Hunting for primordial black holes with stochastic gravitational-wave background in the space-based detector frequency band

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Introduction

- Assuming that primordial black holes compose a fraction of dark matter, some of them may accumulate at the center of galaxy and revolve against the gravitation of the central massive black hole.

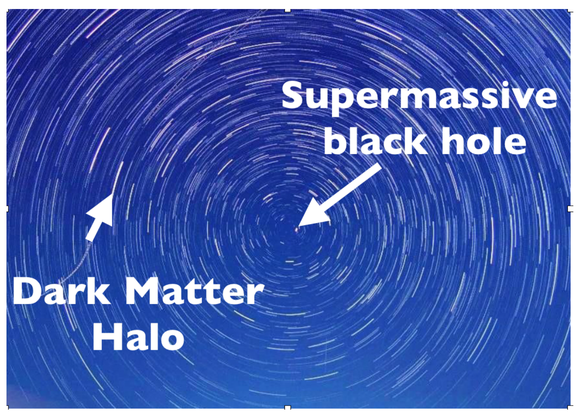


Figure 1: A schematic figure. (source: http://www.ivsky.com)

- Such extreme mass ratio inspirals can emit gravitational waves and form stochastic gravitational-wave background.
- We calculate the energy density spectrum of stochastic gravitational-wave background in this scenario and forecast the ability of constraints in the future.

Event Rate Modeling

- Dark Matter Spike Profile:

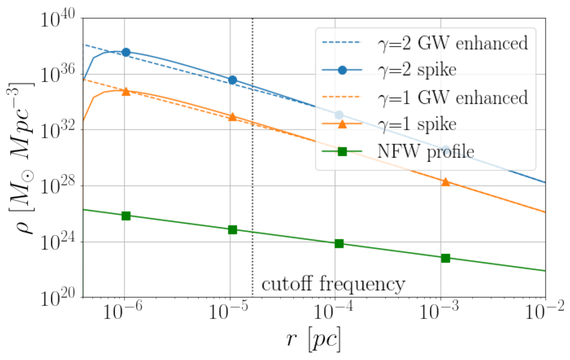


Figure 2: This figure shows the dark matter spike profile around SgrA *, the massive black hole in the milky way.

- Massive black hole mass function:

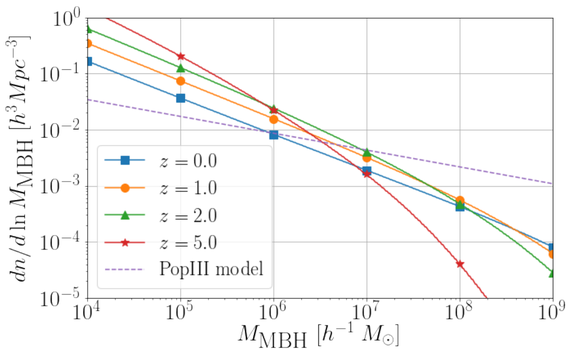
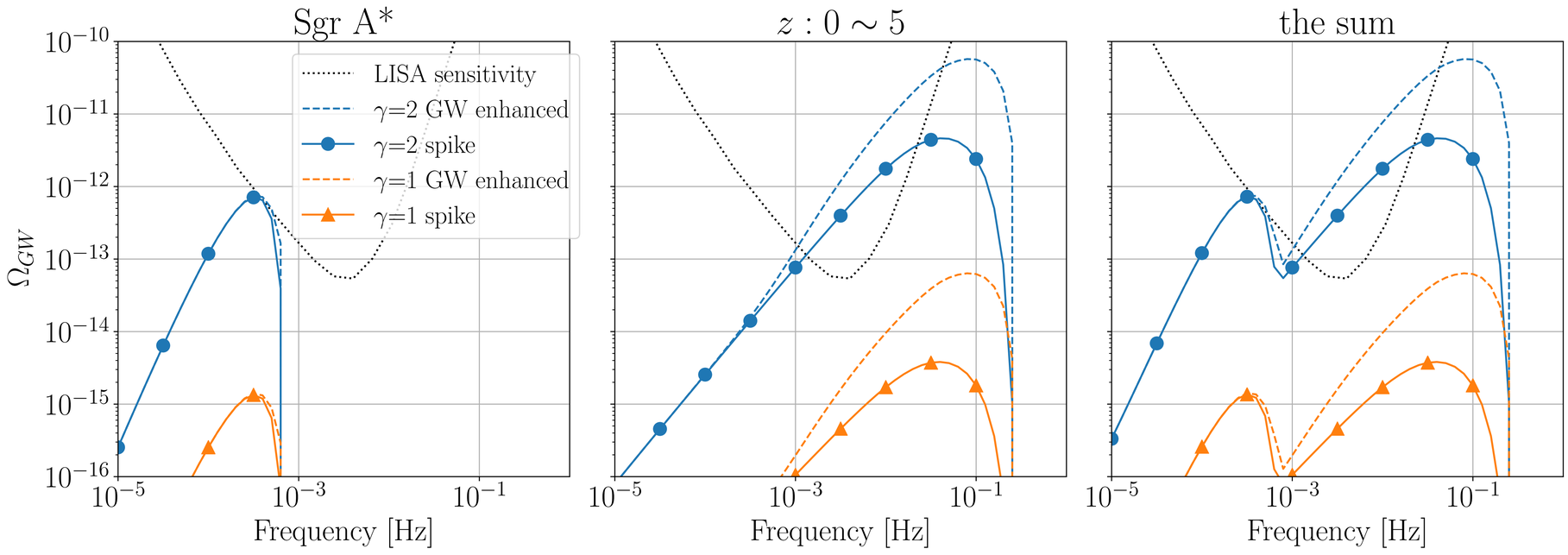


