

# Isabel Longbottom

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## EDUCATION

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DECEMBER 2021 Bachelor of Philosophy - Science (Honours), Mathematics major  
**The Australian National University**, Canberra  
GPA of 7.00 (out of 7.00), First Class Honours

2017 Western Australian Certificate of Education  
**Rossmoyne Senior High School**, Perth  
Beazley Medal, Dux, ATAR of 99.95

## RESEARCH INTERESTS

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I am interested in algebraic geometry, representation theory, the derived category, and other topics in algebra.

## AWARDS AND SCHOLARSHIPS

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2022 Attended the IAS/PCMI Summer Program on number theory informed by computation

2020 Alan McIntosh Prize for third year mathematics, ANU

2020 Hanna Neumann Prize for third year mathematics, ANU

2020 Priscilla Fairfield Bok Prize for women in third year science courses, ANU

2019 Hanna Neumann Prize for second year mathematics, ANU

2019 Priscilla Fairfield Bok Prize for women in third year science courses, ANU

2018 Hanna Neumann Prize for first year mathematics, ANU

2018 Mavis Prater Prize for women in mathematics, ANU

JULY 2017 Tuckwell Scholarship for an undergraduate degree at the ANU

2015, 2016 AND 2017 Australian Mathematics Olympiad Camp Senior

2015-2017 Bronze (2015, 2016) and Silver (2017) awards, Australian Mathematics Olympiad

## COMPUTER LANGUAGES/TOOLS

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(alphabetically) Ada, Haskell, Java,  $\text{\LaTeX}$ , Lean, Macaulay2, Magma, Python, Sage

## TEACHING & LEADERSHIP EXPERIENCE

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JANUARY 2020, 2021, 2022	Tutor at the National Maths Summer School Guided students to explore mathematical problems and critiqued their proofs.
2020 AND 2021	Demonstrator for MATH1115, MATH1116, MATH2222, and MATH2322, ANU Ran (online and in-person) workshops, and marked assignments and exams for first- and second-year undergraduate courses in calculus, linear algebra, and group & ring theory. This position is equivalent to a TA.
DECEMBER 2020	Maths tutor for the Curious Minds STEM program, Online Ran maths problem-solving sessions for rural female-identifying high school students.
SEPTEMBER-NOVEMBER 2019	Drop-in tutor, ANU Drop-in tutor for first year courses during the exam preparation period.
2019	Peer-Assisted Learning Mentor for MATH1115 and MATH1116, ANU The Peer-Assisted Learning program at the ANU employs second-year undergraduates to prepare activities for and teach tutorials to first-year students.
JANUARY 2018	Experienced Group at the National Maths Summer School, Canberra Explored topics in cryptography, algebraic curves, and algorithms with the aim of discovering results and proofs by hand. Organised social activities for younger students.

## RESEARCH PROJECTS & GRADUATE COURSEWORK

Project Title	Supervisor	Description
Derived Quiver Representations	Dr Asilata Bapat	This was my Honours project. I studied the bounded derived category of quiver representations for an acyclic quiver, and gave a proof that derived reflection functors are equivalences of triangulated categories. I also looked at the iterated weight filtration, which gives a canonical refinement of the Harder-Narasimhan filtration coming from a stability condition.
Crystals: Combinatorial Algorithms and Tensor Categories	Dr Noah White	In this lecture course, we developed the theory of braided and coboundary monoidal categories, and studied the induced actions by the braid and cactus groups. We also defined reflection groups and root systems before proving the classification of irreducible finite real reflection groups. We constructed crystals of semistandard tableaux for the $(GL_n)$ root datum, and studied the RSK algorithm, Schützenberger involution and Littlewood-Richardson coefficients.
Algebraic & Analytic Number Theory	Prof. Amnon Neeman	This reading course was devoted to various topics in modern number theory. The first half proved various standard results in algebraic number theory, such as the Kummer-Dedekind theorem, Minkowski's bound and methods of computing the class group, working from Stevenhagen's <i>Number Rings</i> . We then spent some time analysing techniques specific to Galois extensions of number fields. In the second half, we transitioned into analytic number theory, proving results such as the analytic class number formula. I gave a lecture presenting the proof of the prime number theorem.
Riemann Surfaces	Dr Ian Le	This lecture course developed much of the important theory of Riemann surfaces, including the uniformization theorem, the existence of meromorphic functions on any compact Riemann surface, the classification of elliptic curves, and the Riemann-Roch formula. As a personal project, I wrote a short paper outlining the proof of Riemann-Roch for smooth 1-dimensional curves over finite fields.
Three-Manifolds	Dr Joan Licata	This course was a broad survey of topics in 3-manifold theory, including Heegaard decompositions, (Dehn) surgery, Morse theory, Kirby calculus and more. As a personal project, I gave a talk and wrote a short paper on rational tangle replacement, and the equivalence between 2-fold cyclic branched covers of $S^3$ and manifolds obtained from $S^3$ via surgery on a strongly-invertible link.
Foundations of Algebraic Geometry	Dr Anand Deopurkar	This reading course followed Ravi Vakil's <i>The Rising Sea: Foundations of Algebraic Geometry</i> to develop the theory of sheaves on schemes. The first half focused on the construction and basic properties of schemes and their morphisms, while the second half introduced quasicoherent and coherent sheaves, line bundles and sheaf cohomology.
Vector Bundles & K-Theory	Dr Vigleik Angeltveit	This course was based on Hatcher's book draft <i>Vector Bundles &amp; K-Theory</i> . It developed the theory of vector bundles on a topological space, defining topological K-theory and working through some applications. As a personal project, I studied Schubert calculus and the cohomology of Grassmannians, including the Pieri and Giambelli formulas and Littlewood-Richardson coefficients.
Computational Algebraic Geometry	Dr Martin Helmer	This course gave a computational approach to modern algebraic geometry, developing algorithms and showing their applications using the language Macaulay2. As a personal project, I studied tropical algebraic varieties from the book <i>Introduction to Tropical Geometry</i> by Maclagan and Sturmfels, building towards the Structure Theorem.
Perverse Sheaves & Deligne-Lusztig Theory	Dr Asilata Bapat & Dr Uri Onn	This formal lecture course was divided into two sections. In the perverse sheaves component, we developed the theory of derived categories and t-structures on a triangulated category. We used this to study perverse sheaves and the perverse t-structure induced by a perversity function. The Deligne-Lusztig component was devoted to various classifications for characters on finite reductive groups, including parabolic induction and Deligne-Lusztig induction.
Calculus on Manifolds	Prof. Ben Andrews	I followed the text <i>Calculus on Manifolds</i> by Michael Spivak to learn the elementary theory of differential geometry. Ben Andrews provided resources to extend the project into the topics of Riemannian metrics and de Rham Cohomology.
Combinatorial Game Theory in Lean	Prof. Scott Morrison	This project was an attempt to formalise the basic theory of Conway's combinatorial games in the interactive theorem proving language Lean. While this theory is mostly elementary, it interacted in surprising ways with the inductive type system in Lean, and the difficulty of this project lay in proving well-foundedness of the necessary recursive definitions in Lean by choosing the right data types.