Cosmological SGWB anisotropies

PRD 107 (2023), "*New universal property of cosmological GW anisotropies*" with E. Dimastrogiovanni, G. Domènech, M. Fasiello and G. Tasinato

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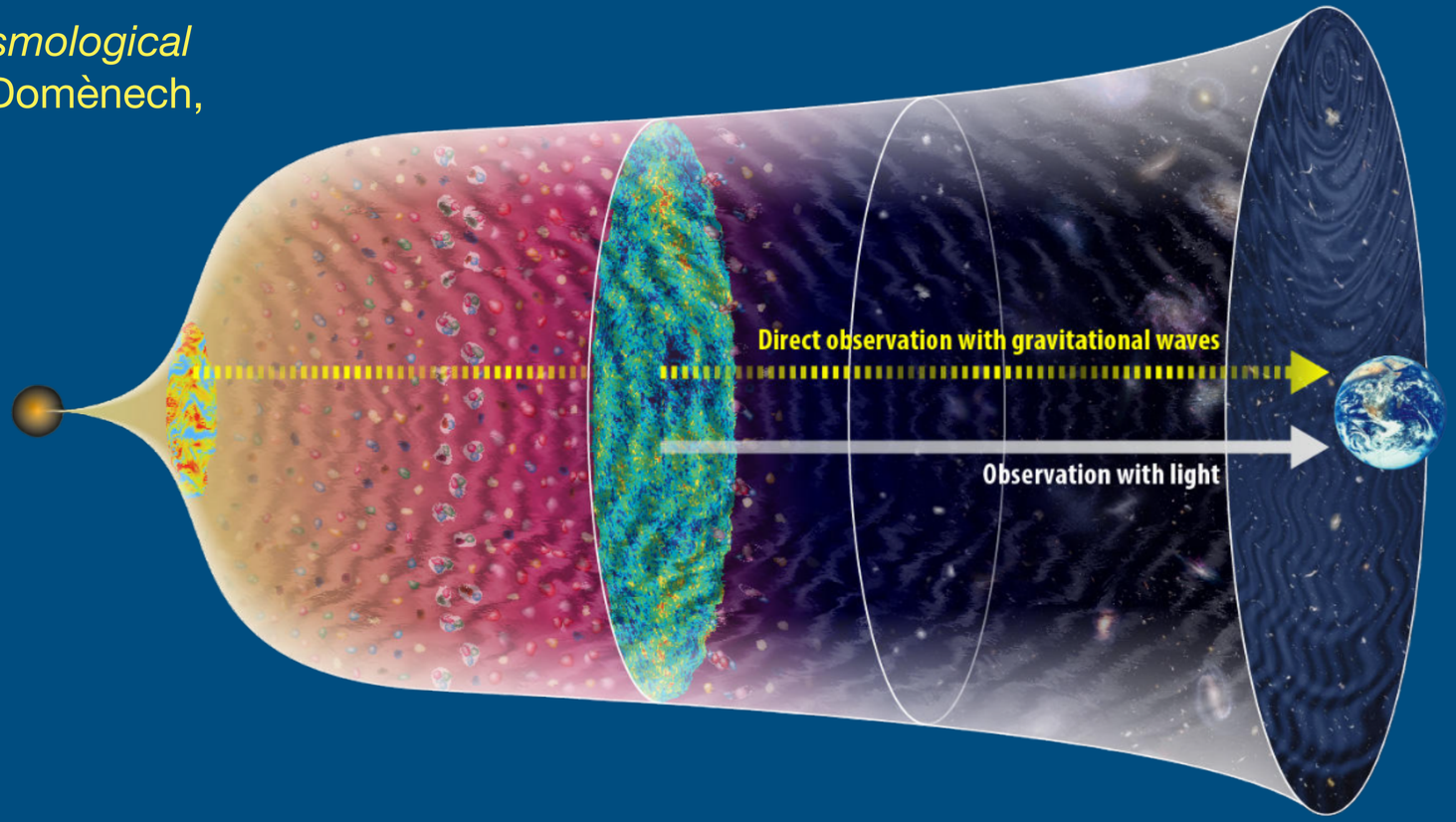
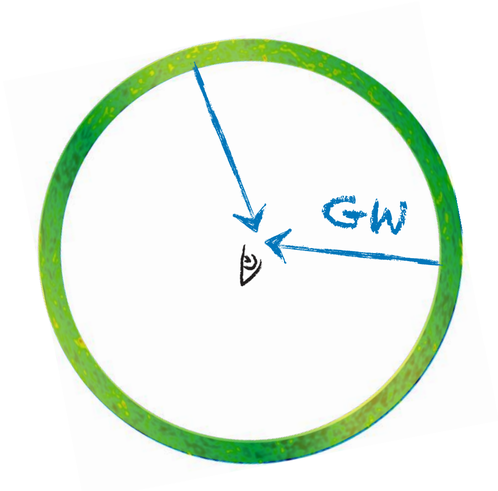
Third EuCAPT Symposium



