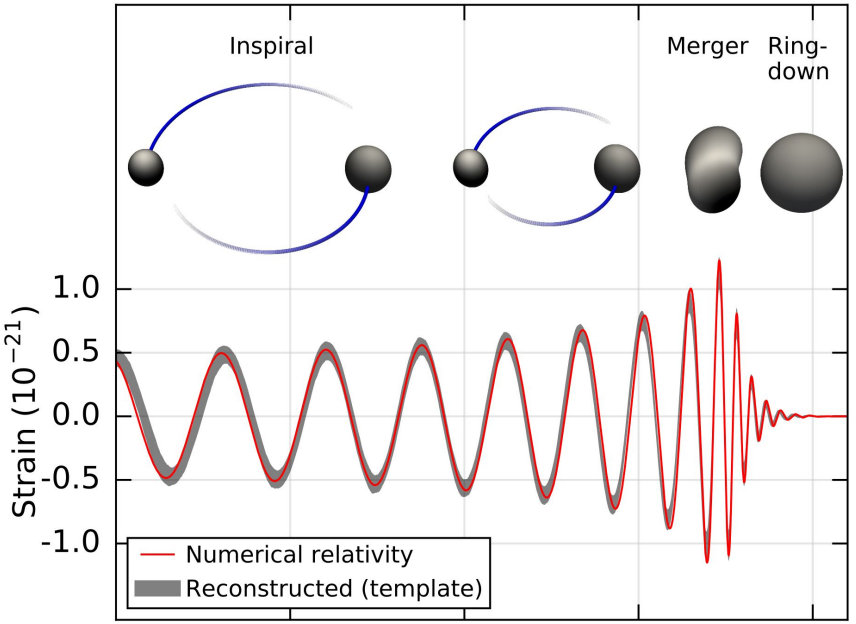
DM and GW: recent results from LVK

Thomas JACQUOT - 2nd year PhD student in Gravitational Waves

Dark Matter day - 6th May 2026

Gravitational Waves

Source : Wkipedia



Source: LIGO-India website

Gravitational Waves + Ultra Light Dark Matter

Physical interaction with the
Michelson interferometer

Analyze detector data for
Scalar (dilaton), Vector (dark photon),
Tensor (boson) dark matter candidates

DM models

Scalar DM: Change in the size and refractive indices of beam splitters/ arm mirrors -> look for the differential strain

Vector DM: “Dark force” directly on the mirrors -> direct displacement of mirrors and secondary strain (light takes time to travel between mirrors in DM field)

Tensor DM: Like GW, stretches the spacetime itself due to Yukawa interaction but with five polarization states

Searches

- Band Sampled Data (BSD): raw data, uses Fast Fourier transform and searches matching peaks in FFT with theoretical peaks and produces Critical ratio

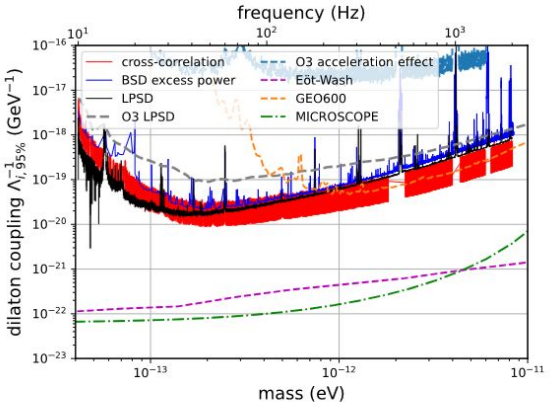
$$CR = \frac{y - \mu}{\sigma}$$

- Cross correlation: gated data, searches for correlated signals in FFT data across detectors and computes Signal-to-Noise ratio (SNR)

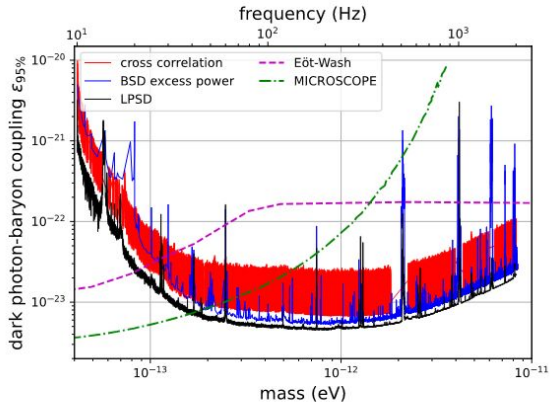
$$\mathrm{SNR}_j = \frac{S_j}{\sigma_j}$$

