



Institute for  
Particle Physics  
Phenomenology



# A study of BSM physics at the LHC

Ilán Fridman Rojas

Supervisor: Peter Richardson



# My Background

The background of the slide is a scenic photograph of Durham, England. In the upper center, the massive stone structure of Durham Cathedral is visible, perched on a hillside. The cathedral's intricate Gothic architecture, including its tall spires and detailed stonework, is partially obscured by lush green trees. Below the cathedral, a river flows through the scene, featuring a small weir or dam that creates a gentle waterfall. The water is dark and reflects the sky, with white foam from the weir. In the foreground, more greenery and a few buildings with red-tiled roofs are visible, nestled among the trees. The sky is a pale blue with soft, white clouds, suggesting a bright but slightly overcast day.

- International Undergraduate Summer School (IUSS) on Particle Physics and Astronomy, 2006.
- MPhys from the University of Manchester, 2008.
- University of Durham Institute for Particle Physics Phenomenology, 2009.
- Working with Dr. Peter Richardson.



# Previous Research

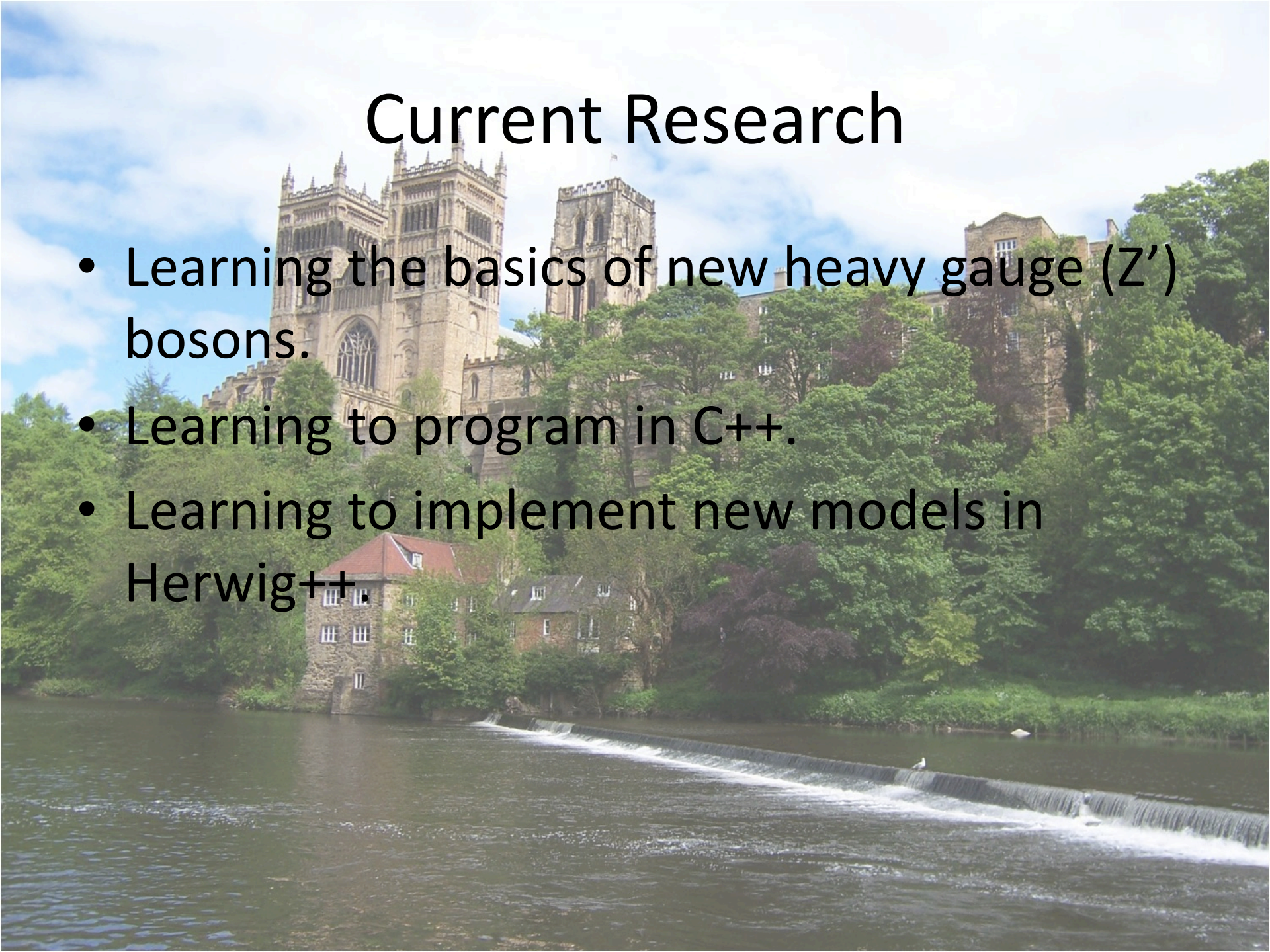
- Neutrinos, microscopic black holes and CPT violation (IUSS 2006), with Dr. Dean Morgan (Sheffield).
- Beam simulations for the ILC, with Dr. Rob Appleby (Manchester).





