William A. Stein ***Project Summary***

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The goal of this proposal is to carry out numerous computational and theoretical investigations with elliptic curves and abelian varieties motivated by the Birch and Swinnerton-Dyer conjecture. These investigations will hopefully improve our practical computational capabilities, extend the data and tools that researchers have available for formulating conjectures, and deepen our understanding of theorems about the arithmetic of elliptic curves, abelian varieties, and modular forms.

Intellectual Merit:

The PI is one of the more sought after people by the worldwide community of number theorists, for computational confirmation of conjectures, for modular forms algorithms, for data, and for ways of formulating problems so as to make them more accessible to algorithms. This project may lead to new conjectures and theorems, provide substantial new data relevant to work on the Birch and Swinnerton-Dyer conjecture, and lead to the creation of new computational tools.

Broader Impact:

The proposed research will likely result in significant improvements to the PI's software SAGE, which is intended to be an optimal open source software environment for research in algebra, geometry, number theory, and related areas.

Continued development of the PI's computational programs promises to have a broader impact on number theory, because the software and tools he has created are standard tools for obtaining data about modular forms and associated objects.

The PI intends to complete the undergraduate textbook *Elementary Number Theory and Elliptic Curves*, which he is writing under contract with Springer-Verlag. He also intends to finish the graduate textbook *Lectures on Modular Forms and Hecke Operators*, which he is co-authoring with Ken Ribet, and which is likely to be published by Springer-Verlag. These textbooks distinguish themselves from similar titles by incorporating specific knowledge and intuition gathered by the PI from his past numerical investigations.