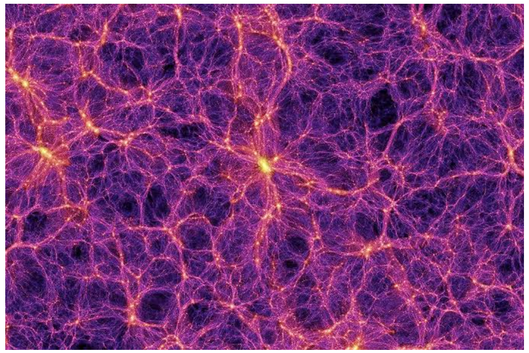
SGWB Anisotropies

GW Production



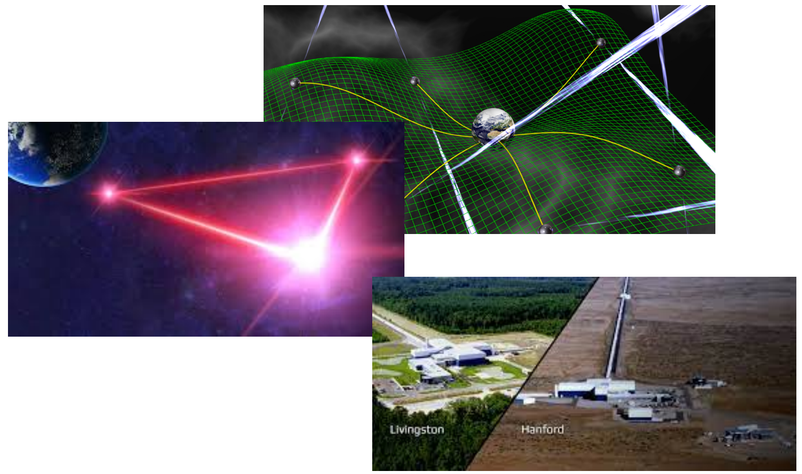
Primordial source properties imprinted on anisotropies
(Inflation, PT, PBH…)