- Logarithm Power Spectral Density (LPSD): gated data, maximize detection sensitivity by matching integration time in each frequency (logarithm scale) and performs likelihood ratio

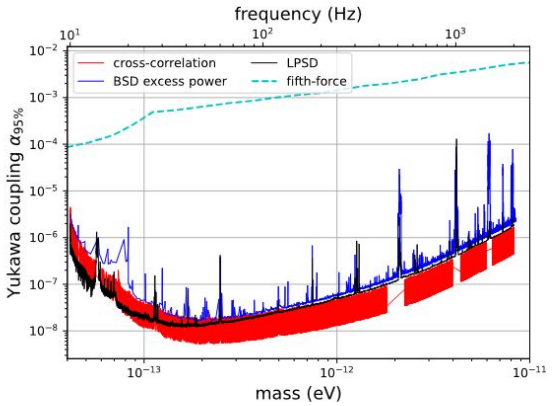
Results



(a) Dilatons



(b) Dark photons



(c) Tensor bosons

Source : [1]

Gravitational Waves + Ultra Light Dark Matter

Physical interaction with the Michelson interferometer

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Analyze GW data for
Scalar (dilaton), Vector (dark photon), Tensor dark matter models

Physical interaction during the merger of a compact binary coalescence

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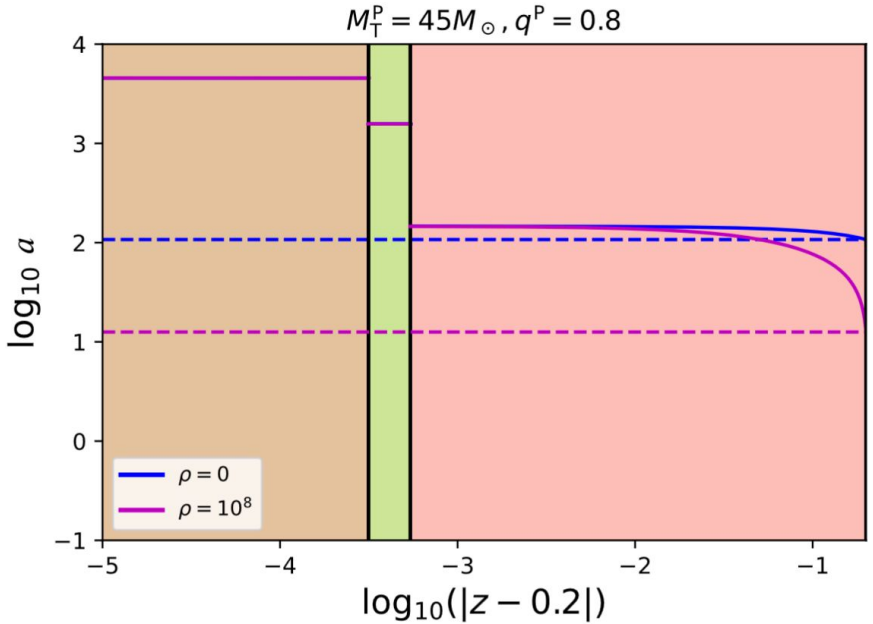
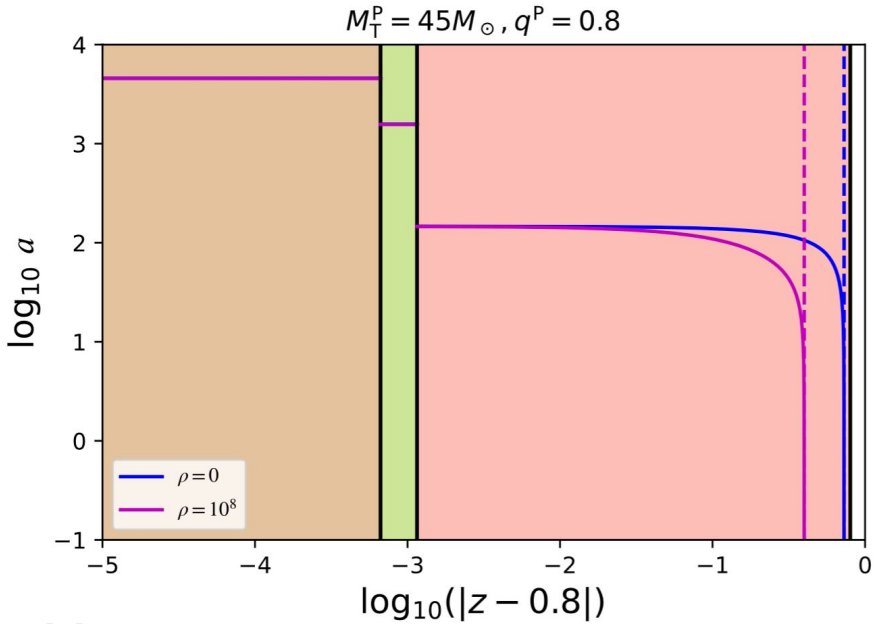
Analyze mergers evolution and GW catalog rates

