Physics 4601
writing proposals
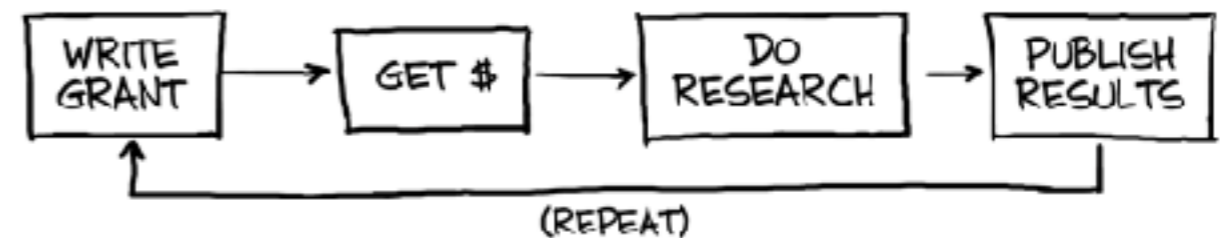
James C. (JC) Gumbart
http://simbac.gatech.edu/phys4601/

School of Physics | Georgia Tech | Spring 2019

some material taken from UIUC Grad College
http://illinois.edu/cms/4931/nsf_grf_wrkshp_2015___kv_bh_slides.pptx

What is a proposal?

it's an offer to carry out a specific project or projects in exchange for resources to do so

It should

- address a well defined "knowledge gap" **AND** why they should be interested in it
- meet the criteria and requirements of the announcement
- have reasonable and clearly stated goals
  - are you capable of carrying out the work?
  - are the goals achievable in the time frame of the proposal?
  - will achieving the goals address the knowledge gap?
- be specific without being too jargon-y (know your audience!)

- **BE EXCITING!**

What is a proposal?

It typically contains

- a brief synopsis
- background/lit. review - needed to understand the context
  - *this should make it clear that there are questions that remain to be addressed!*
- a research plan
- something addressing significance of the work (why should they fund yours over someone else's?)

The National Science Foundation

Federal agency created in 1950 to "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure national defense"

Supports research and education in Science, Technology, Engineering and Math (STEM) disciplines - all fields but clinical biomedical areas (covered by NIH)

NSF annually awards about 10,000 research grants, a proposed 2,000 new graduate fellowships (student as awardee), graduate trainees, and +/- 30,000 research assistantships (via grants to Principal Investigators)

Has a budget of ~$7 billion
(NIH is $31b, NASA is $18b)

Why a proposal needs to be excellent

NSF Success Rates – FYs 2013 & 2012

Organization/ Directorate	FY	Number of Proposals	Number of Awards	Funding Rate	Average Decision Time (months)	Mean Award Duration (years)	Median Annual Size
NSF – Overall	2013	49,013	10,844	22%	5.77	2.62	$115,266
	2012	48,622	11,533	24%	5.64	2.73	$104,269
Biological Sciences	2013	5,937	1,253	21%	5.11	2.87	$138,400
	2012	5,271	1,295	25%	5.27	2.88	$120,004
Computer & Information Science	2013	7,821	1,616	21%	5.61	2.73	$150,076
	2012	7,692	1,738	23%	5.44	2.80	$137,866
Education & Human Resources	2013	4,502	794	18%	6.06	2.99	$164,073
	2012	4,281	889	21%	6.05	3.26	$126,887
Engineering	2013	10,745	2,220	21%	4.92	2.32	$118,140
	2012	11,353	2,080	18%	5.03	2.51	$114,593
Geosciences	2013	6,090	1,568	26%	7.88	2.69	$129,177
	2012	5,249	1,643	31%	7.42	2.78	$111,981
Mathematical & Physical Sciences	2013	8,903	2,201	25%	6.10	2.92	$101,643
	2012	9,006	2,523	28%	5.81	2.92	$104,965
Social, Behavioral & Economic Sciences	2013	4,433	920	21%	5.12	2.10	$46,720
	2012	4,776	1,019	21%	5.05	2.33	$43,170

Source: NSF website - http://dellweb.bfa.nsf.gov/awdfr3/default.asp

NSF Graduate Research Fellowship

to help ensure the vitality and diversity of the scientific and engineering workforce of the United States.

recognizes and supports outstanding graduate students pursuing research-based master's and doctoral degrees in STEM fields and in STEM education.

three years of support for graduate education of individuals who have demonstrated potential for significant research achievements in STEM and STEM education

NSF especially encourages women, members of underrepresented minority groups, persons with disabilities, and veterans to apply.

