Looking for a SFOEWPT in the RxSM at the HL-LHC and LISA

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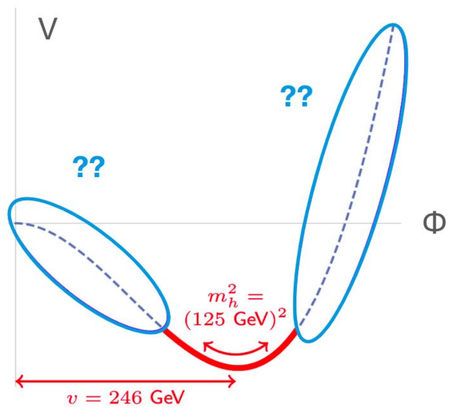
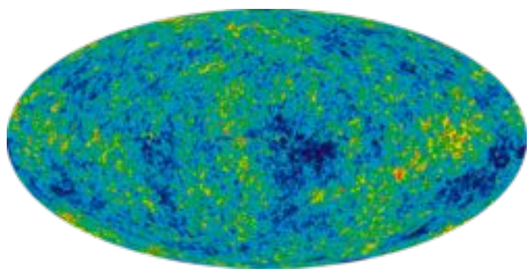
Based on arXiv: 2506.xxxx

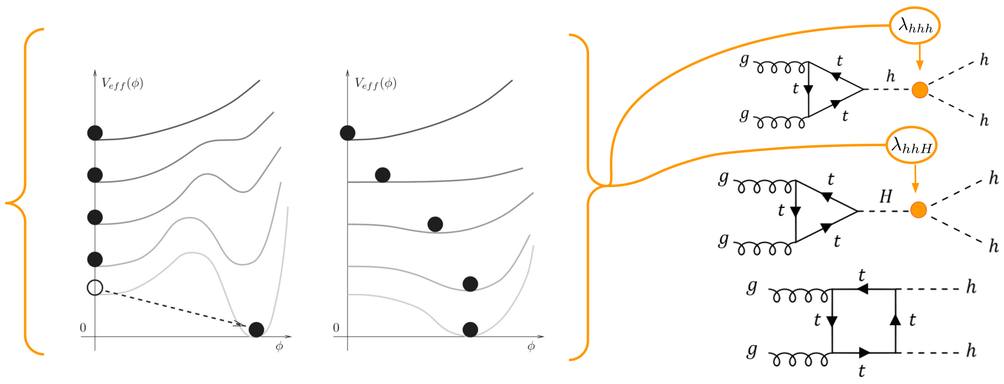
Why?



Away from the electroweak minimum **the Higgs potential is unknown**



The **baryon asymmetry** of the universe can **not be explained in the SM**



Phase transition dynamics information is encapsulated in the **one-loop trilinear Higgs couplings** λ_{ijk} appearing in gg→hh

How?

Model: RxSM

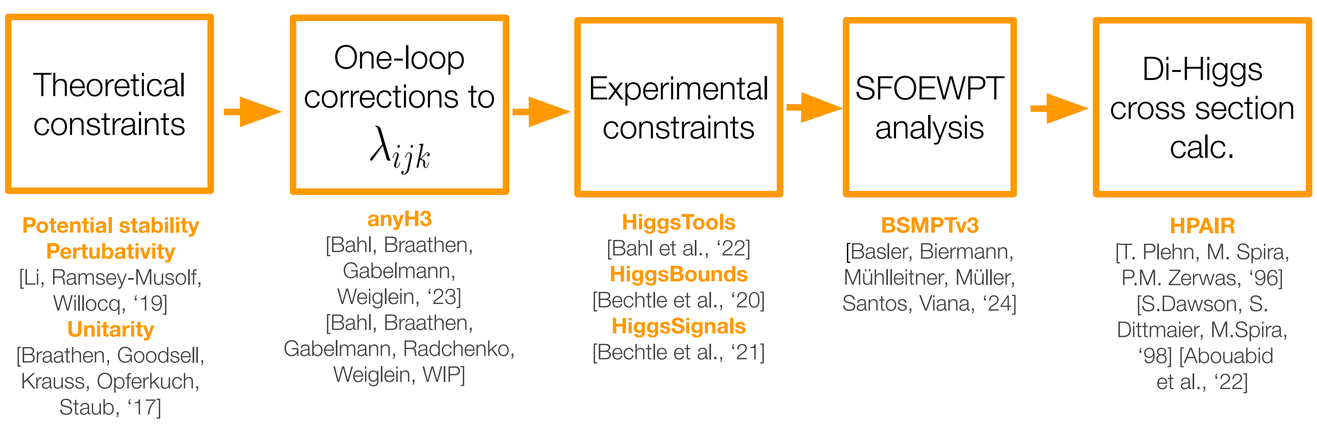
Potential:

$$V(\Phi,S) = \mu^2(\Phi^\dagger\Phi) + \frac{\lambda}{2}(\Phi^\dagger\Phi)^2 + \kappa_{SH}(\Phi^\dagger\Phi)S + \frac{\lambda_{SH}}{2}(\Phi^\dagger\Phi)S^2 + \frac{M_S}{2}S^2 + \frac{\kappa_S}{3}S^3 + \frac{\lambda_S}{2}S^4$$

EW doublet: $\Phi = \begin{pmatrix} 0 \\ \frac{\phi+v}{\sqrt{2}} \end{pmatrix}$ Singlet: $S = s + v_S$ Free parameters: $m_h, m_H, \alpha, v, v_S, \kappa_S, \kappa_{SH}$

Full OS renormalization of the RxSM scalar sector
[Braathen, Heinemeyer, AVS]

Set-up



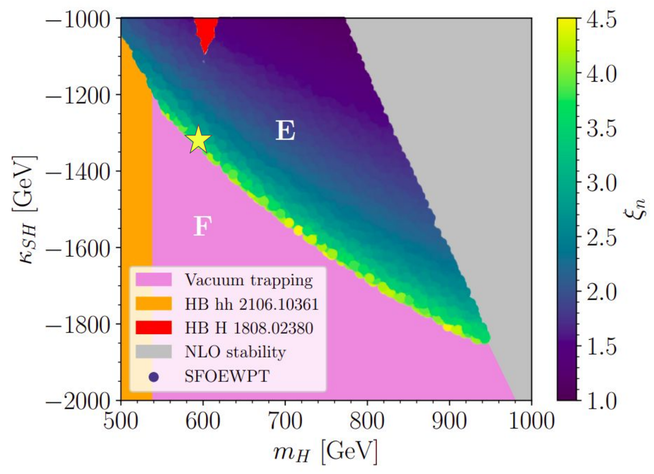
Results

Phase transition analysis

2D Benchmark plane for SFOEWPT:

$m_H \in [260, 1000]$ GeV
$\kappa_{SH} \in [-2000, -1000]$ GeV
$\cos\alpha = 0.98$
$\kappa_S = -300$ GeV
$v_S = 280$ GeV

