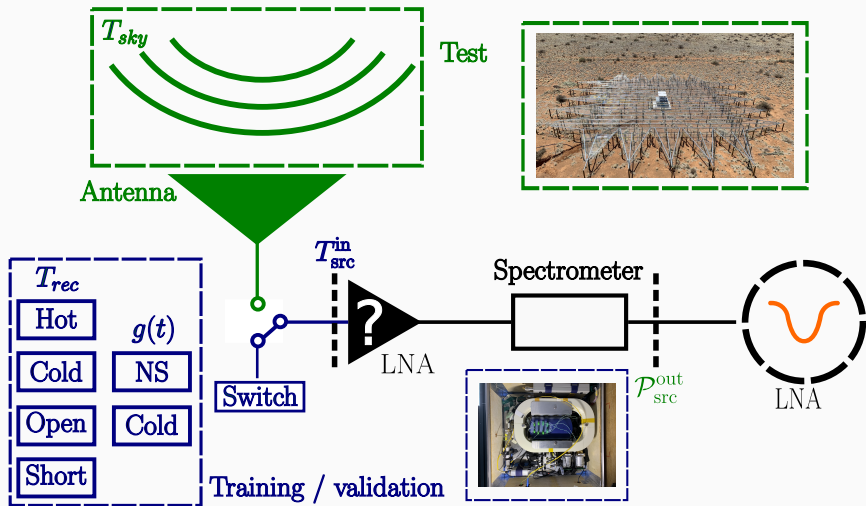
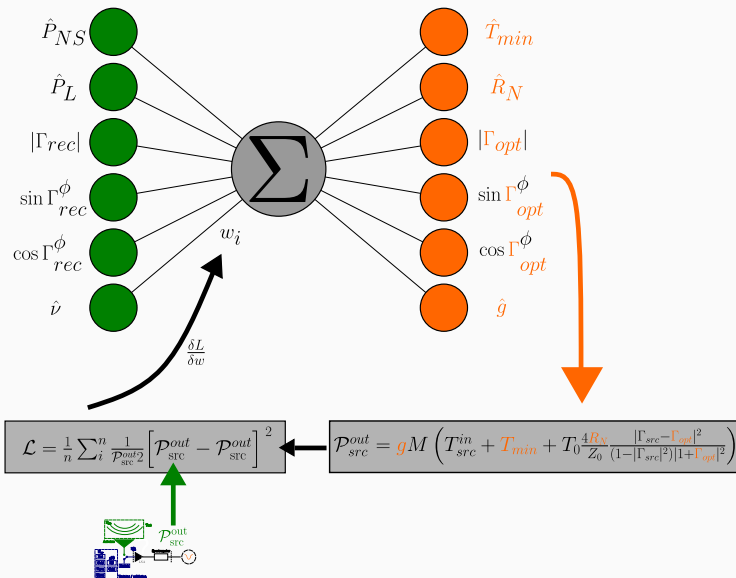


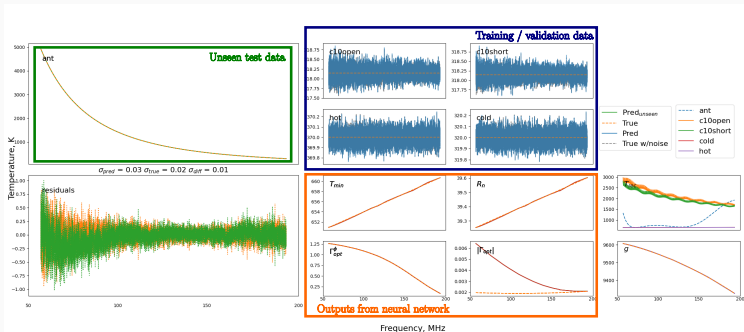
Machine learning for radiometer calibration in global 21cm cosmology




Machine learning for radiometer calibration in global 21cm cosmology




Machine learning for radiometer calibration in global 21cm cosmology







Machine learning for radiometer calibration

Samuel Alan Kossoff Leeny <sakl2@cam.ac.uk>
 Kavli Institute for Cosmology · Cavendish Laboratory · University of Cambridge



