)



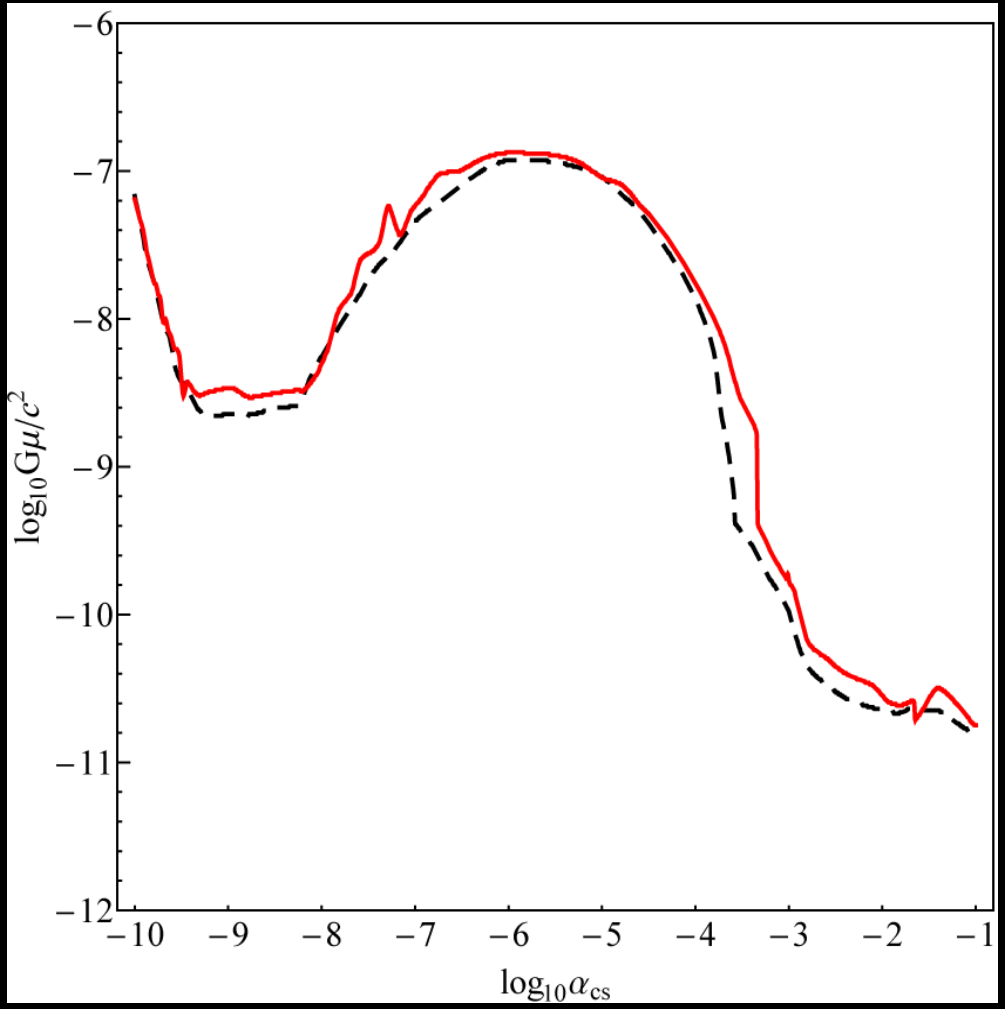
- *Environment and eccentricity may suppress the low frequency signal
- *Eccentricity evolution depends on background rotation
- *Potentially problematic for detection