NSF also encourages **undergraduate seniors** to apply.

NSF GRF benefits

READ PROGRAM SOLICITATION CAREFULLY!

- Three years of support over a five year period

- Annual stipend of $34,000 - cost of living to student

- Tuition support of $12,000 - cost of education allowance paid to institution – remainder covered by university

- Cyber infrastructure access via XSEDE

- International opportunities through GROW initiative

GRF eligibility criteria

- **Academic level**
  - Level 1: Seniors, baccalaureates with no graduate study
  - Level 2: First-year graduate students
  - Level 3: Second-year grad students (12 months of graduate study or less by Aug 1 prior to submission)
    - **NOTE: only Level 2 OR 3, not both!**
  - Level 4: >12 months graduate study – extenuating circumstances

- **Citizenship**
  - U.S. Citizen, National or Permanent Resident

- **Discipline**
  - Research-based Masters or PhD in NSF-Supported Field of study (note changes in various fields, esp. BIO)

NSF-supported disciplines

- Engineering
- Computer and Information Science and Engineering
- Materials Research
- Mathematical Sciences
- Chemistry
- Physics and Astronomy
- Social Sciences (non-clinical)
- Psychology (non-clinical)
- STEM Education and Learning
- Life Sciences
- Geosciences

Some areas are NOT supported

- Clinical work
- Counseling
- Business
- Management
- Social work
- Practice-oriented professional degree programs
- Joint science-professional degree programs (MD/PhD and JD/PhD)
- Medical, dental, law, or public health programs
- Education (except research-focused STEM education)
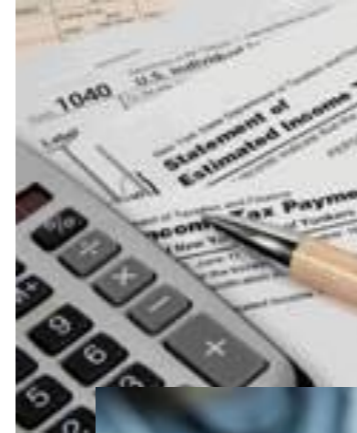
Application Materials
GRFP FastLane

Personal Statement, Relevant Background, and Future Goals Statement (3 pages incl. figs)

Graduate Research Statement (2 pages incl. figs)

Three Letters of Reference

Transcripts (uploaded into FastLane)

(GRE Scores NOT ACCEPTED!)

Graduate Research Plan Statement

"Present an original research topic that you would like to pursue in graduate school. Describe the research idea, your general approach, as well as any unique resources that may be needed for accomplishing the research goal (i.e., access to national facilities or collections, collaborations, overseas work, etc.) You may choose to include important literature citations. Address the potential of the research to advance knowledge and understanding within science as well as the potential for broader impacts on society."

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1. Research Idea
2. Approach
3. Intellectual Merit
4. Broader Impacts

Graduate Research Plan Statement

- Introduce general theory/area of study and importance - a few references will demonstrate understanding of field

- Panelists are experts in general field; *may not* be experts in your specific research specialty - <u>avoid</u> <u>jargon</u>

- Describe your motivation to go into that area and discuss plans to prepare for that field of study - mention school(s), degree programs, potential advisor, etc.

- Spell out specific details of your research and study plan but avoid jargon, specific experimental details, etc.

- Comment on the broader impacts of your activities

- Let the reader know of your career plans, even if tentative

- Demonstrate flexibility ("plan B")

Personal Statement, Relevant Background, and Future Goals (NOT REQUIRED FOR THIS CLASS)

- Three pages—provide the narrative of your story

  - Your <u>motivation</u>, <u>preparation,</u> & <u>potential</u> to contribute to scientific research, education, and innovation

  - Examples of <u>leadership</u> skills, <u>creativity</u>, <u>perspective</u> & <u>unique characteristics</u> (avoid arrogance)

  - How the GRFP will assist you with <u>career goals</u>

- Opportunity for evaluators to see you as a person and understand what "makes you tick"

- Chance to respond to broader impact merit criterion – How will you contribute to science and society?

Relevant Background

- Emphasize experience relevant to your application but include all examples of "research", even if not in field

- List experience with hypothesis formulation and testing, experimental design, data management and analysis, interpretation of results, dissemination of findings

- Highlight what you did (independence) but discuss collaborators (teamwork) and leadership

- A global worldview is important – mention international experience, collaborators, research opportunities, etc.

