

# Mapping the viable parameter space for testable leptogenesis

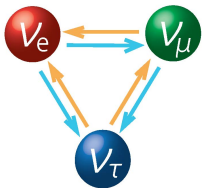
Yannis Georis

based on work in collaboration with M. Drewes and J. Klarić  
[arXiv:2106.16226]

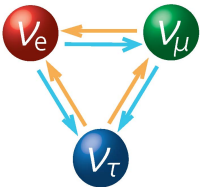
Second EuCAPT Annual Symposium  
May 25, 2022



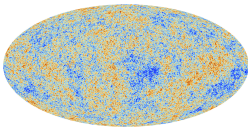
# Beyond the Standard Model



**Neutrino masses**



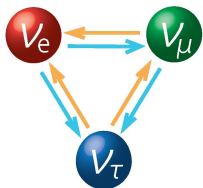
**Neutrino masses**



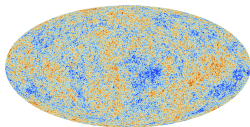
[Planck]

**Baryon asymmetry**

# Beyond the Standard Model



Neutrino masses



[Planck]

Baryon asymmetry

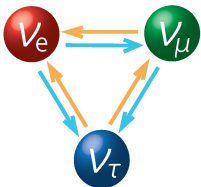
Spin-1/2 fermions						Spin-1 bosons					
Quarks	Left	u	Right	Left	c	Right	Left	t	Right	g	Spin-0 Higgs boson
	Left	d	Right	Left	s	Right	Left	b	Right		
Leptons	Left	ν <sub>1</sub>	Right	Left	ν <sub>2</sub>	Right	Left	ν <sub>3</sub>	Right	Z <sup>0</sup>	
	Left	e	Right	Left	μ	Right	Left	τ	Right	W <sup>±</sup>	

Force carriers

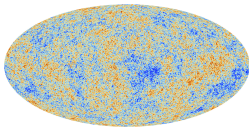
Spin-0 Higgs boson

H

# Right-handed neutrinos (RHN)



Type-I seesaw mechanism

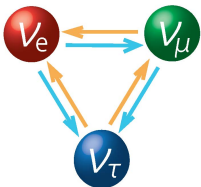


[Planck]

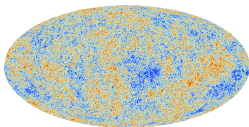
Leptogenesis

Spin-1/2 fermions						Spin-1 bosons		Spin-0 Higgs boson
Quarks		Left u Right	Left c Right	Left t Right	g		$\gamma$	
Leptons		Left d Right	Left s Right	Left b Right	Z <sup>0</sup>			
		Left v <sub>1</sub> Right N <sub>1</sub>	Left v <sub>2</sub> Right N <sub>2</sub>	Left v <sub>3</sub> Right N <sub>3</sub>	Force carriers W <sup>±</sup>		H	

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Type-I seesaw mechanism



Leptogenesis

Spin-1/2 fermions						Spin-1 bosons		Spin-0 Higgs boson				
Quarks		Leptons		Force carriers								
Left	u	Right	Left	c	Right	Left	t	Right	g	$\gamma$		
Left	d	Right	Left	s	Right	Left	b	Right	$Z^0$			
Left	$\nu_1$	Right	Left	$\nu_2$	Right	Left	$\nu_3$	Right	$N_1$	$N_2$	$N_3$	$H$
Left	e	Right	Left	$\mu$	Right	Left	$\tau$	Right	$W^\pm$			

In this work: 3 RHN generations

# Leptogenesis

Sakharov conditions:

- ▶ C- and CP-violation
- ▶ Deviation from thermal equilibrium
- ▶ Baryon number violation



# Leptogenesis

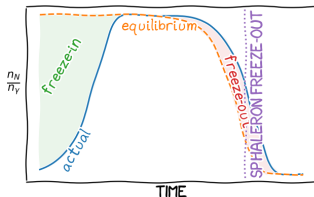
Sakharov conditions:

- ▶ C- and CP-violation
  - ★ RHN decay and oscillations
  
- ▶ Deviation from thermal equilibrium
  - ★ Freeze-out and freeze-in of the RHN
  
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# Leptogenesis

Sakharov conditions:

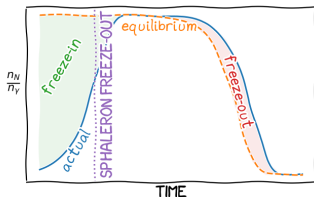
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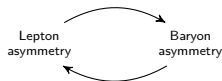
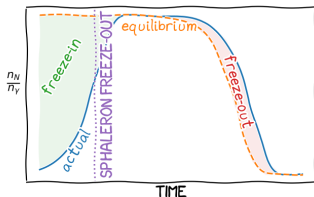
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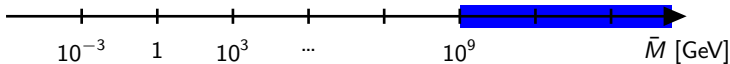
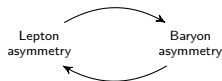
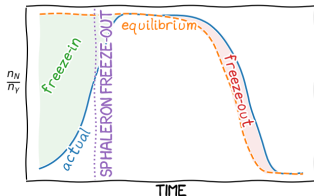
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# Leptogenesis