GW Propagation



Propagation through large scale density perturbations

Detection



Characterising SGWB, parameter inference + model constraints

$t \approx 0$

Today

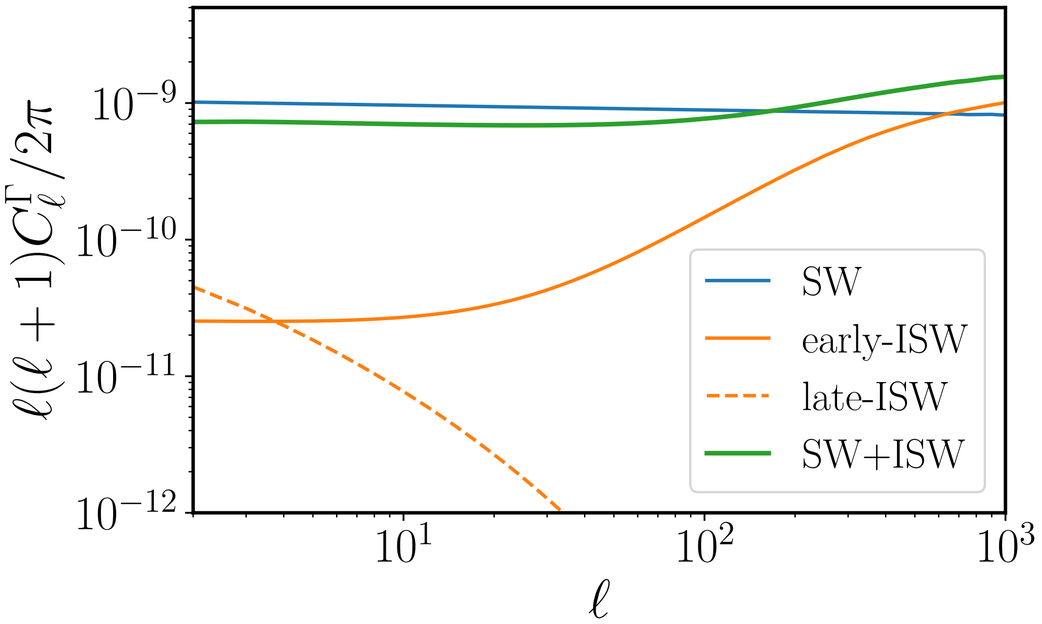
See review by LISA CosWG (2022)

SGWB line-of-sight formalism

CMB-like approach to SGWB anisotropies

$$\underbrace{\Gamma(\eta_0, k, f, \hat{n})}_{\text{“}\Delta T/T\text{” for GW}} = \Gamma_I + \Phi_I + \int_{\eta_i}^{\eta_0} d\eta \left\{\Phi'(k,\eta) + \Psi'(k,\eta)\right\} e^{-i\hat{k}\cdot\hat{n}(\eta_0 - \eta)}$$

$$\Gamma_I \equiv \Gamma(\eta_i, k, f, \hat{n}) \rightarrow \text{initial perturbation}$$
$$\Phi_I \equiv \Phi(k, \eta_i) \rightarrow \text{SW}$$
$$\Phi'(k,\eta) + \Psi'(k,\eta) \rightarrow \text{ ISW}$$



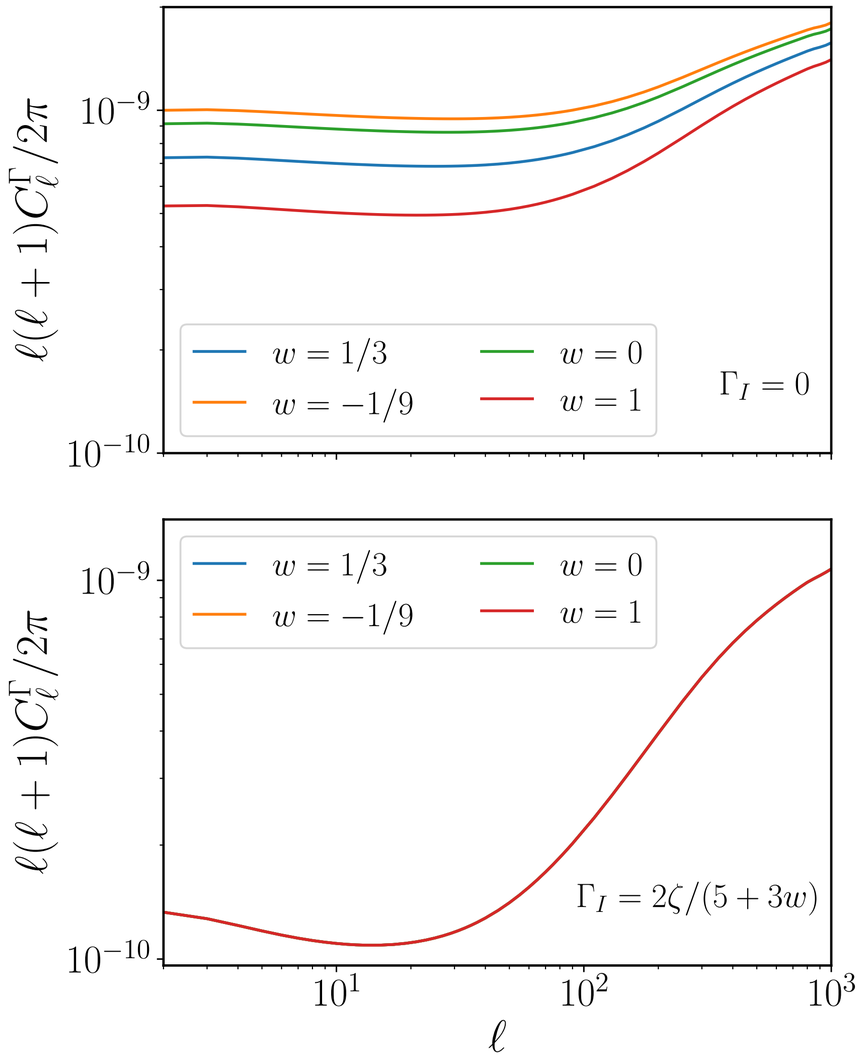
[Alba & Maldacena 2015, Contaldi 2017; Bartolo et al. 2019a, 2019b]