# Current Research

- Learning the basics of new heavy gauge ( $Z'$ ) bosons.
- Learning to program in C++.
- Learning to implement new models in Herwig++.





# Z' Models

- Motivation: It's the simplest extension to SM gauge groups.
- Theoretical framework:
  - GUT
    - Effective Rank 5 Models (ER5M)
    - Left-Right Symmetric Models (LRM)
  - Non-GUT
    - Little Higgs
    - A Heavy SM-like Z' (SSM)
    - The Light and Heavy Generations Model



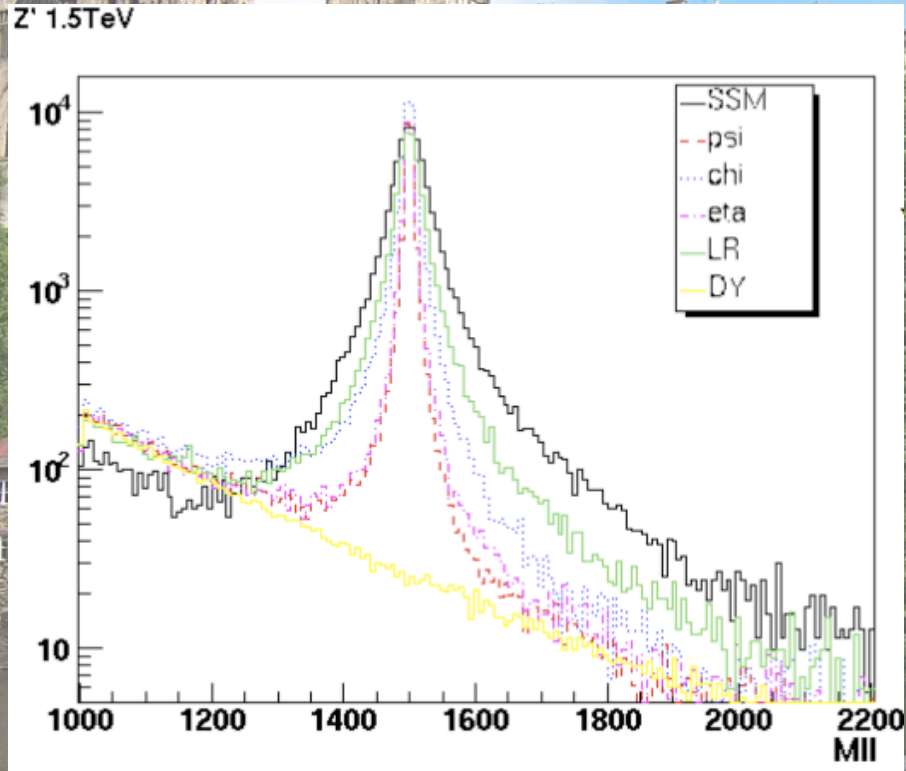
# Relevance

- A  $Z'$  with mass 1.3 - 1.5 TeV (for all of the most common  $Z'$  models) is definitely within reach using  $100\text{fb}^{-1}$  at the LHC (S. Godfrey arXiv:hep-ph/0201093v1).
- Using a Forward- Backward asymmetry measurement (and assuming  $M_{Z'} < 2$  TeV) the LHC should be able to determine the spin of the  $Z'$  and at least constrain its couplings to the SM.
