Forecast for the future detection of gravitational waves coming from supercooled phase transition

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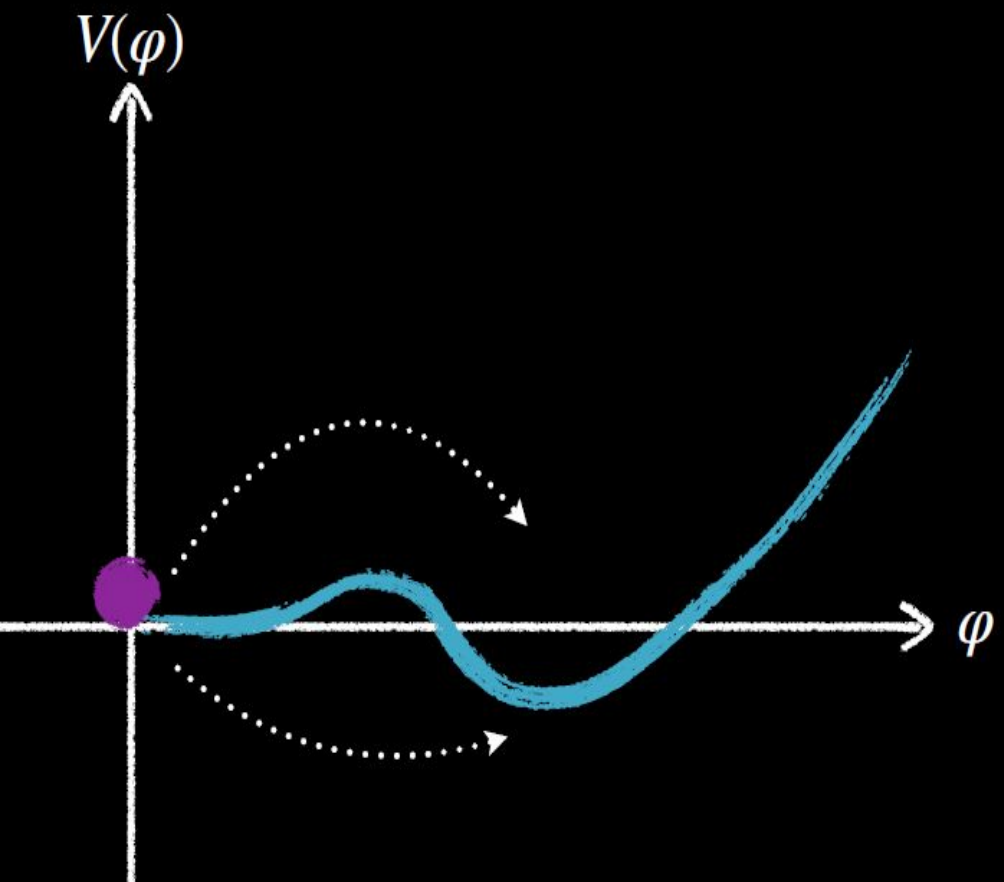
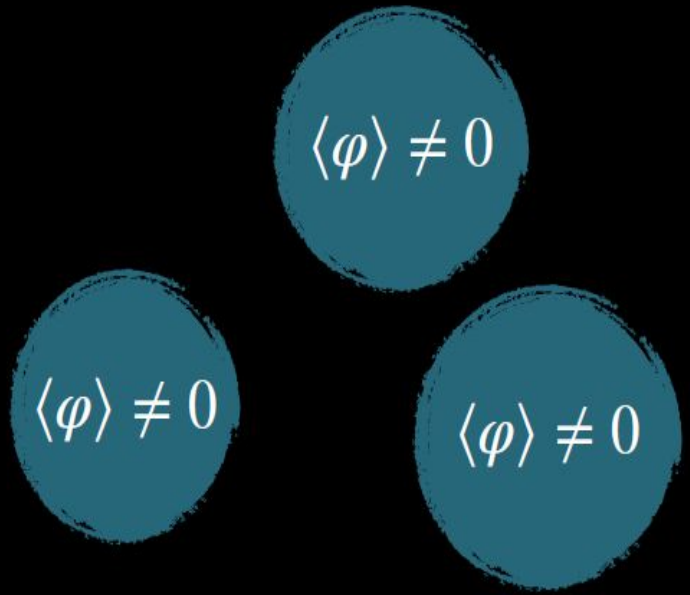
to be published soon

