A model for superheavy dark matter that can possibly be tested with Pulsar Timing Arrays

Rome Samanta

SSM and INFN Napoli

Dark matter production in the Early Universe

Interaction Lagrangian

Cosmological background

Simplest: The mass term, M N N

Simplest: radiation

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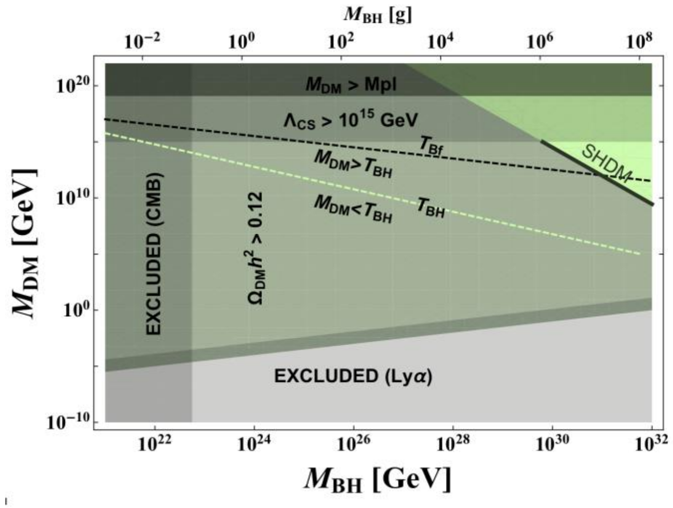

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Samanta et al, JCAP,2022

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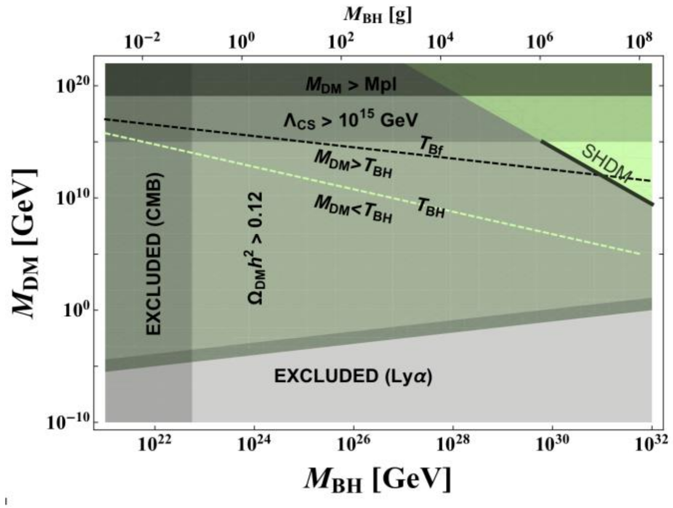

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Signatures?

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GWs relating to ultralight primordial black holes

Graviton emission, Merger formation

High frequency GWs

See e.g., 2211.15726

PBH formation, PBH density fluctuation

Detectable, e.g., at LISA,
But strongly dependent on large initial abundance of PBHs

$$\beta \equiv \frac{\rho_{BH}(t_{Bf})}{\rho_{\rm R}(t_{Bf})}$$

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Work with $\beta \equiv \frac{\rho_{BH}(t_{Bf})}{\rho_R(t_{Bf})}$ so that the PBHs dominate the energy density

The scenario

Lagrangian

Simplest: The mass term, M N N

Make the mass term dynamic (M= f*v) with a gauged U(1): One can find motivation from GUT
Get **cosmic strings: radiate GWs with amplitude μ=v^2**

Cosmological background

Exotic: PBH domination

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SSM
Scuola Superiore Meridionale
INFN
NAPOLI

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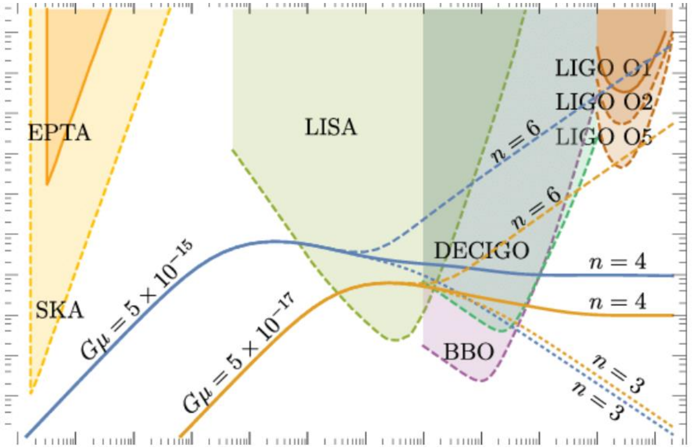