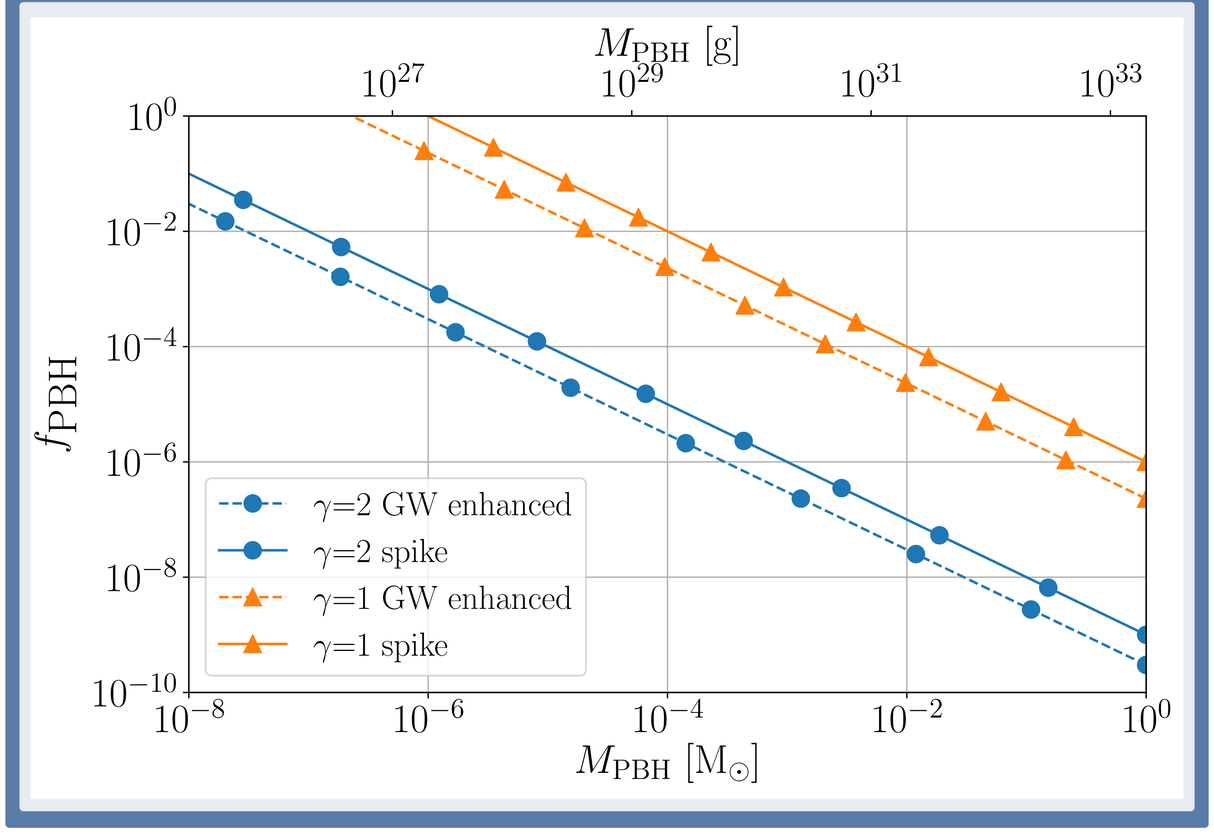
Figure 3: The number density of massive black hole is inferred from dark matter halo population and the correlation between their masses.