- It's unclear how well we will be able to determine the  $Z'$  couplings using LHC data. The ILC will determine them completely.



# Effective Rank-5 Models

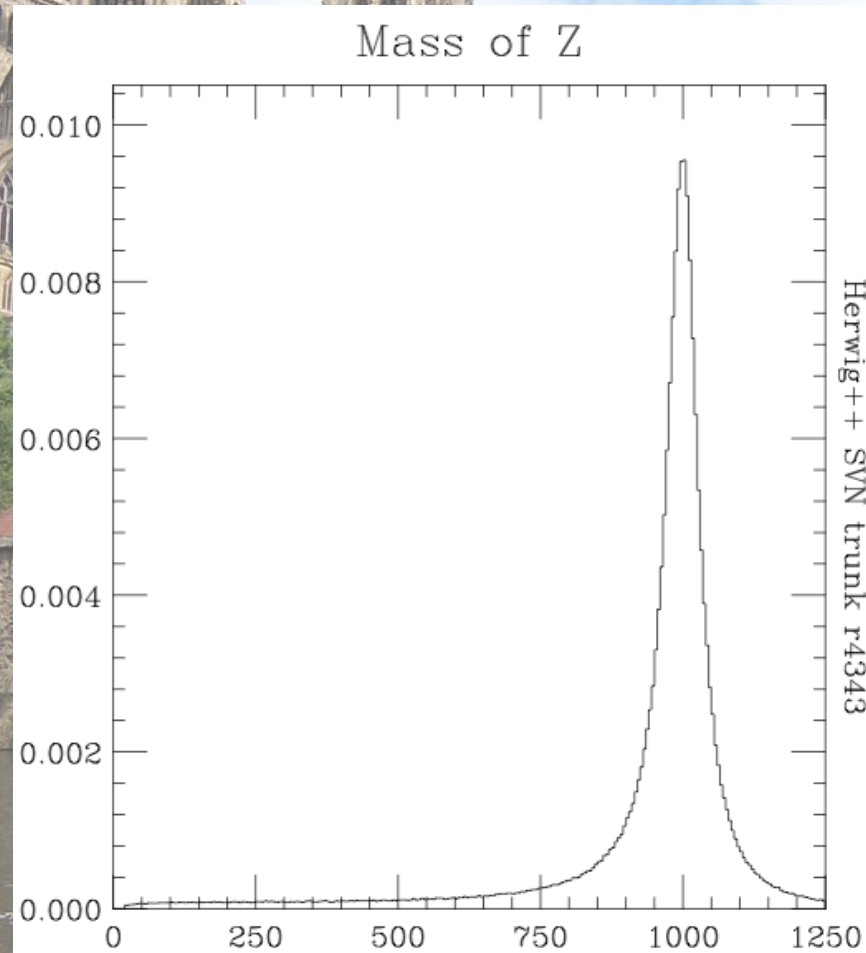
$$E_6 \rightarrow SO(10) \times U(1)_\psi \rightarrow SU(5) \times U(1)_\chi \times U(1)_\psi \rightarrow SM \times U(1)_\beta$$



T. Rizzo (arXiv:hep-ph/0610104v1)



# Herwig++ implementation





# Plans

- Finish learning how to implement simple SM extensions in Herwig++ (i.e. finish implementing a generic  $Z'$  boson).
- Look at other interesting possibilities, such as how to model the effects of the quantum mechanical interference between two nearby particle resonances (e.g. [hep-ph/0906.3417](#)) in a Monte Carlo event generator.