Proposal Panel 1 : [redacted]

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Agency Name: National Science Foundation

Agency Tracking Number: [redacted]

Panel Summary

Panel Summary Brief Summary of Project: The PI proposes to design and to analyze randomized Krylov subspace methods for computation involving matrix functions, such as low rank approximations, spectrum approximation, and partial traces. Intellectual Merit: Strengths: Reviewers find the ideas good and interesting for the proposed methods with potential practical value. The PI has been productive with an award-winning work in the past. Weaknesses: The proposal could be improved by making the novelty of the ideas more clear, and using preliminary results to show how the ideas can actually work out. In addition, using test cases from real applications would improve the proposal. Broader Impacts: Strengths: The PI has a detailed plan for recruiting/selecting students for research. The PI also showed the commitment to integrate first generation college students into research. Weaknesses: The plan for undergraduate student involvement can be more consistent. The panel felt that some of the topics are too advanced for undergraduate students. Results of Prior NSF Support: The PI has been highly productive from prior NSF support. Data Management Plan: The proposal could benefit from a more detailed data management plan. RECOMMENDATION Although there are positive aspects in the proposal, the panel felt the main ideas lack novelty and the successful paths to carry out the study are not clearly established. The panel placed this proposal in the category: Not competitive This summary was read by/to the panel and the panel concurred that the summary accurately reflects the panel discussion.

PANEL RECOMMENDATION: Not Competitive

Proposal Review 1 : [redacted]

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Agency Name:	National Science Foundation
Agency Tracking Number:	[redacted]
Organization:	
NSF Program:	COMPUTATIONAL MATHEMATICS
PI/PD:	Chen, Tyler
Application Title:	Randomized Krylov subspace methods for matrix functions
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.

BRIEF SUMMARY OF PROJECT:
The goal of the proposed project is to go deeper in the analysis of randomized
Krylov subspace methods when used to compute quantities related to matrix equations,
such as the evaluation of f(A)v, or the computation of the trace of f(A).
One of the premises of the proposal is that practitioners who are not mathematicians
or perhaps more precisely, scientists who are not specialized in Numerical Linear
Algebra, often use the methods as black boxes, and thus, cannot take full advantage
of techniques which may improve the convergence of the method for specific applications.
The proposers intends to facilitate to these practitioners the use of techniques
for their specific applications.
The proposal includes the training of several undergraduate students to work on
the project.

INTELLECTUAL MERIT:
For the evaluation of matrix function times vector, the proposer will analyze
the existing sketching paradigms, and think of possible improvements when
using a block Krylov iteration. Proposer will look into memory efficient algorithms
and will analyze the effect of inexact products.

Strengths:
1. A better understanding of Randomized Krylov methods for matrix functions is
a good topic of research.
2. Good publicly available software would be useful.

Weaknesses:
1. The topic proposed is already in high gear in Germany and Italy, and the proposer
does not seem to know about them. See, e.g.,

https://arxiv.org/abs/2306.06481
Sketched and truncated polynomial Krylov methods: Evaluation of matrix functions
Davide Palitta, Marcel Schweitzer, Valeria Simoncini
June 2023

https://arxiv.org/abs/2308.07722
Analysis of stochastic probing methods for estimating the trace of functions of sparse symmetric matrices
Andreas Frommer, Michele Rinelli, Marcel Schweitzer
August 2023

2. The use of black boxes to help practitioners is an established practice,
espoused, e.g., by Y. Saad, and it is the policy of the National Laboratories, precisely
because most practitioners do not want, or do not have the expertise to change
things "under the hood." It is not clear from the proposal, how the proposed
paradigm will be implemented, and how much of a difference can this bring to the
applications.

3. The topics of the proposal require an extensive background in Numerical Analysis,
some understanding of Probability, and very advanced Linear Algebra, at the level of
a graduate student. It appears that undergraduate students may not be at the level
needed to advance the theory.

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

BROADER IMPACTS:
Strengths:
The proposer intends to seek specific applications in quantum physics and chemistry,
and to involve undergraduates in the research.

Weaknesses:
There is not enough detail on how the specific applications will be brought to
the inter-disciplinary applications.

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

Results from prior NSF support:
PI was a recipient of both an NSF Graduate Fellowship.
This proposal is the first as an independent researcher.

Data Management Plan:
Data Management Plan is adequate.

Summary Statement

This proposal is in the lower third of the proposals I reviewed this year

Proposal Review 2 : [redacted]

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Agency Name:	National Science Foundation
Agency Tracking Number:	[redacted]
Organization:	
NSF Program:	COMPUTATIONAL MATHEMATICS
PI/PD:	Chen, Tyler
Application Title:	Randomized Krylov subspace methods for matrix functions
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 PI is knowledgeable on the subject. There are a number of good ideas suggested. It is interesting to incorporate restarting techniques from Arnoldi (RD2) and to combine variance estimation using statistical techniques with Lanczos estimates (RD4).

In spite of good ideas, it is hard to tell have things will work out. Somewhat risky proposal.

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

Broader Impact seems acceptable.

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

Summary Statement

Middle third of proposals.

Proposal Review 3 : [redacted]

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Agency Name:	National Science Foundation
Agency Tracking Number:	[redacted]
Organization:	
NSF Program:	COMPUTATIONAL MATHEMATICS
PI/PD:	Chen, Tyler
Application Title:	Randomized Krylov subspace methods for matrix functions
Rating:	Very 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.

Strengths:
1) It is novel to combine randomized sketching in the block Krylov subspace method (KSM) for matrix functions.
2) The PI plans to develop error bounds which can be used as stopping
criteria for KSM. This is of great pactical value.
3) The PI plans to introduce "restart" to mitigate memory overhead, and
use appopriate acceleration polynomials with povable convegence guarantees.
4) Based on the new randomized-KSP methods above, the PI plans to develop
new trace estimation algoithms for matrix functions.
5) The PI is clearly a rising star in the field. Since started as Ph.D. student
in 2017, he already published close to 20 papers. He has already made
tangible contributions in KSM for matrix functions.

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

Strengths:
1) The proposed work aims to improve the usability of the randomized KSM in practical settings.
2) The PI is actively involved in mentoring first-generation college students.

He serve as faculty advocate for the NYU program "Faculty Connect, Proud to Be First program at NYU", which pairs NYU faculty with first generation students.

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

- PI received NSF Graduate Research Fellowship, resulted in 16 publications.

Summary Statement

This proposal will support the design and analysis of randomized KSMs for tasks involving matrix functions.