

Closing Remarks

Developing the AEDGE Programme

AEDGE Workshop @ CERN

July 22/23, 2019

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Searches for Light Dark Matter

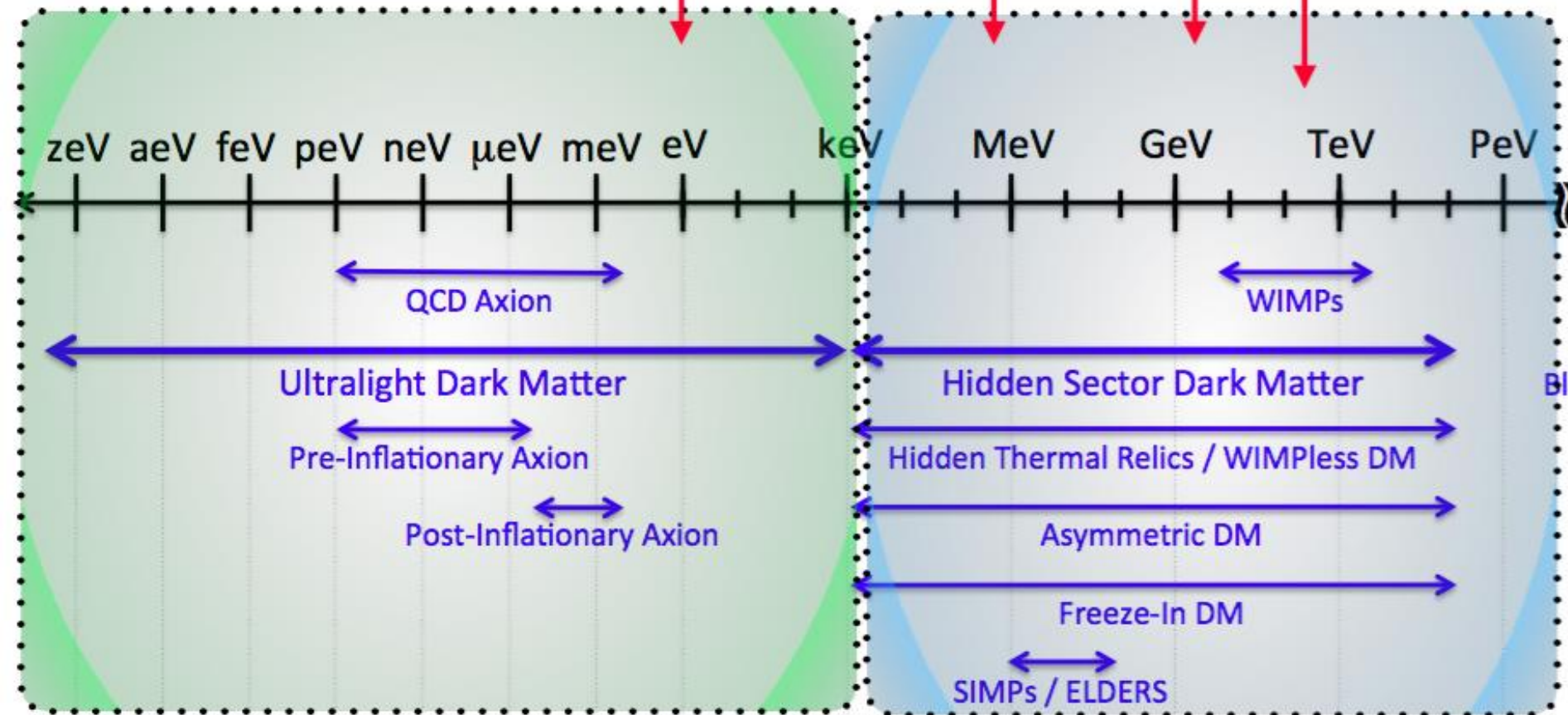
Known particle masses:

neutrino

electron

proton

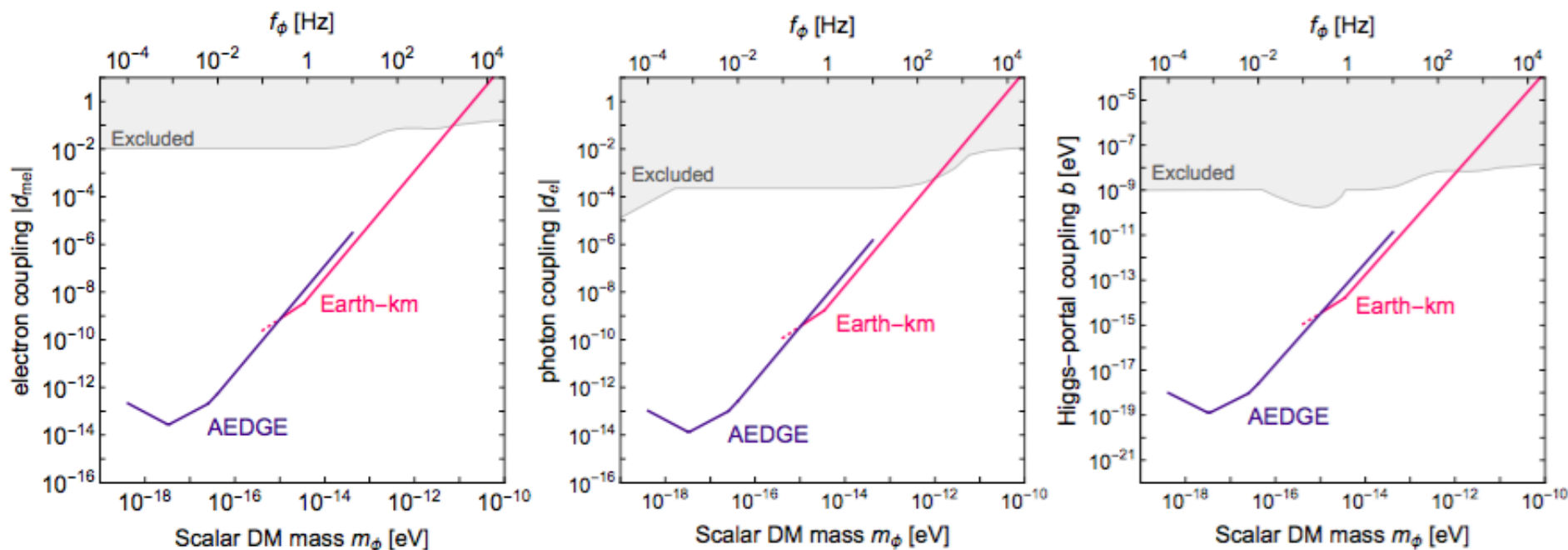
Higgs



'Ultra-Light' dark matter

'Massive' dark matter

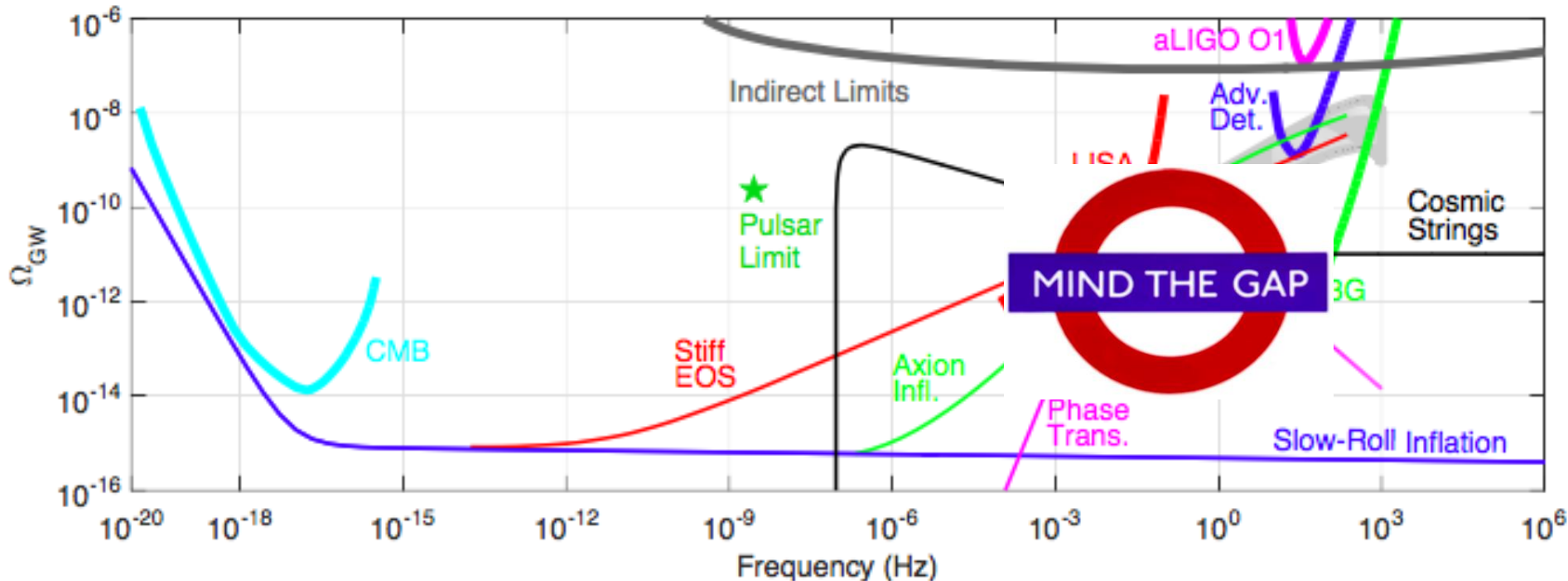
Searches for Light Dark Matter



Future DM Tasks

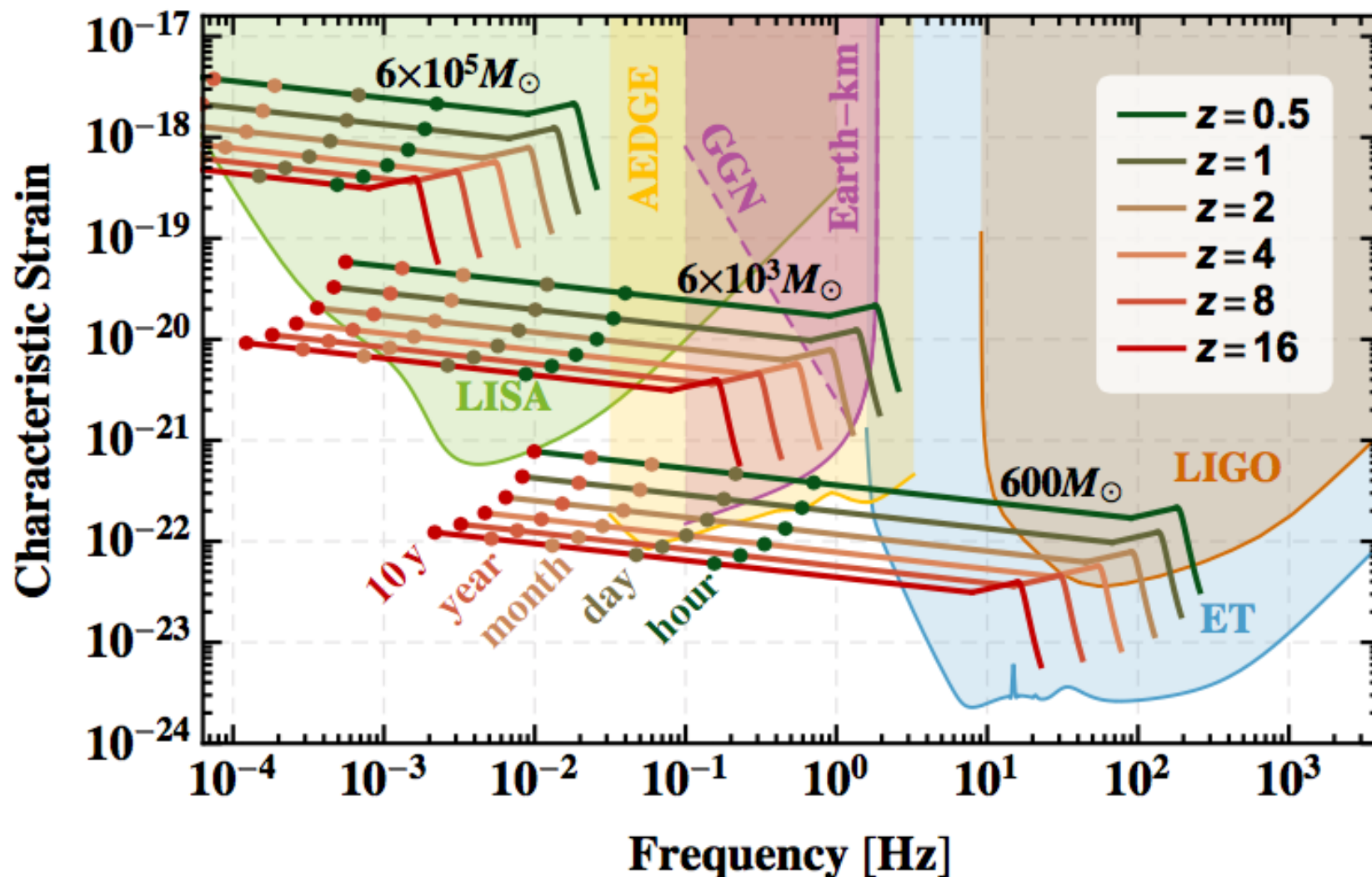
- Understanding the synergies between dark matter searches in this mass range and other astrophysical and cosmological observations.
- Exploring the synergies between AEDGE and other laboratory probes of ultra-light bosonic dark matter.
- Showing how to identify unambiguously dark matter as the origin of a signal in AEDGE, rather than a signal from, e.g., time-varying physical parameters or GWs, and extract the dark matter properties from the signal.

Gravitational Wave Spectrum



- Gap between ground-based optical interferometers @ LISA
- Electroweak phase transition? Cosmic strings?