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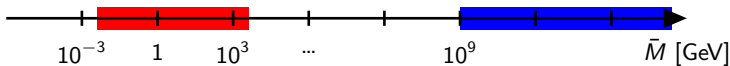
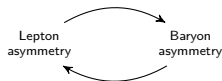
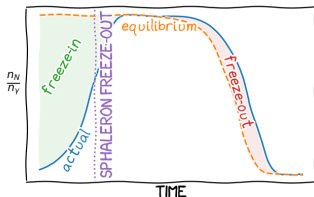
Thermal leptogenesis

[Fukugita/Yanagida '86]

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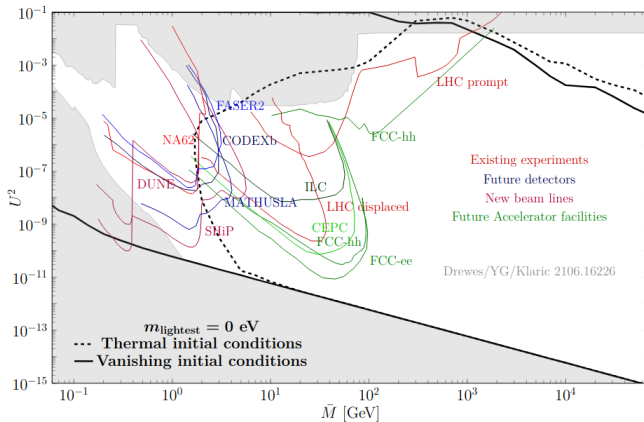
Low-scale leptogenesis

[Akhmedov/Rubakov/Smirnov '98, Asaka/Shaposhnikov '05]

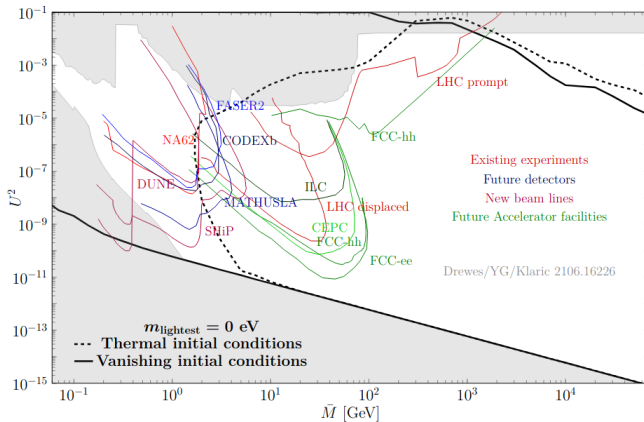
Thermal leptogenesis

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# Viable parameter space



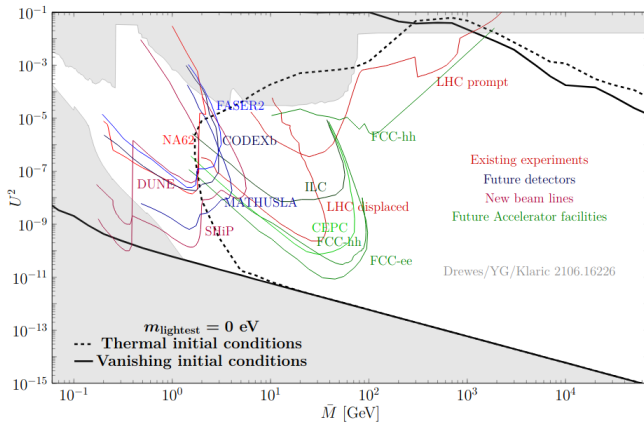
# Viable parameter space



- ▶ Experiments will cut deep into  $n = 3$  parameter space.

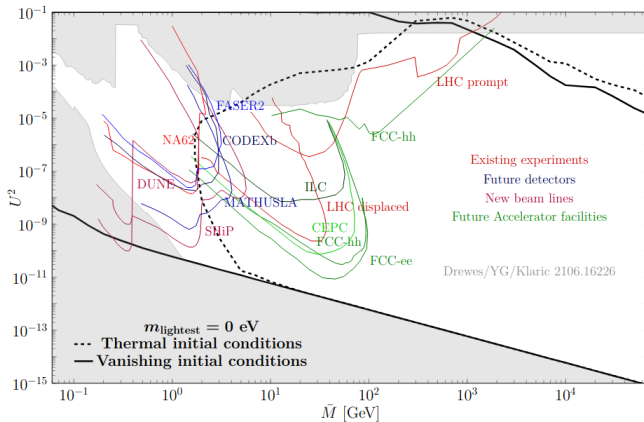


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- ▶ Can expect to produce thousands of displaced vertices at HL-LHC: Testability !
- ▶ Leptogenesis with thermal initial conditions works for masses as low as  $\mathcal{O}(1.7)$  GeV: testable at e.g. NA62.