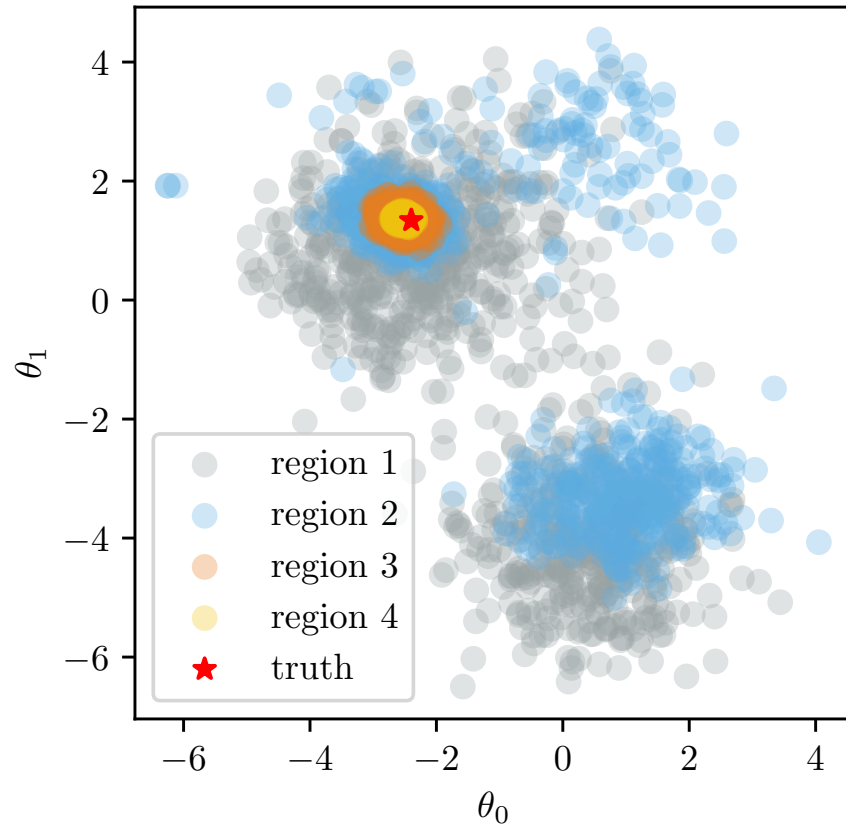


We propose a Physics based AI framework for precise radiometer calibration in global 21cm cosmology. These experiments aim to study the formation of the first stars and galaxies by detecting the faint 21-cm radio emission from neutral hydrogen. This global or sky-averaged signal is predicted to be five orders of magnitude dimmer than the foregrounds. Therefore, detection of the signal requires precise calibration of the instrument receiver, which non-trivially amplifies the signals detected by the antenna. Classical approaches are challenging to apply in this high precision regime, causing a major bottleneck in all such experiments. Unlike other methods, our receiver calibration approach is expected to be agnostic to in-field variations in temperature and environment and furthermore does not rely on assumptions that certain critical components are impedance matched. For the first time, we propose the use of machine learning for calibration of global 21-cm experiments.

