Slide 1

- Thank you for inviting me to talk, I think it'll be fun to talk to you all about my own research (and not just workshop material).
- I am a 3rd Year PhD student, with Johan Martens as my supervisor.
- My research has motivations stemming from Mathematical Physics, which is how I will introduce my research in this talk today.
- Though in reality it is much more geometry and algebra focussed.

Slide 2

- Phase space describes the configuration of a system in terms of its possible positions and momenta.
- Similarly in quantum mechanics, though now given by wavefunctions. They represent the probability (density) of finding the state in such a configuration.
- For us, wavefunctions are given by homogeneous polynomial, which are polynomials with each term of a specific degree k.

Slide 3

- Special type of phase space (symplectic toric manifolds), which have a very nice property that is each one has an associated polytope.
- We can extract information about the phase space from the combinatorics of the polytope.
- The "size" of the polytope is analogous to the quantum level of the system, which in the example has level $k = 3$.

Slide 4

- Another example of this is that each lattice point inscribed inside of the polytope corresponds to a homogeneous monomial.

- So counting up the lattice points gets us the dimension of the quantum space for our phase space!

Slide 5

- Sometimes it helps us to investigate the combinatorics of the polytope by viewing it as the intersection of a finite number of half-spaces.

Slide 6

- A half-space has a direction associated to it.
- What if we now consider both sides? Well clearly the configuration now is unbounded.
- If the lattice points in this configuration is to correspond to a quantum dimension, then it will now be infinite-dimensional!
- Whilst this is sort of an answer, it isn't a very helpful one.

Slide 7

- Instead, we can count up the lattice points found in smaller pieces of this configuration, and seeing how many points lie in that.
- We can scale the amount that we compactify by, hopefully giving us a more interesting result.
- This compactified configuration is what we call a *"polyptych"*, coined by my supervisor Johan (who himself thought of the term from the 'Ghent Altarpiece/Adoration of the Mystic Lamb' in Ghent, Belgium).

Slide 8

- Originally was interested in studying Chemistry, as I found the rules in which chemical elements bond really interesting.
- Decided that I should pick up Physics and Further Mathematics in order to truly appreciate the science.

- But then Theoretical Physics won me over so I read Mathematics & Physics at Warwick, as studying mathematics too would only help me more.
- In the 2nd Year Differentiation course, we were introduced manifolds and Lie groups. The lecturer commented on how Lie groups come up in the Standard Model and how important symmetries were in discovering new physical theories.
- From then, I devoted myself to geometry.

Slide 9

- After my integrated Masters, applied for PhDs but was unsuccessful (I hadn't applied to Edinburgh that time).
- Disheartened by still determined, read for a Masters of Advanced Studies in Pure Mathematics, specialising more in algebra and algebraic geometry, which I couldn't study during my previous degree due to credit allocation.
- Glad I did that.
- When it came to PhD applications again, received an offer from Edinburgh to read a Geometry & Topology PhD.