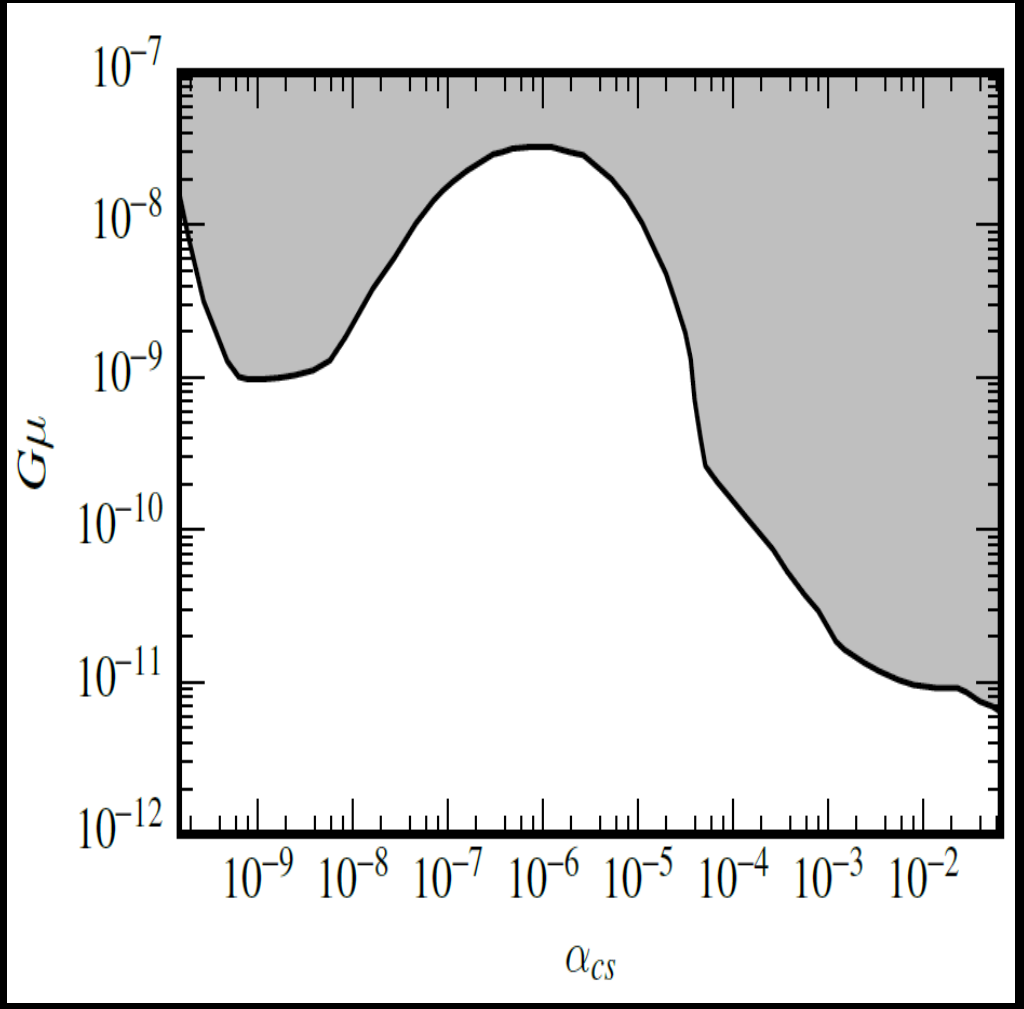




Limits on cosmic string tension

(Talk by Sanidas)





***EPTA beat the CMB limit**

***NANOGrav bring it down by another factor of 4**

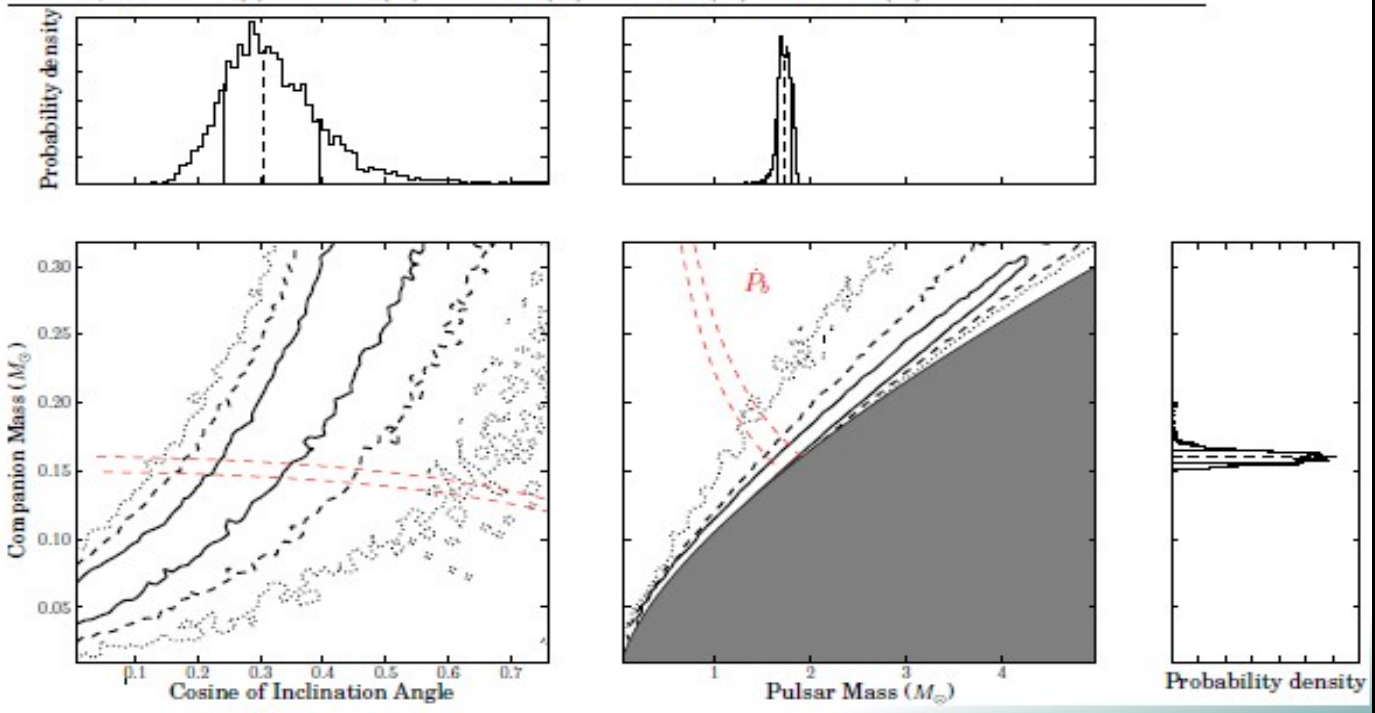
Example of other first class science with PTAs