Gravitational Waves from IMBHs

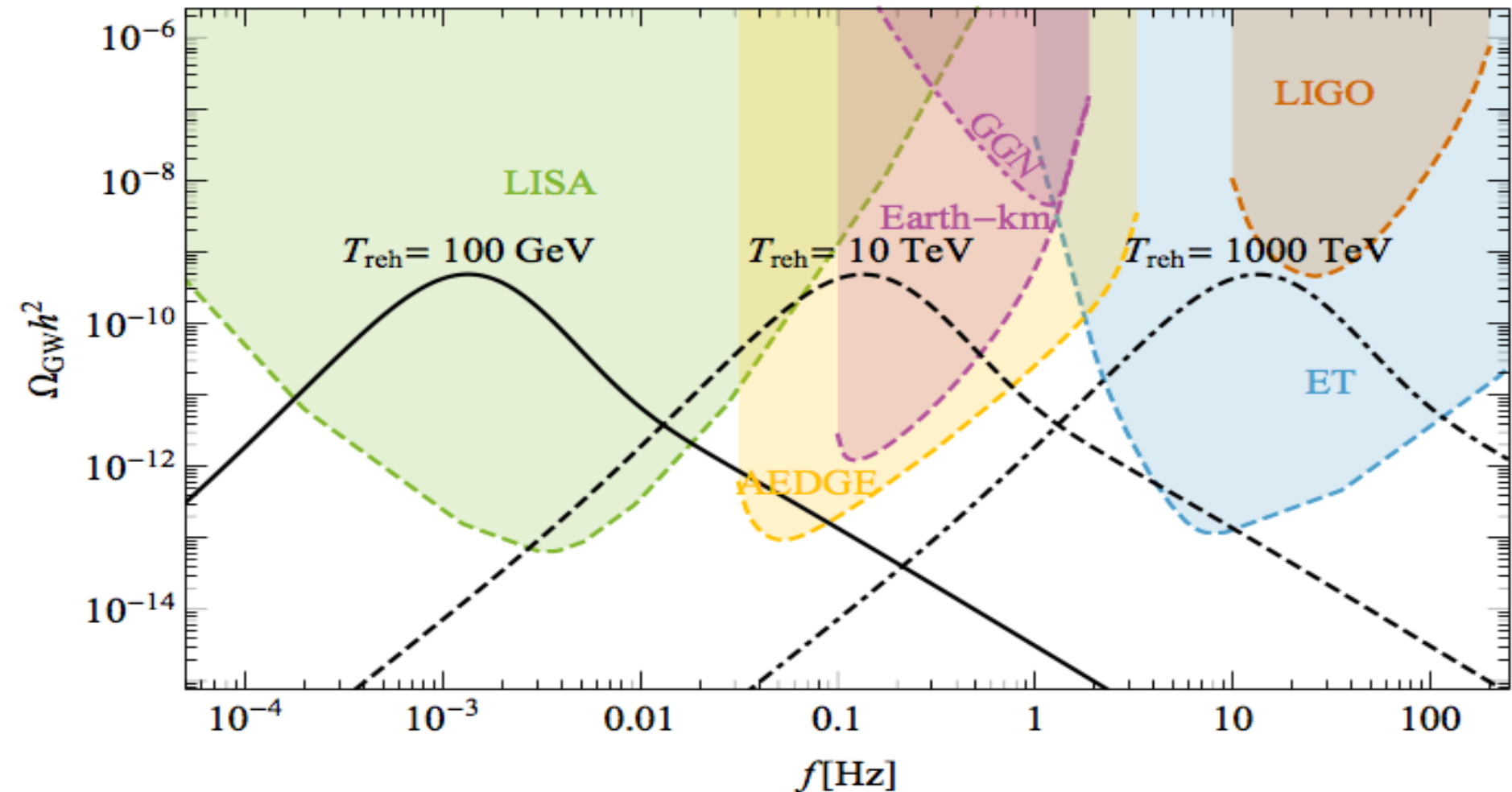


Probe formation of SMBHs, synergies, test GR

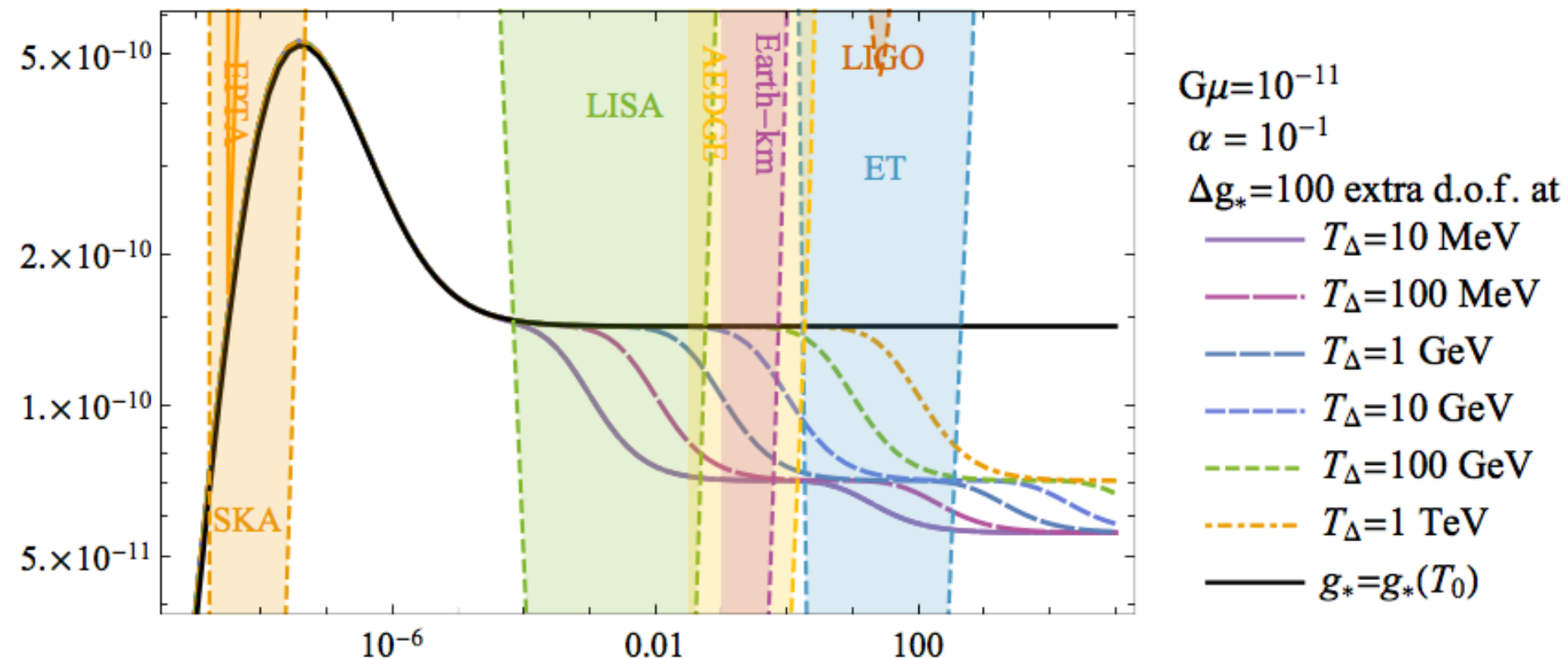
Gravitational Waves from Phase Transition

Marek Lewicki

$$\alpha=1/2, HR_*=10^{-1}$$



Gravitational Waves from Cosmic Strings



Probe expansion history of early universe

Possible GW Tasks

- Modelling astrophysical sources whose GWs peak in mid-frequency range, e.g., intermediate-mass BHs (seeds for supermassive BHs observed today), providing insight into their evolution and their host galaxies.
- Understanding synergies of multiband GW astronomy combining GW searches in this frequency range with LISA, LIGO/Virgo/KAGRA & other astrophysical observations, e.g., for predicting timing, directions & distances of future merger events.
- Novel tests of the strong-gravity regime via, e.g., accurate timing of the GW phase evolution, that are not accessible with ground-based interferometers and LISA alone. Calculating mid-frequency GW signatures of cosmological phase transitions, e.g., at the electroweak scale, and relating them to collider signatures of possible extensions of the Standard Model.
- Sensitivity to cosmic strings

Explore Beyond Dark Matter & GWs

- High-precision measurement of the gravitational redshift, probes of Bell inequalities and the equivalence principle
- Probing fundamental “constants”, chameleons, dark energy
- Detecting astrophysical?
- Long-range fifth forces?
- Lorentz violation?
- Fundamental (\neq environmental) decoherence?

Summary

- The nature of DM is one of the most important and pressing in particle physics and cosmology
- Experience with electromagnetic waves shows the advantages of making astronomical observations in a range of different frequencies, and the same is expected to hold in the era of gravitational astronomy
- Other possible opportunities for AEDGE in fundamental physics, astrophysics and cosmology have been identified, but not yet explored in detail
- AEDGE is a uniquely interdisciplinary mission that will harness cold atom technologies to address key issues in fundamental physics, astrophysics and cosmology

Future Steps

- Prepare White Paper (deadline August 5th)
- Open authorship for arXiv/publication
- Link communities (CA, GW, PP)
- Identify “pathfinders”
- Construct roadmap
- Role for CERN?
 - Technology? “Recognized experiment”?