FIRST-ORDER PHASE TRANSITION

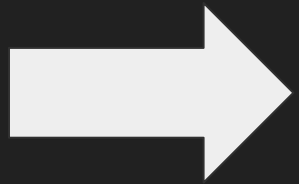
Courtesy of
B. Świeżewska





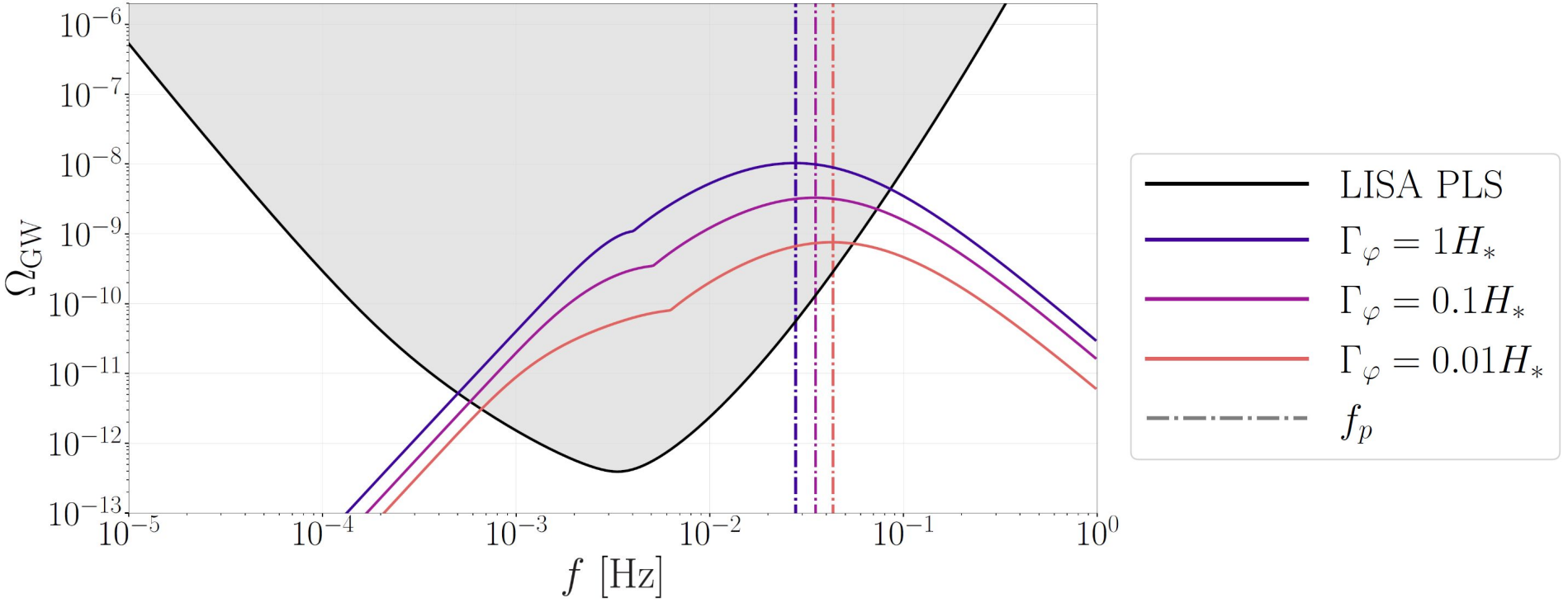
Simplified key idea

- How can we differentiate between models when observing gravitational waves coming from a supercooled phase transition (PT)?
- Do gravitational waves carry any information about fundamental interactions?