Y. Cui et al, 2019

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Cosmological background

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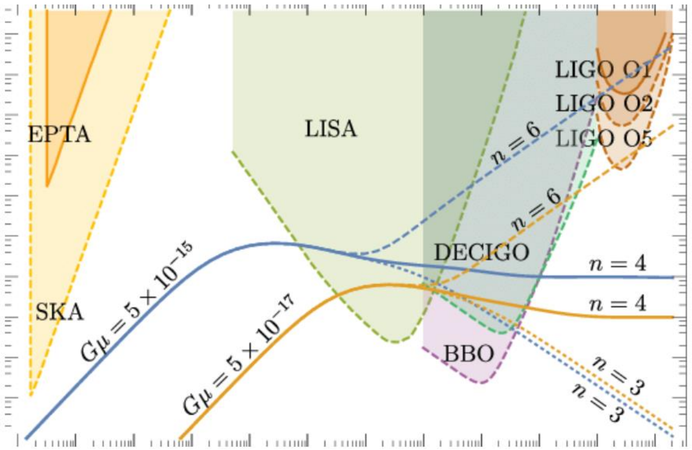
Correct relic of super heavy DM

$$f_* \simeq 2.1 \times 10^{-8} \sqrt{\frac{50}{z_{\rm eq}\alpha\Gamma G\mu}} \left(\frac{M_{DM}}{T_0}\right)^{3/5} T_0^{-2/5} t_0^{-1}$$



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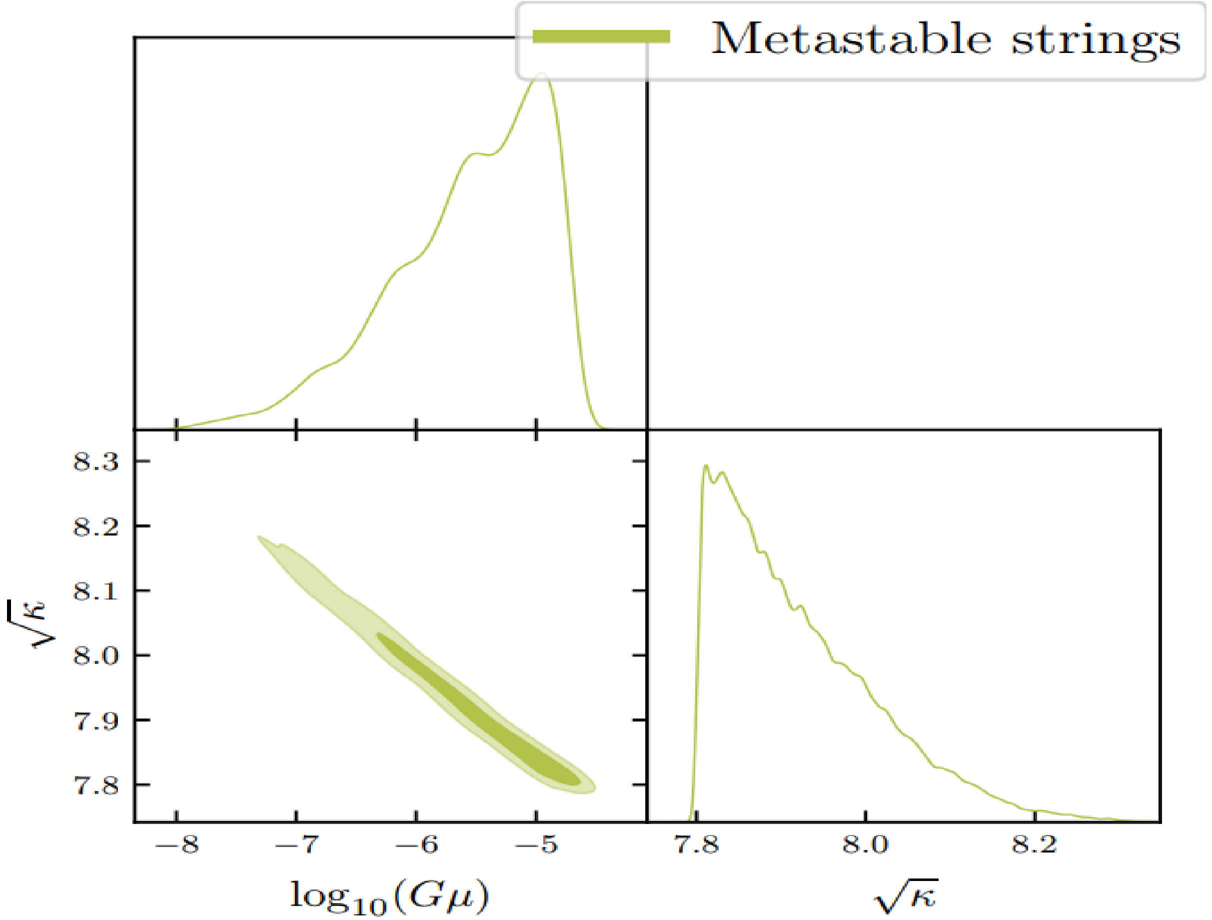