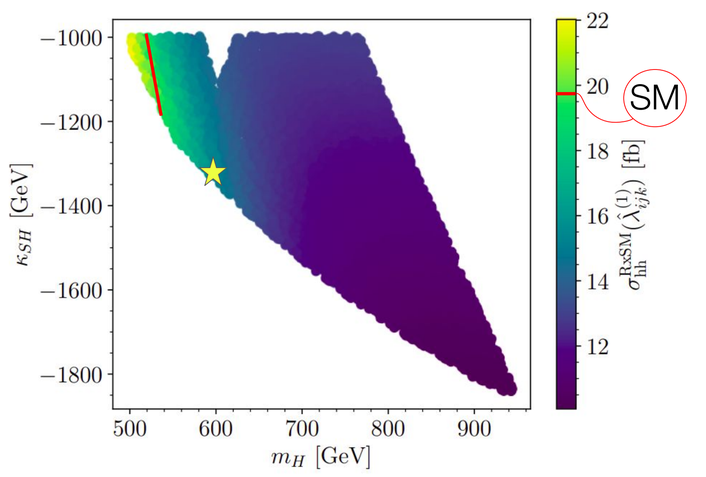
SFOEWPT: $\xi_n = v(T_n)/T_n \gtrsim 1$



Total gg→hh cross-section

The LO QCD SM result is 19.8 fb

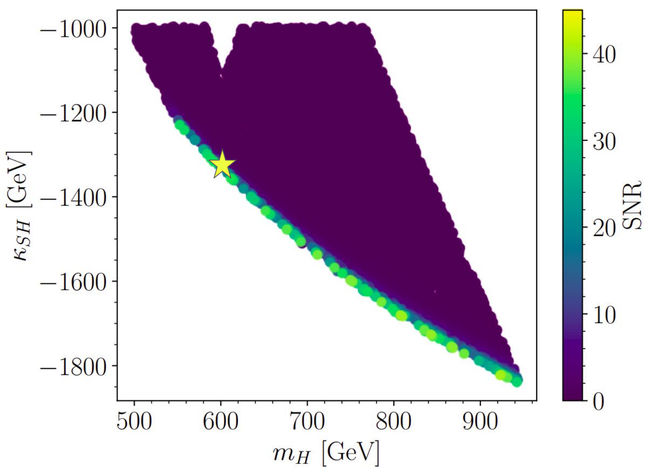
Decrease with respect to the SM due to the increase in κ_λ



Gravitational wave signal

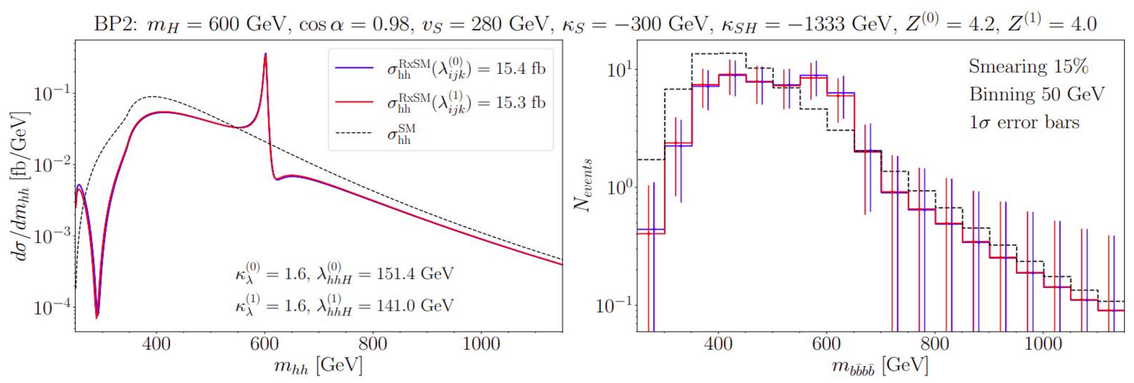
Observability at $LISA_{3y}$: SNR > 10

Narrow observable band within the uncertainty on the bubble wall velocity



Differential gg→hh cross-section

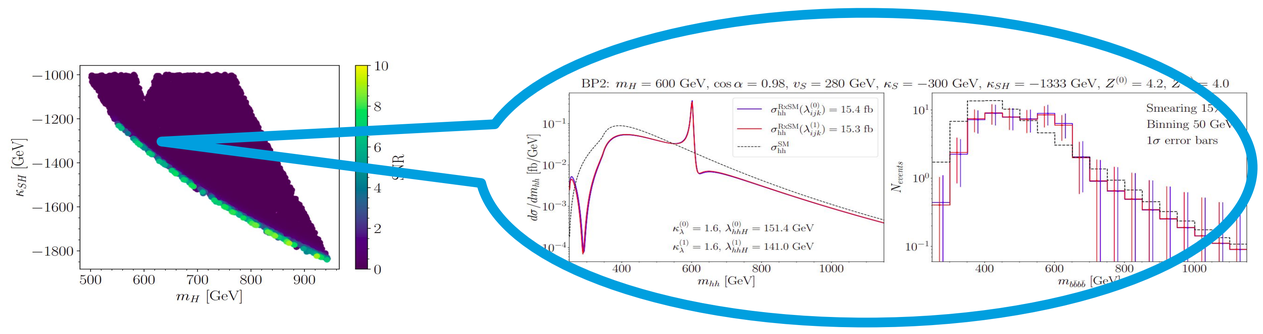
Distinguish the RxSM from the SM also considering experimental uncertainties



Take home message

Step 1

If a **GW signal is observed** at LISA there are **many possible sources**



Step 2

Then **look for a compatible collider signal** to cross-check if we are in a BSM model with a SFOEWPT

If you have any questions, please feel free to ask

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