Adiabatic initial conditions

- SGWB produced during an epoch with equation of state w (e.g. kination, eMD..)

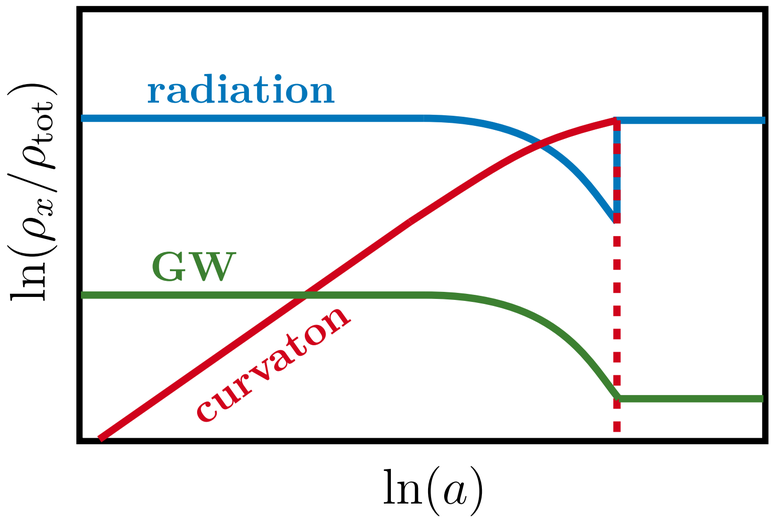
$$\Gamma_I = \frac{2\zeta}{5+3w}, \qquad \Phi_I = -\frac{3(1+w)}{(5+3w)}\zeta$$

- **No** effects in the anisotropies, adiabaticity $\Longrightarrow$ ζ conserved on superhorizon scales



Isocurvature: curvaton mechanism

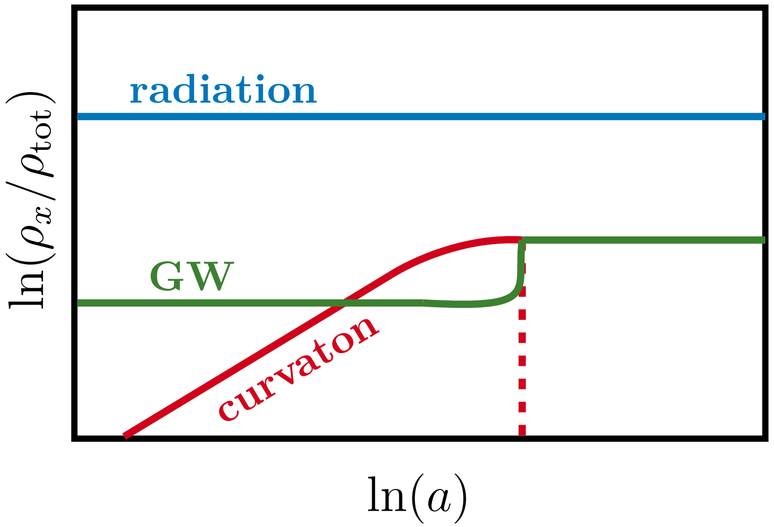
Scenario I



$$C_\ell^\Gamma \propto \left[-\frac{4}{3}\zeta_r \, j_\ell[k\eta_0] + \mathrm{ISW} \right]^2$$

