

Budget Justification

Start date: 5/15/2020

End date: 5/14/2023

Support for three (3) years of effort is requested. The majority of the requested funding each year is for support for graduate student researchers.

Salary and Wages

Senior Personnel

For PI **Prof. Chris Churchill**, we request two-months of summer salary during Years 1, 2, and 3. It is during the summers that the PI will dedicate substantial effort to the project that is undistracted by his academic year teaching and administrative duties. Year 1 will be the “start-up year”, and the first summer will require the very first push to get all moving pieces of the project coordinated and moving forward. During Years 2 and 3, the project will require the PI’s substantial efforts in order to synthesize and tie together each previous year of work and then, in Year 3, to also complete the proposed work effort. PI Churchill will lead and manage the project. His efforts will include further development of analysis tools and methods, mentoring the graduate students, supervising the contributions of the post-doc and his mentoring of the graduate students, writing papers, and guiding the final interpretation of the results.

Postdoc **Dr. Sultan Hassan** will not be requesting salary and wages, as his salary and wages are fully covered by his two-year endowed Tombaugh Fellowship. As an expert on machine learning, Dr. Hassan will be engaged in training, guiding, and mentoring the graduate students and team, however, his effort will consume no more than 5% of his full time effort (FTE).

The fringe rate for faculty at NMSU is 20.88%. An annual 3% cost-of-living adjustment is budgeted for subsequent years.

Graduate Students

For NMSU graduate student **Ms. Rachel Marra**, we request three-months summer salary during Year 1. Ms. Marra will be a senior student (fourth year) at this time. She is an expert trained on running and analyzing the output of the HYDROART (hydrodynamic cosmological simulation) code. She is also an expert at implementing the absorption line analysis pipeline MOCKSPEC. Part of her duties will be to teach Mr. Bryson Stemock how to run and analyze both HYDROART and MOCKSPEC so that he can carry this skill set forward. Ms. Marra is expected to defend her Ph.D. in summer 2021.

For NMSU graduate student **Mr. Farhanul Husan**, we request three-months summer salary during Years 1 and 2. Mr. Husan has been a key individual for the construction of the ~ 3500 C IV and ~ 1700 Mg II absorption systems from the UVES and HIRES archival data. He has prepared them for science ready analysis. During his first summer his goals will be to catalog and prepare all captured associated transitions, i.e., H I, Si II, Si III, Si IV, C II, C III, Al II, Al III, Fe II, etc., with these C IV and Mg II selected systems in order to provide a science-ready catalog of all captured transitions and species for all these systems. During his second year he will work with graduate student Mr. Bryson Stemock to apply the machine learning methods to the observed data. This collaboration will be instrumental for constraining chemical and ionization conditions (densities) at multiple cosmic epochs. These portions of the project have the added benefit that they will serve to further the Ph.D. dissertation of Mr. Husan.

For NMSU graduate student **Mr. Bryson Stemock**, we request three-months summer salary during Year 1. During Years 2 and 3, we request nine-months academic salary and three-months summer salary. Mr. Stemock, an extremely talented, hard working, and productive student, will be the main individual exploring an implementing the machine learning techniques in collaboration with postdoc Dr. Hassan. Once both the leveraging aspects (and limitations) of the machine learning methodologies are fully explored, Mr. Stemock will apply the machine learning to the observed data, following which the science will follow. This work constitutes the central components of Mr. Stemock's Ph.D. dissertation research and the funding would carry him through to completion.

The fringe rate for a graduate research assistant salary at NMSU is 0.98%. An annual 3% cost-of-living adjustment is budgeted for subsequent years.

Equipment

For Year 1, we request one Macbook Pro laptop for graduate student Mr. Bryson Stemock, who will be the main computational person on the team. Mr. Stemock will utilize this laptop for the duration of the project as it will be his main computing platform. At the NMSU Astronomy Department, the central computing facility is supplemental for everyday processing and non-intensive computations. In practice, the vast majority of the research is performed on personal laptops. For this project, intensive computing (mostly the processing of the simulations) will be performed on the supercomputer "swinStar" hosted at the Centre for Astrophysics and Supercomputing at the Swinburne University of Technology through our collaboration with Deputy Director Dr. Glenn Kacprzak.

Travel

For Years 2 and 3, funding for travel is requested for two trips to a domestic specialty or general meeting. For Years 2 and 3, funding for travel is requested for two trips to a foreign specialty conference. These conferences will be instrumental for disseminating newly published and/or pre-published results, which is important for timely impact of the work, for early peer review and input, and for providing opportunities to graduate students and senior personnel to network, present their results, and promote their careers. The travel will be focused on the career development of the graduate students.

Other Direct Costs

Other requested direct costs are a nominal amount for materials and research supplies (there are no computer support expenses at NMSU), and for publication charges (page charges) for two to three modest page number refereed journal articles each year in which the results from the proposed research are presented for peer review.

Student Support

For NMSU graduate student **Ms. Rachel Marra**, we request academic tuition for Year 1.

For NMSU graduate student **Mr. Farhanul Husan**, we request academic tuition for Years 1 and 2.

For NMSU graduate student **Mr. Bryson Stemock**, we request academic tuition for Years 1, 2 and 3.

NMSU graduate students take nine credits per semester. The current cost per credit (not including additional fees) is \$270. We are requesting tuition only (no fees) for 18 credits for a two semester academic year. NMSU does not provide any tuition or tuition relief for graduate students, regardless of their assistantships. Most of our students resign to taking out student loans to make up their income gap for their cost of living and to purchase minimal health insurance. This is the case for all of the students who would be supported by this grant. Covering their tuition would allow them to avoid digging deeper debt.

There are no indirect costs associate with tuition requests.

Indirect Costs

The administrative costs are at a rate negotiated and approved by the ONR, NMSU's cognizant federal agency. The fixed rate for NMSU is 48% of the direct costs.