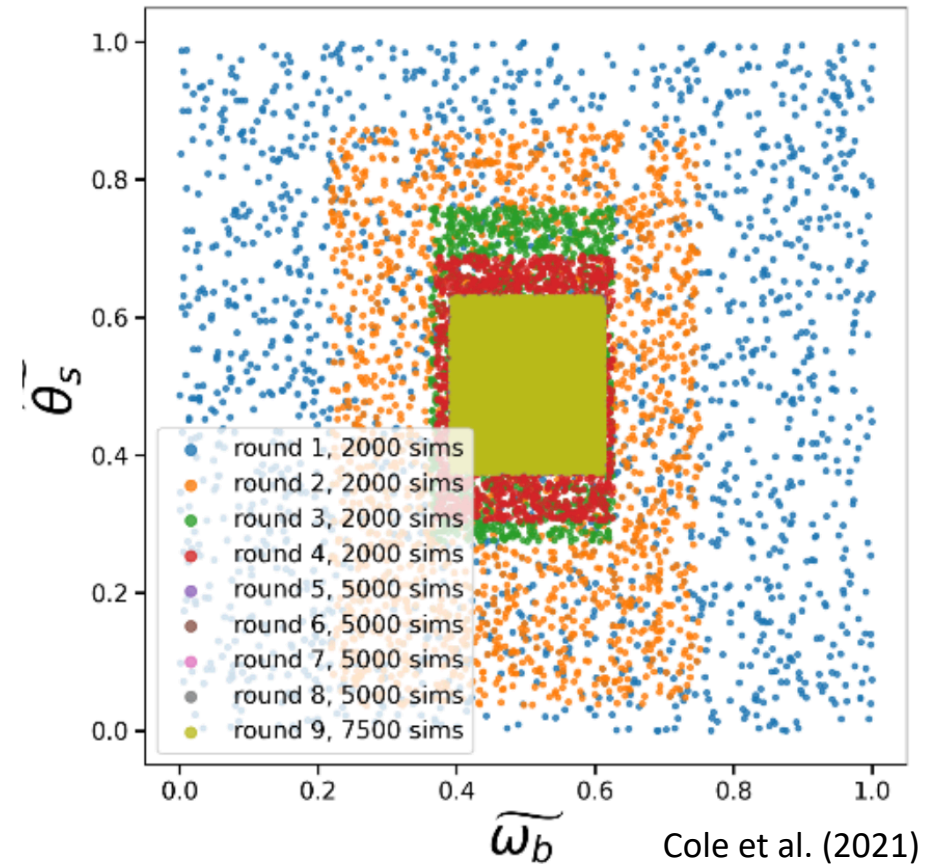


PolySwyft: Sequential simulation-based nested sampling

Nested sampling



SBI (with NRE)

