

Proposal All Reviews: 1855608

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Agency Name: National Science Foundation

Agency Tracking Number: **1855608**

Organization:

NSF Program: Combinatorics

PI/PD: Williams, Nathan

Application Title: Geometry of Braid Groups in Combinatorics

Review 1

Rating:

Multiple Rating: (Very Good/Good)

Review:

Summary

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to intellectual merit.

This proposal considers problems in the combinatorics of braid groups and the fundamental groups of complexified arrangements. Specific projects include explicit comparisons of different models of Eilenberg-MacLane spaces, explicit presentations of the pure braid group of a finite Coxeter group, explicit presentations of arbitrary complexified real central hyperplane arrangements. The topological work is deeply connected with important combinatorial objects like noncrossing partitions.

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to broader impacts.

The PI has organized many conferences, seminars, and workshops; has worked with many undergraduates and has started working with a graduate student; and has begun initial work with students in his new appointment. His substantial background and the thought he has put into problems that are suitable for different levels of student research suggest that this level of activity will continue. His broader impacts are impressive for an early-career researcher.

Please evaluate the strengths and weaknesses of the proposal with respect to any additional solicitation-specific review criteria, if applicable

Summary Statement

This is a solid proposal in an area that combines braid groups, topology, and algebraic combinatorics. The broader impacts are good, and the PI could at some point also consider submitting a proposal for REU funding.

Review 2

Rating:

Good

Review:

Summary

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to intellectual merit.

The proposal is on finding a presentation of the pure braid group of a finite Coxeter group. For the symmetric group (type A) this was done by Emil Artin. The PI proposes a new approach should work for all finite Coxeter groups. Even in type A, the proposed presentation will be different from the one by Artin.

The research project is certainly interesting, but rather narrowly focused.

In the project description, the PI gives an excellent introduction to braid groups and pure braid groups.

Overall I think the PI could have used more space to explain his research, include more projects and build a stronger proposal.

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to broader impacts.

The Broader Impacts are excellent. The PI is very active in directing undergraduate research via REUs and honors thesis supervision. He is also the advisor of a PhD student.

He has designed new undergraduate and graduate courses in his department, and he is running a representation theory seminar. He has organized a graduate student conference, three sessions and an AIM workshop.

He also served as a consultant on a televised report regarding the NCAA basketball bracket.

Please evaluate the strengths and weaknesses of the proposal with respect to any additional solicitation-specific review criteria, if applicable

Summary Statement

The proposal is very nicely written, but somewhat lacks in breadth and depth in the research project.

Review 3

Rating:

Multiple Rating: (Very Good/Good)

Review:

Summary

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to intellectual merit.

The proposal has a very pleasing motivation: to generalize the understanding (i.e., proofs) of many results in Coxeter-Catalan combinatorics by studying presentations of braid groups. This is a worthy and nontrivial task.

The proposed idea is creative, with a mix of old ideas (mid-20th century) and new (last 15 years). In some ways, the proposed work could signal a definitive topological understanding of Catalan combinatorics.

Probably the main weakness of the proposal is its narrowness and its lack of specific, clear intermediate goals and problems.

The PI has a very strong track record of high-profile work in algebraic combinatorics, especially for a fairly young researcher.

In the context of the five review elements, please evaluate the strengths and weaknesses of the proposal with respect to broader impacts.

The PI has plans to continue to travel giving talks and organizing special sessions at AMS meetings. The PI has specific plans for continuing work with students, both an REU project and

graduate student supervision.

There is nothing especially original about the proposal with respect to Broader Impacts.

Please evaluate the strengths and weaknesses of the proposal with respect to any additional solicitation-specific review criteria, if applicable

Summary Statement

The proposal under review suggests to study presentations of braid groups of Coxeter groups in order to give a uniform geometric/topological understanding of combinatorial phenomena (Ft Catalan combinatorics). The proposal is well-written and makes the projects sound exciting and worthy of study. However, this reviewer was left wanting more somehow. As compared with other NSF proposals, there was a lack of specificity about the plan for tackling the problems described. Taken at a glance, the proposal seems a bit narrow in scope (braid group presentat though this is probably not the case. Perhaps the applications and implications of obtaining such presentations could have been developed further. One might expect half a dozen or more intermediate results or special cases to be spelled out, especially if the PI hopes to give parts of the project to students. More generally, the PI's track record shows interest and abilities in parts of algebraic combinatorics (e.g., dynamical combinatorics) and it might have improved the proposal if there were connections to other areas.

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