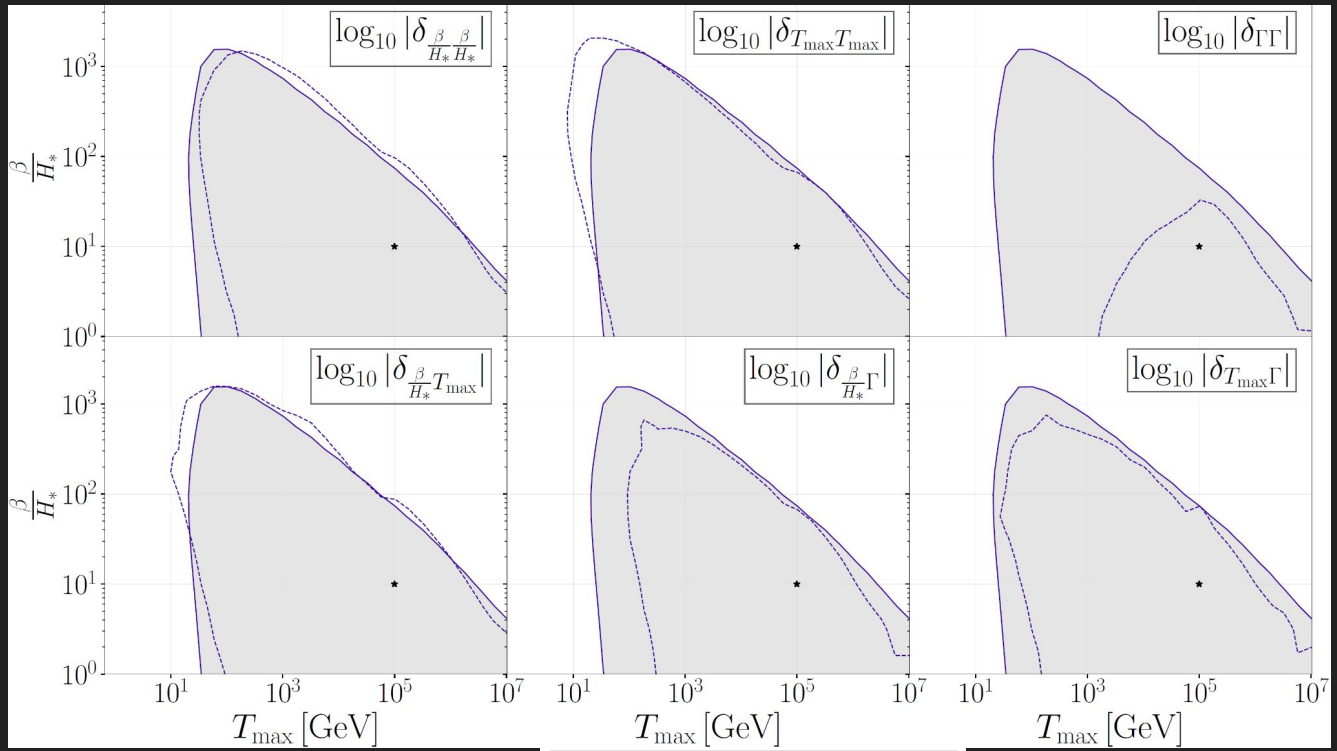


- Our answer lies in measurement of scalar field decay rate Γ/H, from the gravional wave spectra. This parameter determines how long reheating lasts after the phase transition.
- Different models yield different values of Γ/H.
- Precise measurement of Γ/H, would serve as messenger about fundamental interactions.

Gravitational waves from supercooled phase transition.