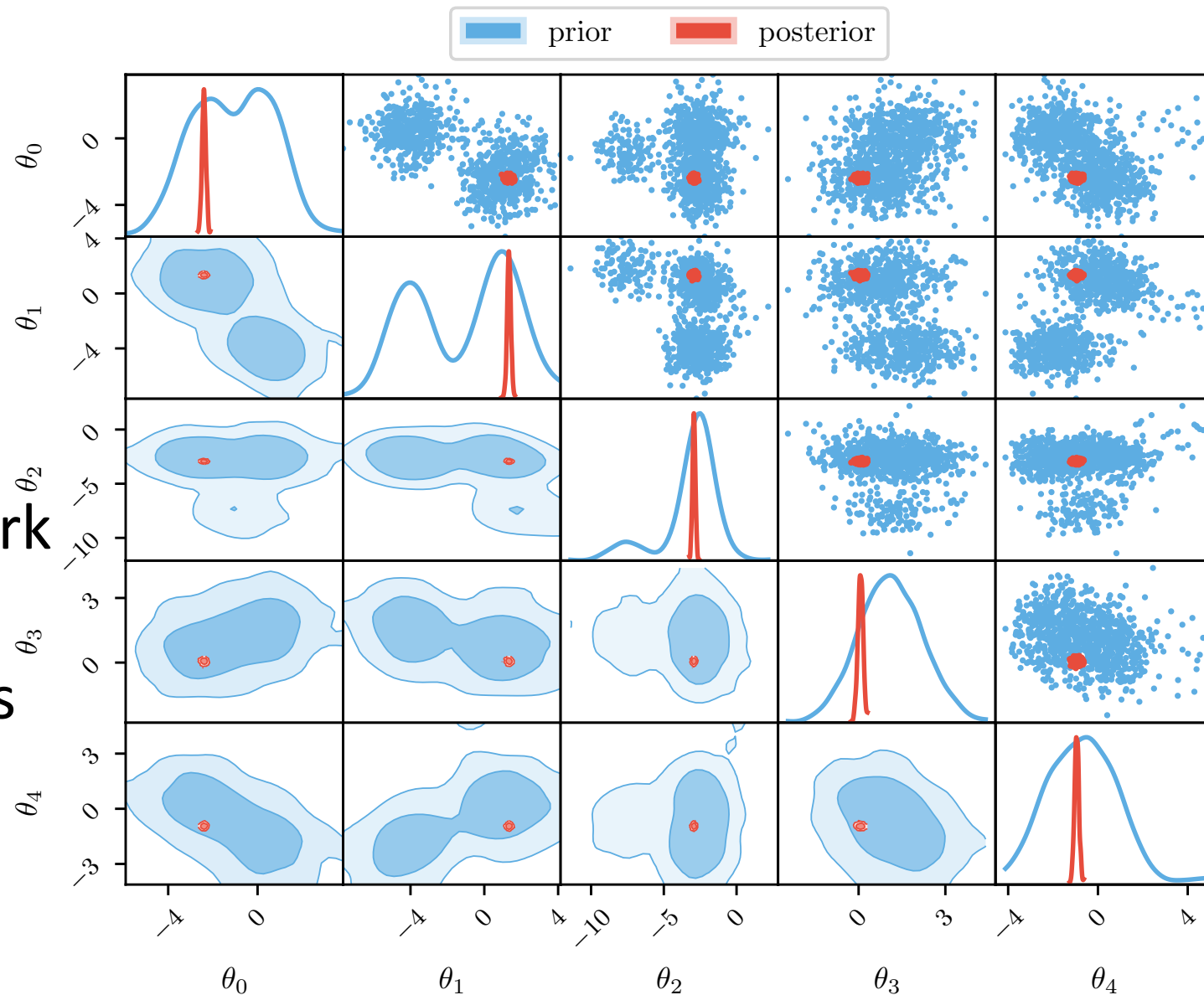


PolySwyft



Merging NS and SBI into
a general Bayesian framework

Accurate posterior estimates
without a likelihood !



Bayesian Hierarchical Inference for **D**ark **M**atter Detection from Overheated Exoplanets

