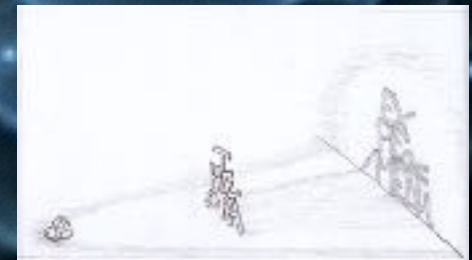


High Energy Physics Phenomenology

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Where do we stand in HEP?



- ◆ *Standard Model of Particle Physics*
- ◆ *Standard Model of Cosmology*

Tel. "Categorien van de massa (fermionen)"

	I	II	III	IV
Quarks	u (up)	c (charm)	t (top)	b (bottom)
Leptons	e (electron)	μ (muon)	τ (tau)	ν (neutrinos)

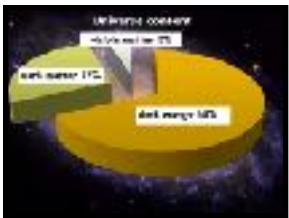
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Many fundamental questions still open...

- Force Unification ?
- String Theory ?
- Quantum Gravity ?
- Inflation ?



- Hierarchy problem ?
- Dark matter ?
- Matter-Antimatter ?



Physics Beyond the Standard Model (BSM)

What is the experimental signatures?

✦ *BSM physics at colliders*

- Model building on dark matter physics and axions
- Unconventional signatures at the LHC (e.g. displaced vertices)
- Future colliders (FCC, muon collider ...)

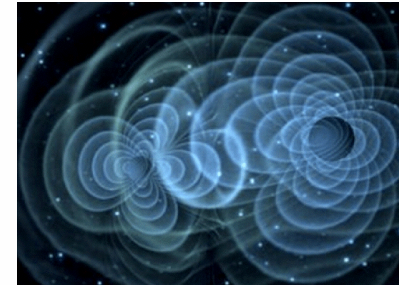
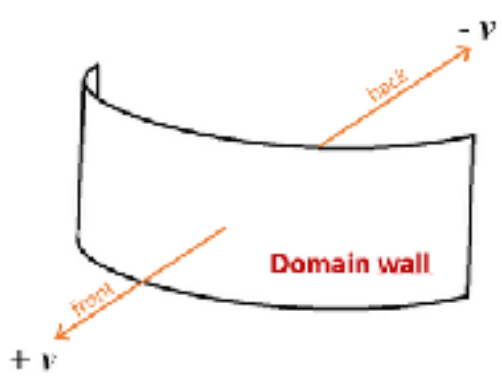
✦ *Gravitational waves*

- Focus on Stochastic Gravitational Wave background (SGWB)
- Data analysis to detect astrophysical SGWB (BH and NS mergers)
- Modelling of cosmological SGWB to explore early stages of our Universe, Phase transitions and cosmological defects
- Members of LIGO-Virgo-Kagra and Einstein Telescope

Ripples of spacetime from extended cosmological defects

◆ *Cosmic strings and domain walls*

- Location of spacetime with high energy density
- They form during history of the Universe at phase transitions in BSM models
- They deform the spacetime and source gravitational waves



◆ *Questions to be studied*

- What is the spectrum of gravitational waves?
- What is the correct theory to describe their interactions?
- How these defects interact with surrounding cosmic plasma?

Example of Thesis

◆ *Master Thesis*

- A new window for leptophilic dark matter (S. Junius 2018)
- The strong CP problem and gravitational waves (K. Turbang 2020)
- Dark Matter phases and gravitational waves (M. Lalleman 2021)
- Gravitational waves from domain walls dynamics (A. Rase 2021)
- Dark Matter and naturalness problem (Y. Qian 2022)
- Gravitational waves from first order phase transitions (X. Nagels 2022)

◆ *Bachelor Thesis*

- Displaced leptons as dark matter signatures at the LHC (N. Saini 2018)
- Dark matter production: freeze out vs freeze-in (M. Lalleman 2019)
- GW from binaries: direct, indirect observation and beyond (E. Van den Bossche 2022)