Intellectual Merit Criterion

Overall Assessment of Intellectual Merit
Excellent

Explanation to Applicant
The applicant has strong research experience, with two first-author papers published on his undergraduate research. He also completed two summer internships, one at STScI and the other at the Harvard-Smithsonian CfA. The applicant showed initiative and independence on these internships, for example, developing machine learning methods at STScI that were new to his advisor. The applicant is well prepared academically and was a Goldwater Scholar in 2018.

Broader Impacts Criterion

Overall Assessment of Broader Impacts
Good

Explanation to Applicant
The applicant's work with large data sets has applications in related areas. The applicant works for two years as a physics tutor and hosted a "Python Master Class" to share programming skills with other students.

Summary Comments
The applicant has an impressive record in research. The broader impact of this proposal are weaker than competing proposals.

Intellectual Merit Criterion

Overall Assessment of Intellectual Merit
Very Good

Explanation to Applicant
The applicant is a member of the Dartmouth Stellar Evolution Research group, which has written the Dartmough Stellar Evolution Program (DSEP). The DSEP solves the linearized equations of stellar structure in one-dimension, specifically for the evolution of low mass (M < 5 solar masses) stares. Stars of similar ages and compositions are referred to as "isochrones", which must be simulated in large numbers to conduct realistic Monte Carlo (MC) studies. In it present form, DSEP would take months to generate a sufficient number of isochrones for a good MC simulation. Thus, as an alternative the applicant proposes to use graphic cards in a simulated supercomputer to conduct MC stellar evolution modeling, which would reduce the run time to about 1 day. The applicant has access to the Dartmouth high performance computer cluster, Discovery, that contains two Nvidia K80 GPUs. Each GPU has 5000 cores and 24 GB of memory that can be programmed using the Nvidia language "CUDA", of off-shoot of C. The project has two stages: (i) modifying DSEP to use programming conventions in line with CUDA (length of time 1.5 years), and (ii) modifying DSEP to actually run on a GPU. The applicant has a record of experience and success in neural network research. One such project resulted in a single author publication, "The applications of deep neural networks to sdBV classification", Open Astronomy, 26, 258. The applicant is also first author of another publication and co-author of a third paper--both of which involved neural network applications. The applicant was recipient of 5 undergraduate scholarships. The letters are complimentary and supportive of the proposal.

Broader Impacts Criterion

Overall Assessment of Broader Impacts
Good

Explanation to Applicant

The overarching broader impact theme is that such programming developments make astrophysics more accessible to researchers, specifically those tho work with big data sets, but may not have access to large and expensive computational facilities. In addition, the application applies programming skills to tutee peers on Python and other languages. This includes teaching Python master classes on a range of aspects. Since DSEP is open-source software, the applicants code will also be made available to anyone, especially to other stellar researchers.

Summary Comments

The intellectual merit of this proposal is very good. The broader impact is good. The proposal can be strengthened by addition of a wider range of broader impacts and service, especially to the non-physics community. The potential for the proposed activity to advance knowledge within stellar research is very good. The proposed activities suggest creative for programming run time improvement using parallel processing. The plan for carrying out the proposed activities are well-reasoned. The plan incorporate a mechanism to assess success--as measured by the reduced run time factor. The applicant is qualified to conduct the proposed activities, with adequate resources available at Dartmouth.

Intellectual Merit Criterion

Overall Assessment of Intellectual Merit

Very Good

Explanation to Applicant

The candidate has a demonstrated ability to independently generate novel ideas and instantiate collaborations with other scientist in the field of astronomy. The candidate's mostly self-directed undergraduate foray into ML demonstrates these abilities and provides a solid foundation for the proposed work. The candidate also has an appreciation for the need of observation to validate and verify modeling efforts. The candidate's work is motivated by the inability to directly observe stellar interiors and thus improving the slow, computationally intensive models to predict this structure. While the proposed work may lead to novel discoveries with respect to stellar structure, really only the modification of the DSEP program is addressed as a goal which is more or less an exercise in programming/development. The proposal could be vastly strengthened by the inclusion of a potential novel result the candidate expects to generate as a result of the modification of DSEP.

Broader Impacts Criterion

Overall Assessment of Broader Impacts

Good

Explanation to Applicant

The candidate is eager to share computational expertise with others and has served as a TA for several classes. The candidate's work will clearly impact all users of DSEP and improve accessibility for generating isochrones.

Summary Comments

Overall the candidate has a well written proposal and a demonstrated ability to generate computational advances in astronomy, however the proposal as-is is somewhat limited to a programming exercise of converting code from CPU to GPU. The proposal could likely be improved by addressing a potential novel exploration of the resulting improvements to DSEP or a potential observation campaign to validate/compare against.