María Benito Castaño

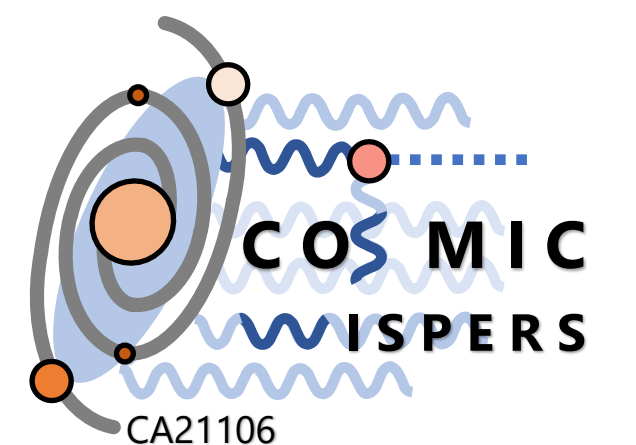
EuCAIFCon 2024



UNIVERSITY OF TARTU
Tartu Observatory



Estonian
Research Council



Dark Matter particle landscape



Primordial Black Holes

$$10^{-17} - 50 M_{\odot}$$

$$10^5 M_{\odot}$$

$$10^{71} \text{ eV}$$

Must fit inside
dwarf galaxies

$$m_{\text{DM}} \lesssim 10^{71} \text{ eV}$$

WIMPs ♡

$$10 \text{ GeV} - 10 \text{ TeV}$$

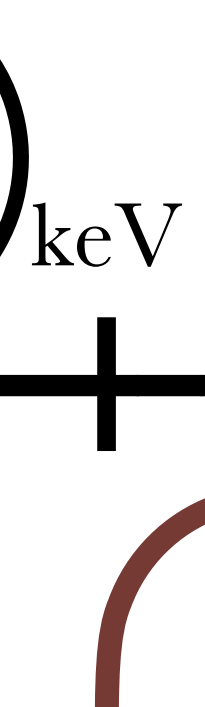
sub-GeV DM

$$1 \text{ MeV} - 10 \text{ GeV}$$

$$\text{TeV}$$

$$\text{GeV}$$

$$\text{MeV}$$



QCD axion

$$10^{-6} - 10^{-4} \text{ eV}$$

$$\text{eV}$$

$$\text{meV}$$

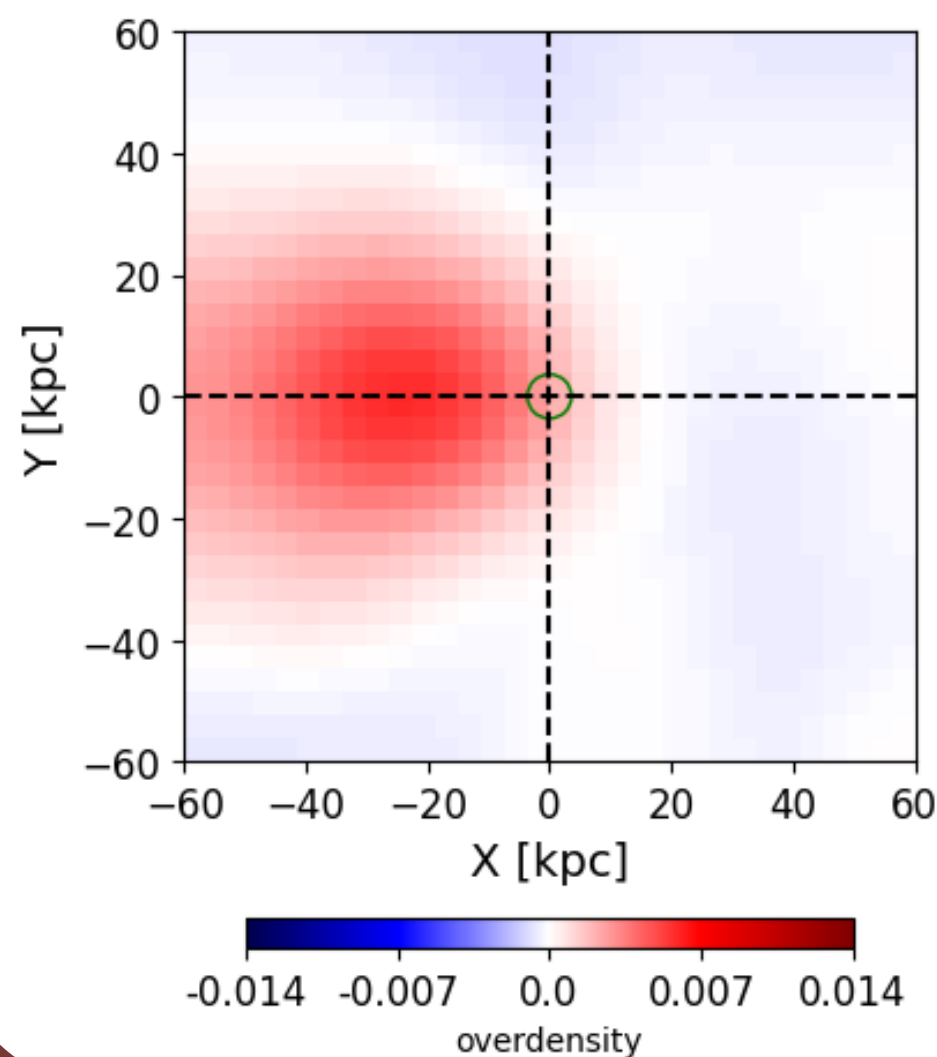
$$\mu\text{eV}$$