- 9 new proper motions (additional 7 PM improved by a factor 10)
- 7 new parallaxes and improvement on a few others
- All Px corrected from the Lutz-Kelker bias
- 6 new apparent $\dot{x}$
- new Shapiro measurement in PSR J1918-0642
- good Shapiro measurement in PSR J1600-3053
- update on the masses of PSR J0751+1807

(Talk by Desvignes)

J0751+1807: Mass-Mass diagram

PSR JName	D_π (kpc)	$\dot{P}_b$ ($\times 10^{-13}$)	$\dot{P}_{b\_kin}$ ($\times 10^{-13}$)	$\dot{P}_{b\_kz}$ ($\times 10^{-13}$)	$\dot{P}_{b\_dgr}$ ($\times 10^{-13}$)	$\dot{P}_{b\_GR}$ ($\times 10^{-13}$)	$D_{\dot{P}_b}$ (kpc)
J0751+1807	1.0(2)	-0.350(25)	+0.103(21)	-0.0101(11)	+0. 0117(24)	—	—

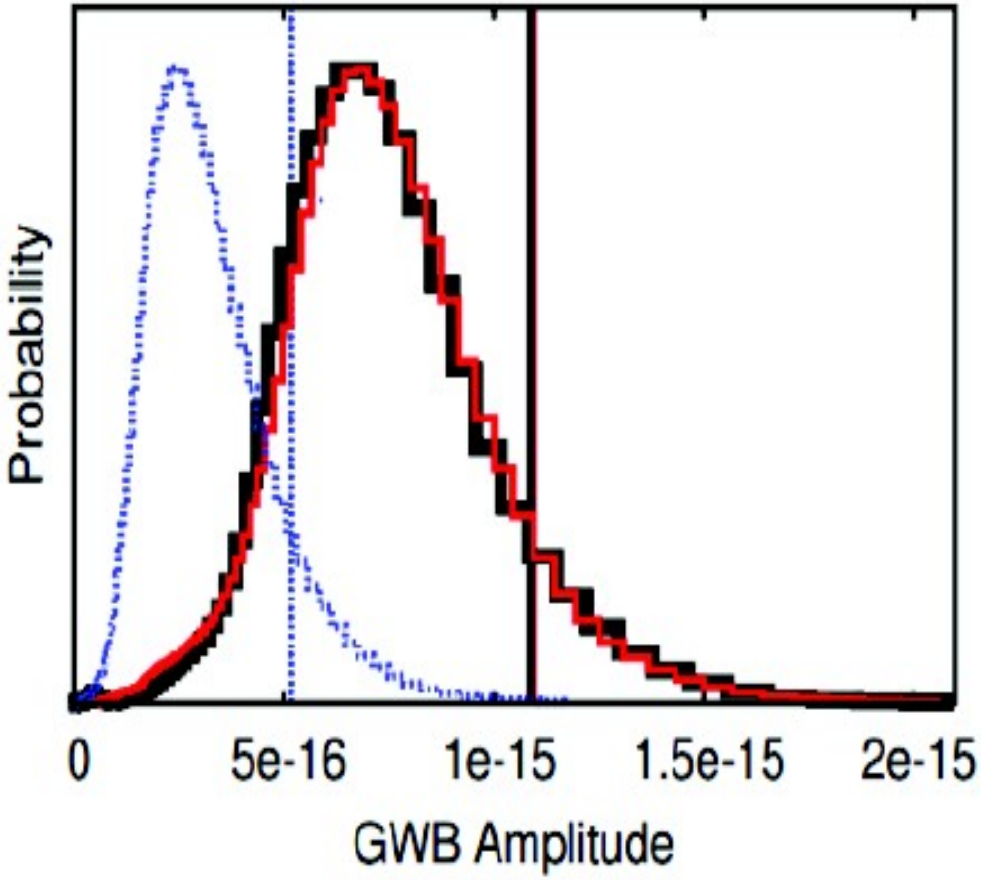


$$M_p = 1.72^{+0.07}_{-0.07}\ M_\odot$$
$$M_c = 0.160^{+0.005}_{-0.005}\ M_\odot$$