4x adiabatic term

Scenario II

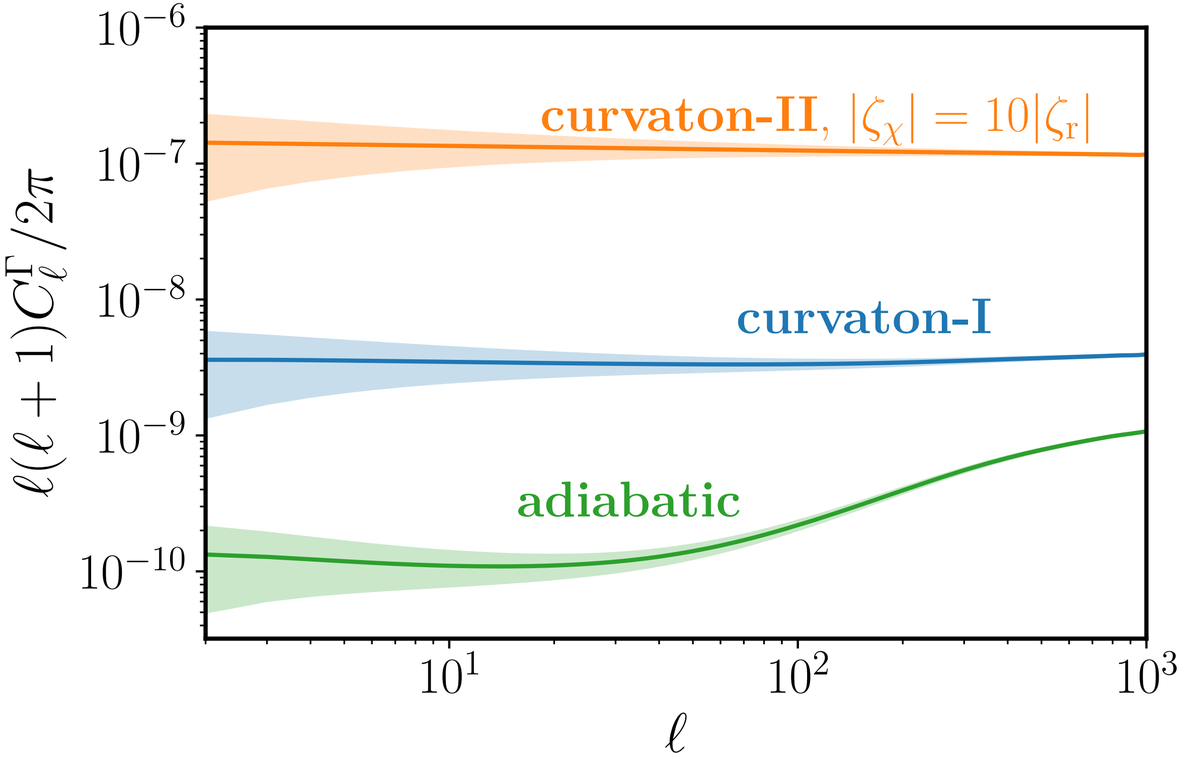


$$C_\ell^\Gamma \propto \left\{ \left[\frac{(1+w_\chi)}{(1+w_r)}\zeta_\chi - \tfrac{1}{3}\zeta_r \right] j_\ell[k\eta_0] + \mathrm{ISW} \right\}^2$$

independent curvaton fluctuations

Summary

- Anisotropies a key property of the SGWB
- Adiabatic anisotropies independent of primordial equation of state
- Distinctive predictions for isocurvature anisotropies based on curvaton mechanism



Thank you!

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