Samanta et al, Arxiv: 2409.03498

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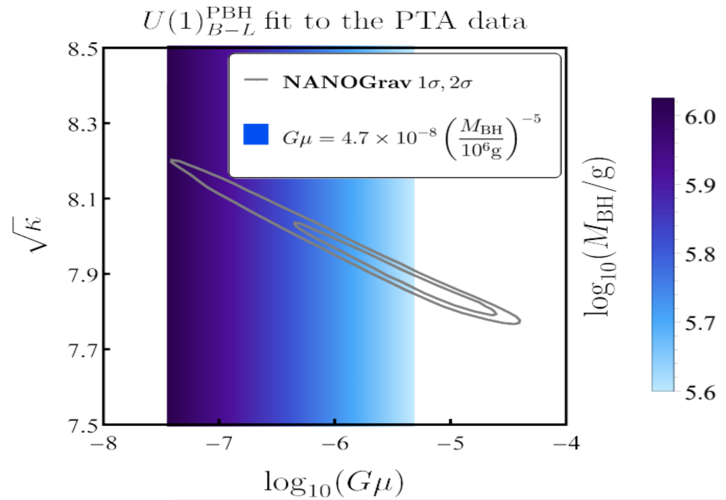

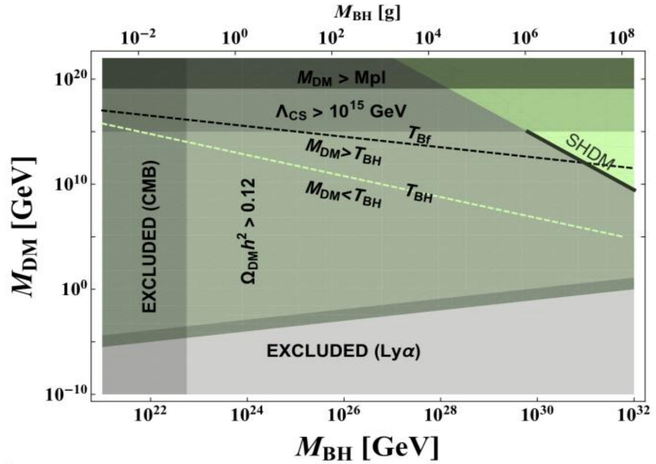

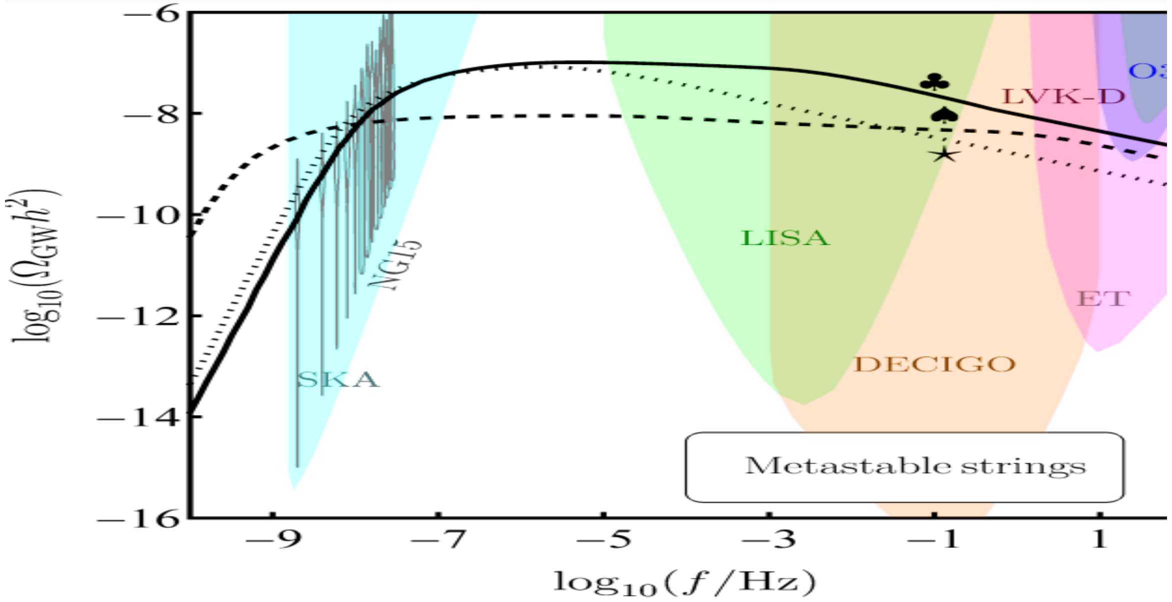

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Conclusion

PBH seeded Super heavy DM model can fit the PTA data very well

It predicts a broken scale invariant GW spectrum at LISA/DECIGO band

Automatically evades LIGO-O3 bound on GWs

Can be tested with the next LIGO run

Could be improved by adding interaction terms to constrain lifetime: robust prediction for cosmic ray searches