New techniques to improve sensitivity

(Talk by Lentati)

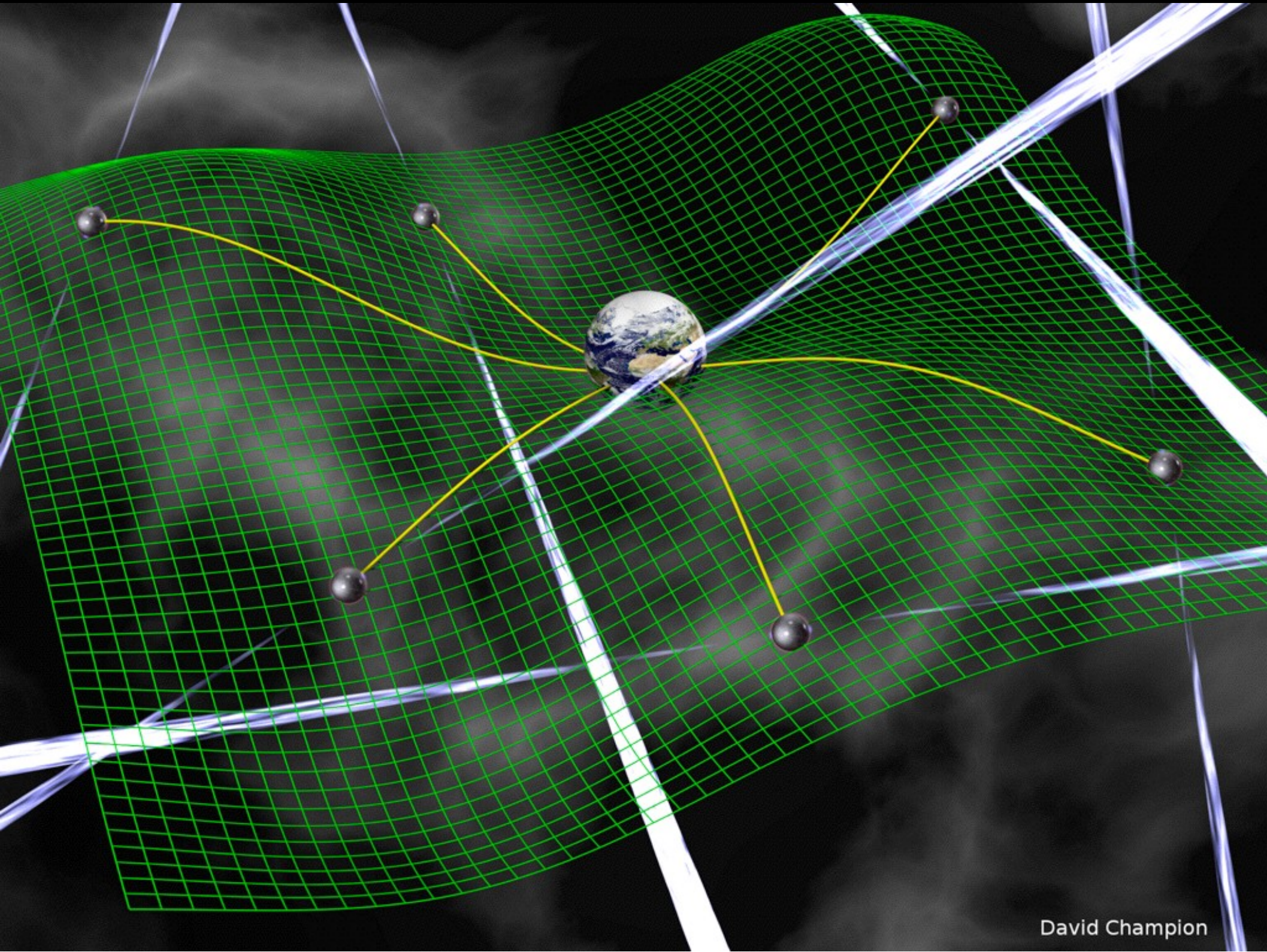
Profile Domain Analysis:



Standard analysis: Shifts and shape change totally covariant.
Profile domain: Shifts and shape change decoupled.

Upper limits significantly improved in the presence of shape variation.

From Previous Simulation


David Champion