$$10^{-21} \text{ eV}$$

$$\text{zeV}$$

Macroscopic
quantum effects

$$m_{\text{DM}} \gtrsim 10^{-22} \text{ eV}$$



See Sven
Pöder's poster

Dark Matter particle landscape



Primordial Black Holes

$10^{-17} - 50 M_{\odot}$

$10^5 M_{\odot}$

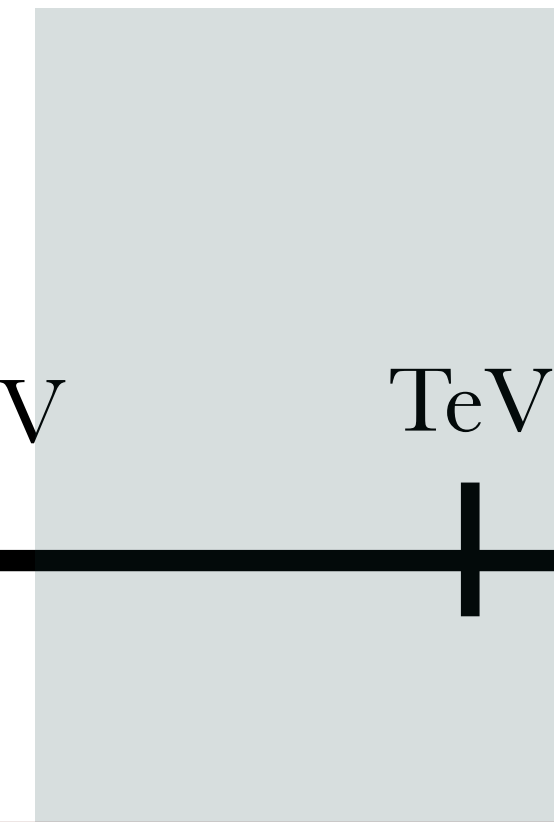
10^{71} eV

Must fit inside
dwarf galaxies

$m_{\text{DM}} \lesssim 10^{71} \text{ eV}$

WIMPs ♡
 $10 \text{ GeV} - 10 \text{ TeV}$

sub-GeV DM &
below



MeV

GeV

TeV

Exoplanets & Brown

Dwarfs are new, excited and
powerful detectors of DM

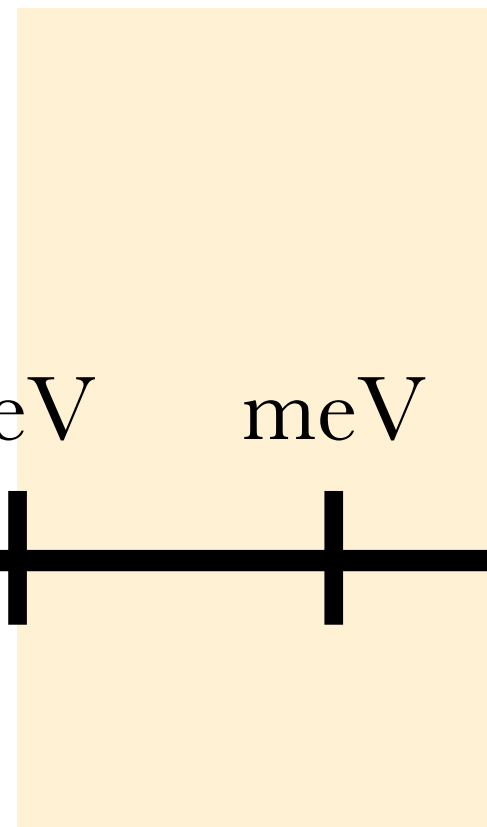
Leane & Smirnov [2010.00015]

Acevedo et al. [2303.01516]

Benito et al. (very soon to appear on arXiv)

