**Undergraduate Research Project**

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| **Project Name:** | Computational Quantum Algebra and the Anyon Wiki | **Number of Positions:** | 2+ |
| **Supervisor:** | Gert Vercleyen (postdoc), Colleen Delaney (professor), Eric Samperton (professor) | | |
| **Supervisor e-mail:** | [gvercley@purdue.edu](mailto:gvercley@purdue.edu), [colleend@purdue.edu](mailto:colleend@purdue.edu), [eric@purdue.edu](mailto:eric@purdue.edu) | | |
| **Project Description:** | Help us discover and catalog new species of quasi-particles with topological properties called “anyons.” These are useful for both quantum error-correction and condensed matter physics.  We have two programming-oriented projects immediately available to be supervised primarily by Dr. Vercleyen:  1. We have a Mathematica program to find all fusion rings with a given rank and multiplicity. Currently, the program generates some C code containing hundreds of nested for loops that individually range over very small numbers. No optimization is used, and someone with knowledge of C and parallel computing might be able to speed up the code by a significant factor. If this is achieved, then we might furthermore be able to extend the range for which computing clusters can classify low-rank fusion rings.  2. An important part of our program for finding fusion categories relies on the Smith and Hermite decomposition of integer matrices. These decompositions are also important in several other branches of discrete math, and accordingly well-studied—but not by us! It would be worthwhile to have a student try to study and implement various algorithms from the literature, e.g. in the Julia programming language, and compare their properties.  We are also interested in finding students with web development or database skills that can help us polish up the Anyon Wiki, the public database for anyons:  <https://anyonwiki.github.io/> | | |
| **Final Deliverables:** | Credited contributions to a public code base most likely; publications possible. | | |
| **Weekly Working Hours** | Depends on the student | | |
| **For Credits/Voluntary** | Credits possible if desired by the student | | |
| **Desired Qualifications** | Required: For Dr. Vercleyen’s project 1, knowledge of C. For project 2, a willingness to learn modular arithmetic and the Julia programming language.  Preferred: For Dr. Vercleyen’s project 1, familiarity with optimized tree search methods. For project 2, experience with matrix decompositions. | | |

**If you are interested in participating in this research project, please send an e-mail to the supervisor e-mail listed above together with a resume, a list of what courses you’ve taken or a copy of your transcript, and a personal statement explaining why you are interested in this project.**