Results: relative error and detectability in LISA



$\Gamma_\varphi = 1H_*$

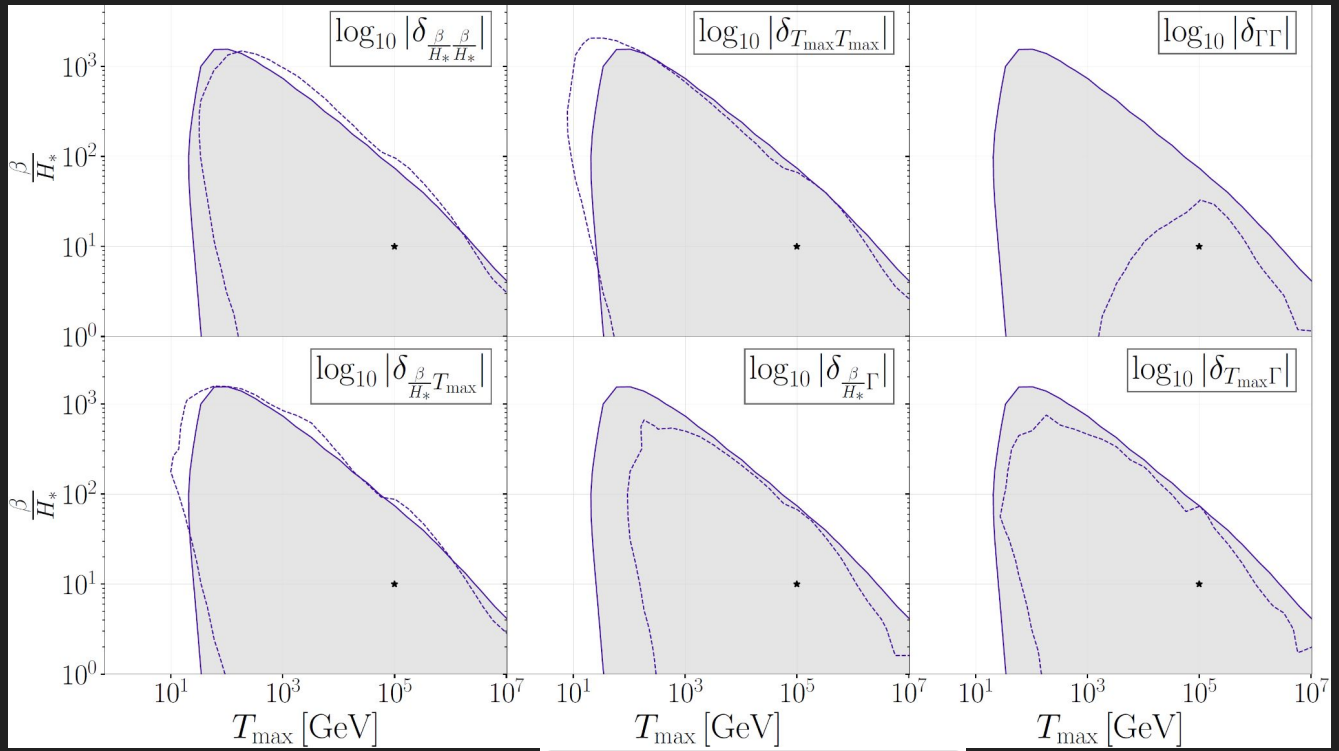
$\log_{10}\delta_{xy} = -1$

$\mathrm{SNR} = 10$

Relative Error

Border of Detection

Results: relative error and detectability in LISA



Conclusions:

- We will be able to determine temperature and β/H assuming we will observe such a signal.
- Determining Γ/H would require a very strong signal, which might be realized in nature.
- Gravitational wave may give us information about fundamental physics models.

Fisher Estimation

Back-up-slide

IX. *On the Mathematical Foundations of Theoretical Statistics.*

By R. A. Fisher, M.A., *Fellow of Gonville and Caius College, Cambridge, Chief Statistician, Rothamsted Experimental Station, Harpenden.*

Communicated by Dr. E. J. Russell, F.R.S.

Received June 25,—Read November 17, 1921.

$$F_{\alpha\beta} = T_{\rm obs} \int_{f_{\rm min}}^{f_{\rm max}} {\rm d}f \, \frac{\frac{\partial \Omega_{\rm GW}}{\partial \theta_\alpha} \frac{\partial \Omega_{\rm GW}}{\partial \theta_\beta}}{\left(\Omega_{\rm noise} + \Omega_{\rm GW}\right)^2}$$