- List any publications, posters, presentations, prizes, awards, grants, special recognition, etc.

Review criteria

- What is the potential for the proposed activity to
  - a) <u>advance knowledge</u> and understanding within field or across different fields (**Intellectual Merit**); and
  - b) <u>benefit society</u> or advance desired societal outcomes (**Broader Impacts**)?

- To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?

- Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale?

- **Does the plan incorporate a mechanism to assess success?**

- How well qualified is the individual, team, or organization to conduct the proposed activities?

- Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Intellectual Merit Criterion

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

- Academic performance & background (grades, curricula)
- Awards/honors
- Communication skills
- Research experience
- International experience
- Independence/creativity
- Publications/presentations
- Research plan
- Choice of institution
- References

Broader Impacts Criterion

- "advance societally relevant outcomes"

- Accomplished through the research itself, activities directly related to specific research projects or that are complementary to the project.

- Full participation of women, persons with disabilities, and minorities underrepresented in STEM fields

- STEM education and educator development at any level – increased public scientific literacy & development of STEM workforce

- Partnerships between academia, industry, and others

- Improved national security

- Increased economic competitiveness of the US

- Enhanced infrastructure for research and education

Broader Impacts Criterion

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

- Prior accomplishments
- Community outreach
- Impact on society and connectivity
- Future plans
- Leadership potential
- Individual experiences
- Integration of research and education
- Potential to communicate to diverse audiences

The life of a scientist sounds way more fun when you describe it like you're a six year old.

Letters of reference

- Three required - should know you as scientist and person

- Will compare you with NSF Graduate Research Fellows & other successful students they have known based on: potential to make unique contributions to discipline, ability to conduct original research, leadership potential, productive member of scientific community, and originality of plan of study

- Will state their role in assisting with the application

- Provide referees sufficient time; share application materials with them; ask for advice

- Track letters on FastLane - remind referees about deadline

Panelist Review of Applications

- Applications are sent to panelists in December allowing <u>several weeks for review</u>

- Applications are scored numerically for overall merit by three panelists. Applications are also ranked by each panelist using standard NSF categorical ranks (poor/fair/good/very good/excellent)

- Panelists comment on intellectual merit and broader impacts criteria highlighting strengths and areas for improvement – comments are provided to applicants

Panelist Review of Applications

- Program office normalizes the numerical scores using a z-score approach and ranks applications by an average of these scores

- Virtual panel sessions held in Jan & Feb to permit discussion and recommendations to NSF

- Applications with inconsistent scoring (Z-score) are discussed and/or re-evaluated

- Final ranking is primary determinant of award choice but NSF uses ranking and other factors to determine awardees and honorable mention

Award Announcement

Usually in late March or early April

Awardees and recipients of Honorable Mention listed on the program FastLane website

Final numbers dependent upon funding made available to the program office

Success rates across disciplines not always equal, but overall, it is **~10-15%** (2015: 2000 awards/16,000 apps; 2017: 2000 awards/12,439 apps)

For this course

You will write a 2-page research proposal suitable for the NSF GRFP

The proposal will be due on the last day of class, but we will have multiple intermediate deadlines through the semester (see the website!)

The proposal will be written in Latex

LATEX

Latex (Lah-tek or Lay-tek) is a typesetting language used by many scientists, especially physicists

you type in "code", which is then compiled to produce the document

one of the main benefits is mathematical equations and symbols

```
\displaystyle\int_{-\infty}^{+\infty} dx~e^{-\alpha x^2} = \sqrt{\pi \over \alpha}
```

$$\int_{-\infty}^{+\infty} dx\ e^{-\alpha x^2} = \sqrt{\frac{\pi}{\alpha}}$$

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```
@article{Li2014,
    author={J. Li and K.F.
Jaimes and S.G. Aller},
    title={Refined structures
of mouse {P}-glycoprotein},
    journal = PS,
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    number = {1},
    pages = {34--46},
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}
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and references!
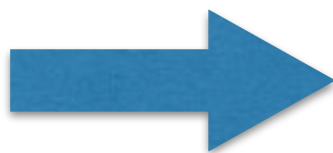
[14] J. Li, K. Jaimes, and S. Aller. Refined structures of mouse P-glycoprotein. *Prot. Sci.*, 23:34–46, 2014.