Results

The stochastic gravitational-wave background contributed from Sgr A* is comparable with that from extragalactic massive black holes. The sum of both spectra shows an interesting bimodal feature!



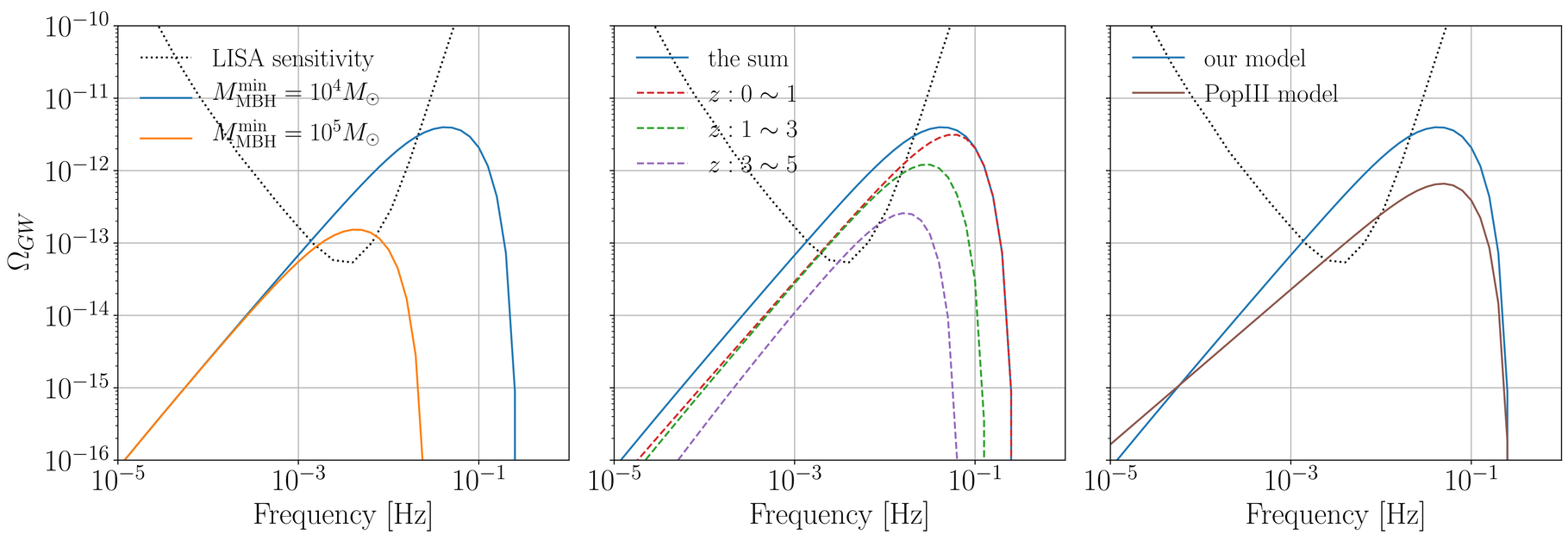
Constraints on primordial BH abundance



Conclusions

- The space-based gravitational-wave detector LISA can constrain the abundance of $1M_\odot$ primordial black holes to $10^{-6} - 10^{-9}$.

Robustness tests



We also perform tests of robustness. Left: Choosing different lower mass cutoff for massive black holes; Middle: Comparing contributions from different redshift bins; Right: Changing population models of massive black holes.