The inverse of the Fisher matrix gives the squared covariance matrix

$$\sigma^2 = F^{-1} \, .$$

Arxiv:2108.01167

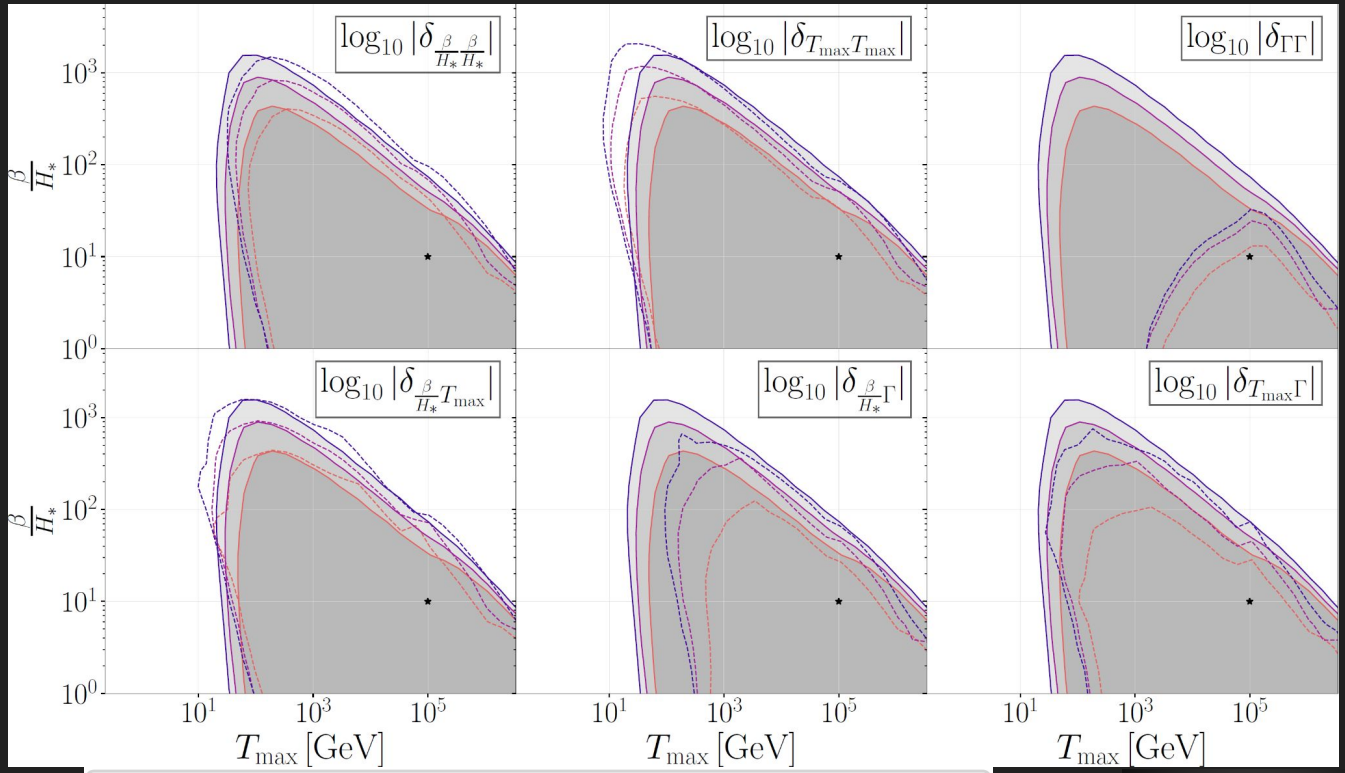
LISA CONSORTIUM — Laser Interferometer Space Antenna

Ref : LISA-LCST-SGS-TN-001	
Issue : 1	Revision : 0
Date : 2021/08/04	Page : 1/ 42

LISA Sensitivity and SNR Calculations

N/Ref :	LISA-LCST-SGS-TN-001
Title	**LISA Sensitivity and SNR Calculations**
Abstract	This Technical Note (LISA reference LISA-LCST-SGS-TN-001) describes the computation of the noise power spectral density, the sensitivity curve and the signal-to-noise ratio for LISA (Laser Interferometer Antenna). It is an applicable document for ESA (European Space Agency) and the reference for the LISA Science Requirement Document.

Results: relative error and detectability in LISA (back-up-slide)



$\Gamma_\varphi = 1H_*$

$\Gamma_\varphi = 0.1H_*$

$\Gamma_\varphi = 0.01H_*$

$\log_{10}\delta_{xy} = -1$

$\mathrm{SNR} = 10$

Relative Error

Border of Detection

Conclusions:

- We will be able to determine temperature and β/H assuming we will observe such a signal.
- Determining Γ/H would require a very strong signal, which might be realized in nature.
- Gravitational wave may give us information about fundamental physics models.