

Scalar Matter in Lorentzian Quantum Gravity

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- The spectral-fRG provides direct access to real-time/ Lorentzian objects such as the *graviton spectral function*

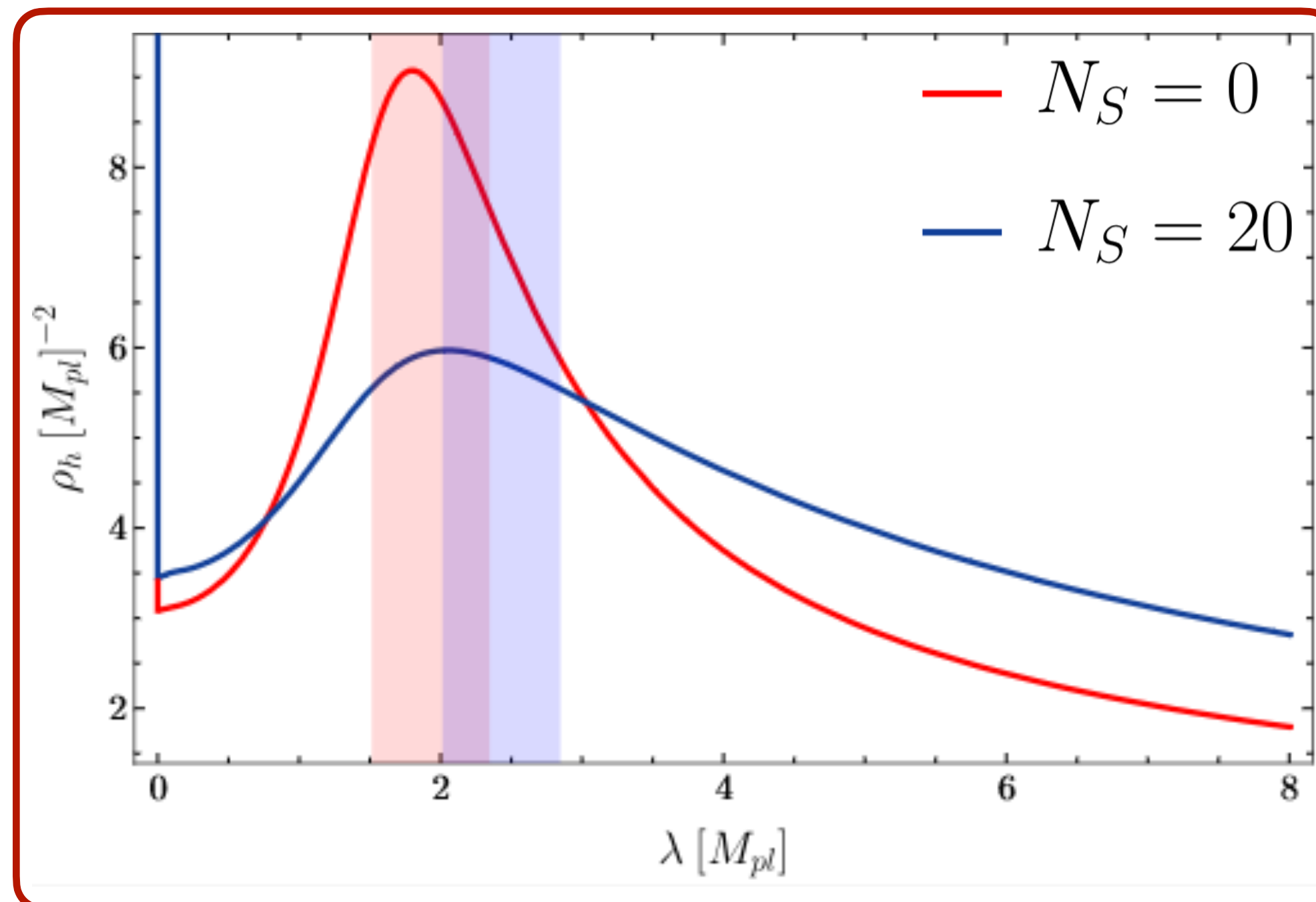
$$\rho_h(\lambda) = \frac{1}{Z_h} \left[2\pi\delta(\lambda^2 - m_h^2) + \theta(\lambda^2 - 4m_h^2)f_{h,\text{grav}} + \theta(\lambda^2 - 4k^2)f_{h,\text{scalar}} \right]$$

- Asymptotic safety in the Lorentzian signature must be compatible with *matter*:

$$\partial_t \Gamma_k^{(hh)} = \text{[Diagram: Solid loop with cross]} + N_S \text{[Diagram: Dashed loop with cross]}$$

Incorporating *Scalar* matter!

*Transverse
Traceless
graviton
spectral
function*



- Scalar matter makes a *positive* contribution
- The spectral function remains positive - compatible with *unitarity*