QCD axion

$10^{-6} - 10^{-4} \text{ eV}$



10^{-21} eV

zeV

μeV

meV

eV

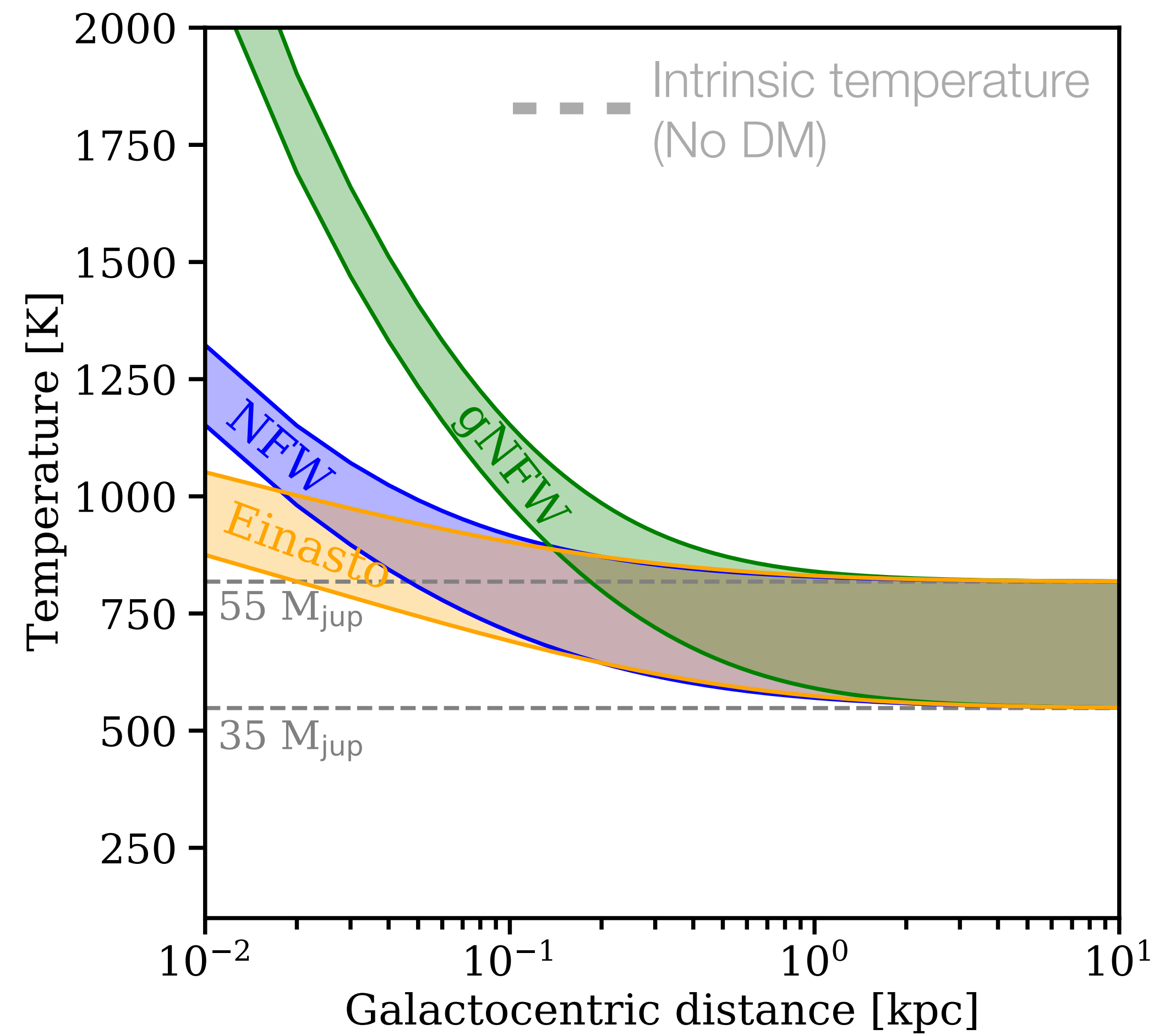
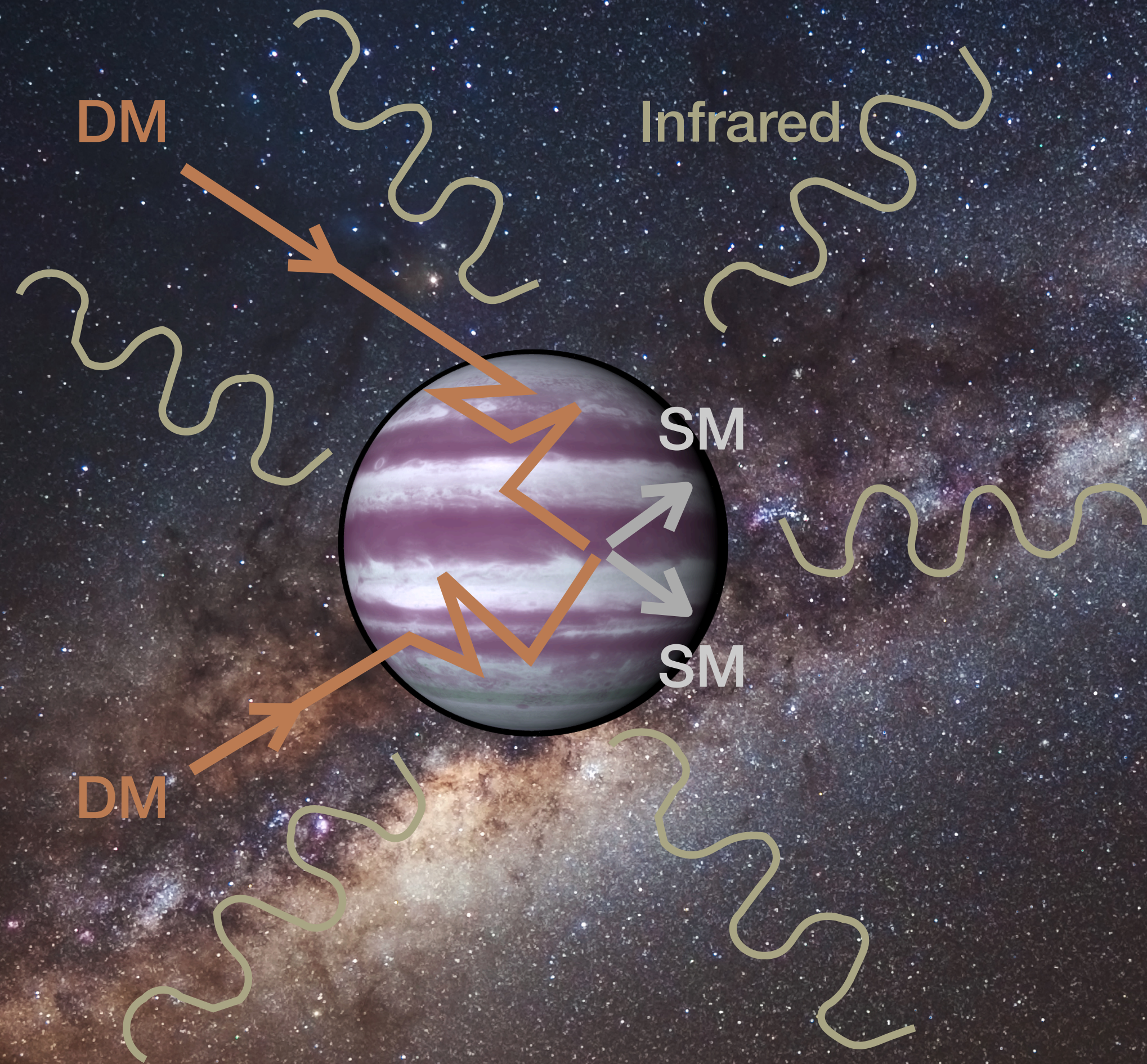
keV



Macroscopic
quantum effects

$m_{\text{DM}} \gtrsim 10^{-22} \text{ eV}$

Indirect **D**ark **M**atter search



Bayesian Hierarchical Model

Details & results in poster, during coffee break, soon arXiv



Konstantin Karchev & I
would be happy to discuss
further

