Astronomy 2115 Final Project

Fall 2024

You are a well respected faculty member at a major US University. As always you need funding to support students and postdocs, purchase equipment, go to conferences, and to pay for your summer salary. You have been invited to make a presentation for research support to a special panel convened by the National Science Foundation based on a recent, and perhaps controversial, scientific paper. The presentation can be performed in powerpoint, keynote, google slides, or a similar presentation software. The length should be about 7 minutes. You should be sure to take advantage of the resources available to you at your University. You should not use AI for any part of this project.

The Papers:

1) A radio technosignature search towards Proxima Centauri resulting in a signal-of-interest, Smith et al. 2021 https://arxiv.org/abs/2111.08007
2) One month convection timescale on the surface of a giant evolved star, Vlemmings et al. 2024, https://www.nature.com/articles/s41586-024-07836-9
3) An absorption profile centered at 78 megahertz in the sky-averaged spectrum, Bowman et al. 2018, https://www.nature.com/articles/nature25792
4) A highly magnified star at a redshift of 6.2 , Welch et al. 2022, https://www.nature.com/articles/s41586-022-04449-y
5) The discovery of a radio galaxy of at least 5 Mpc, Oei, et al. 2022, https://doi.org/10.1051/0004-6361/202142778
6) A potential mass-gap black hole in a wide binary with a circular orbit, Wang et al. 2024, https://www.nature.com/articles/s41550-024-02359-9
7) DMS and Methane in the atmosphere of K2-18b, Madhusudhan et al. 2023 https://arxiv.org/abs/2309.05566

You must read the abstracts for all 7 papers and then select the one that you are most interested in proposing for funding to try to confirm and/or expand on the result. Selections must be made by October 17.

The Universities:

We will hold a drawing in class to find out where your University appointment is. They are:

ASU: Faculty have access to national facilities like the VLA, VLBA, ALMA, GBT, HST, Chandra, Fermi, LWA, etc. Some access to space missions including cube-sats (very small, inexpensive

satellites) is also available. ASU is also one of the largest universities in the US and as such many class sizes are quite large.

Caltech: Faculty here have access to telescopes accessing almost every wavelength in the electromagnetic spectrum. These include the Keck telescopes, Palomar Observatory, the Owens Valley Radio Observatory, etc; and all the national facilities, and LIGO.

Harvard: Faculty here have access to telescopes accessing almost every wavelength in the electromagnetic spectrum. These include the 60 inch telescope in southern Arizona, the Sub-Millimeter Array (SMA), etc; and all the national facilities. Harvard also has many theorists at the CfA and runs the Chandra Observatory. Harvard has good access and experience with space-based instruments.

MIT: Faculty have access to Haystack Observatory, a radio observatory that hosts cm and mm wave instruments and does instrument design work. MIT also hosts the X-ray Diffraction Facility and they are the premier instrument builder for X-ray telescope instrumentation. Also has access to Magellan telescopes, LIGO, and TESS.

Johns Hopkins University. Faculty have access to space missions as well as the national facilities. Founded in 1876, JHU is also the oldest University in the US. The Space Telescope Science Institute is on campus ensuring many opportunities for collaborations using HST.

Stanford: Faculty here have access to the Stanford Linear Accelerator Center (SLAC) for particle physics studies, the national facilities and the Kavli Institute of Theoretical Physics (KIPAC) so theorists are in great abundance. Parking on campus is nearly impossible.

UCLA: Faculty have access to the Keck telescopes and to the national facilities. US News ranks UCLA the #1 public school in the US. Class sizes are fairly large.

UC Berkeley: Faculty have access to the Keck telescopes and to the national facilities. Berkeley gets only ~3% of its revenue from the state of California, the rest is tuition and Federal funding. US News ranks Berkeley the #1 public school in the US, and it is highly ranked for its Astronomy department as well.

UNM: The Physics and Astronomy Department faculty have access to national facilities and the Long Wavelength Array. UNM is also a minority serving institution with a diverse student body.

TTU: Faculty have access to national facilities and the Long Wavelength Array. TTU is also a minority serving institution with a diverse student body. US News ranks TTU #116 in public schools but it is 5 times cheaper than Berkeley and has a good physics and astronomy department.

UC Boulder: Like Berkeley, Boulder gets over 90% of its funding from tuition and Federal funding. There are several national facilities in Boulder including NCAR and NIST. There is also excellent skiing nearby.

University of Arizona: That other University in Arizona hosts the Caris Mirror Lab under the football stadium and also the Steward Observatory. This provides opportunities for Faculty to use big optical telescopes and also to help build them.

Northern Arizona University: A much smaller University than the above schools, NAU still offers considerable access to large optical telescopes. NAU faculty members have close research collaborations with scientists at local institutions including Lowell Observatory, and the United States Naval Observatory, Flagstaff Station.

NMSU: The Astronomy department operates the 3.5 m telescope at Apache Point so faculty have access to that well equipped telescope. Faculty also have access to national facilities and close ties to NASA. NMSU is also a minority serving institution with a diverse student body.

Content:

Read the paper and think about the science and what experiment you might do to try to confirm or improve upon the results. Look at the citations to the paper and see if you can find some additional information. What are the implications if the results hold up? You should be quantitative in your argument to the maximum extent. That is, if there are back of the envelope calculations you can do then give that a try. Look for related calculations that we have done in class. Try to play to the strengths of your University. Note that NSF requires you address both the "Intellectual Merit" of the idea and also the "Broader Impacts". From the NSF proposal guide:

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit**: The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts**: The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes. [Such as the education of students at all levels, and in all demographics.]

The following slides are required elements of your talk:

Title slide: Title, Name, Affiliation

Intellectual Merit: See above. State how your project will advance our understanding.

Broader Impacts: See above. State how your project will have broader impacts beyond the science.

Budget: Just a rough figure and a few sentences justification on how funds will be spent. Allowable expenses include graduate students ($50K/year), postdocs ($120K/year), summer salary ($10K/month for 2 months), travel ($10K/year), publication costs ($3K/paper), host a workshop ($20K), etc.. You aren't required to have all of the above, just what you think you will need to accomplish the goals of

your proposal. Note that for Caltech, Stanford, and Harvard all personnel costs should be multiplied by a factor of 1.5.

Presenting your final project:
Presentations will be in class on Dec 3, 5 and 10 (during the final exam period). You will also submit a hardcopy of your slide show in class on the day of your presentation. Plan for a 7 minute talk. Everybody in the class must also ask at least one question during the presentations.

Grading for the project will be based on Completeness as regards addressing Intellectual Merit and Broader Impacts (40%), good use of Graphics (20%), Clarity and Style (20%) and Creativity including leveraging University resources (20%).