Merger study

Mergers in ULDM -> accretion + dynamical friction

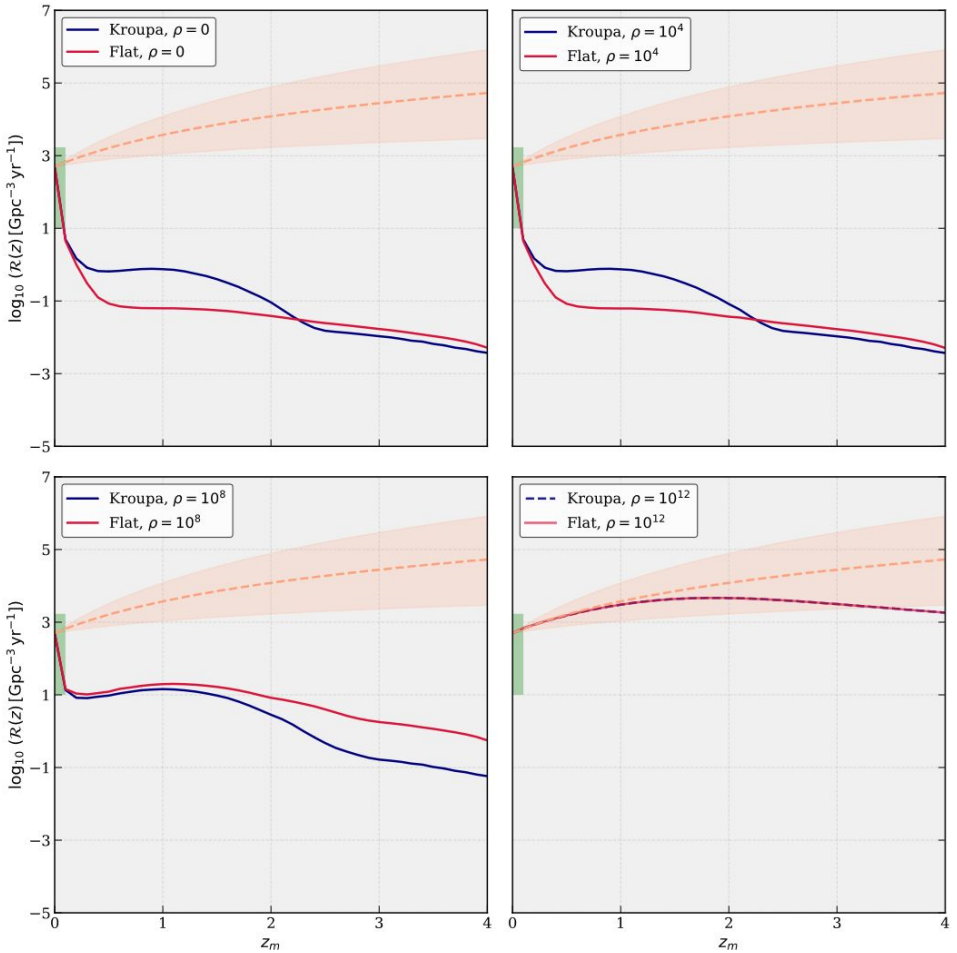




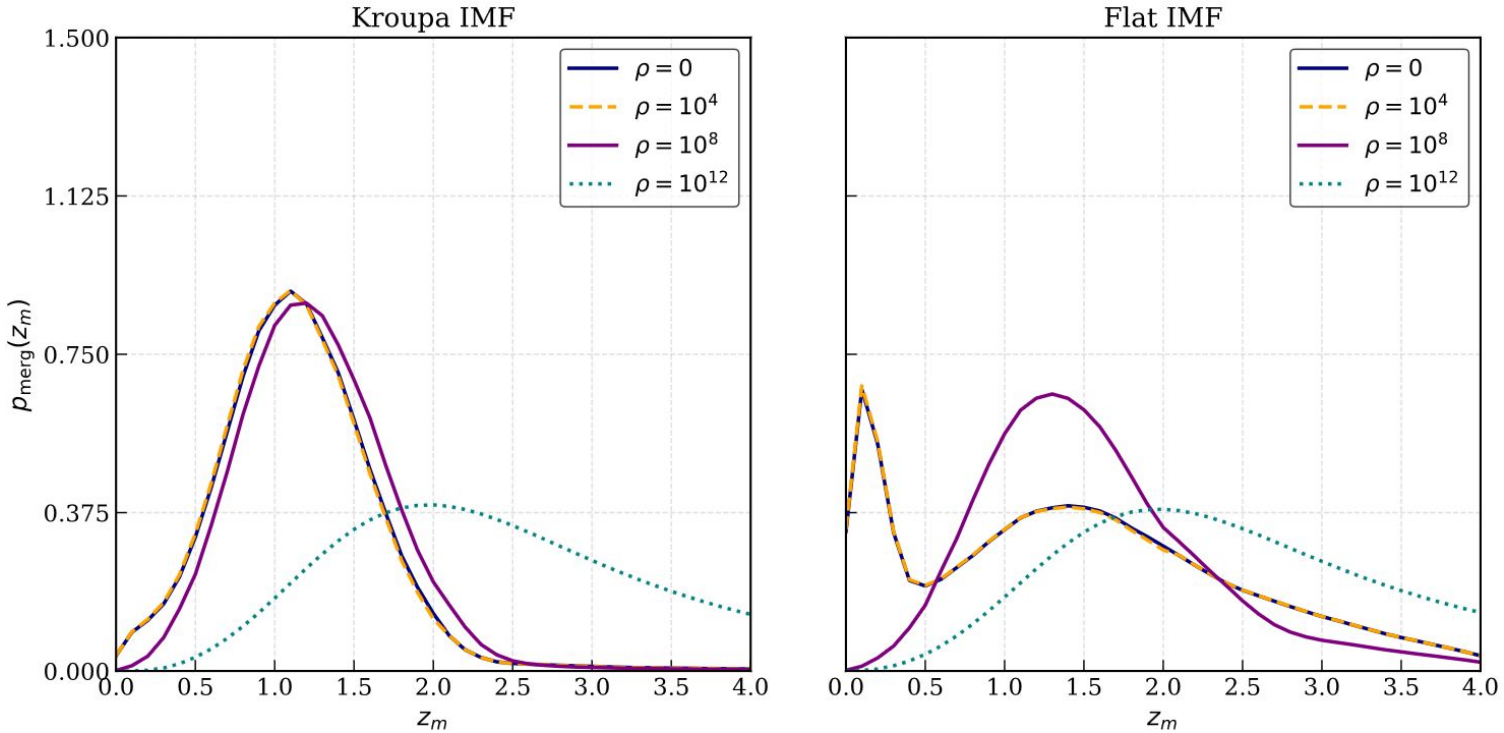
Source: [2]

Merger study

Source: [2]



Merger study



Source: [2]

Conclusion

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References

[1]: Direct multi-model dark-matter search with gravitational-wave interferometers using data from the first part of the fourth LIGO-Virgo-KAGRA observing run

[2]: Effect of ultralight dark matter on compact binary mergers

Thanks for your attention!