Science Communication and Writing Module:

# What Works and What Doesn't in Proposals

UCO/Lick Observational Astronomy Workshop

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# Today's plan

Introductions, and why I'm here

Why proposals matter (and who reads them)

Anatomy of a proposal

How a review panel reads your proposal

Break (10 min)

Case studies: what worked and what didn't

Mini-panel: you be the reviewer

Take-aways, resources, Q&A

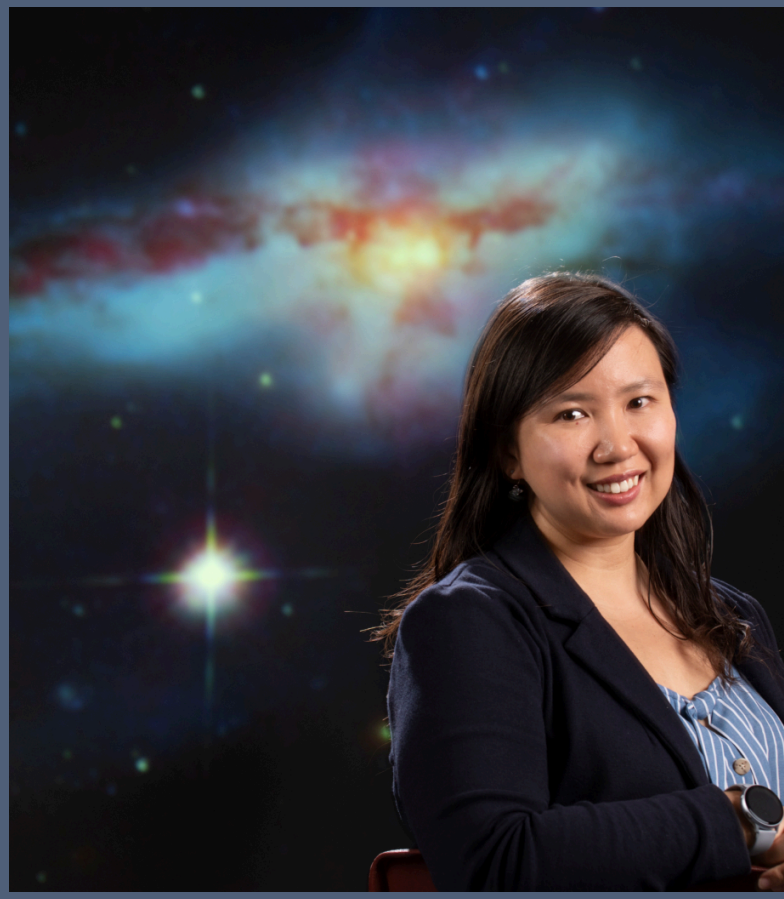
*Ask questions anytime, in chat or out loud.*

# Introductions

- Name
- Campus
- Advisor
- Main research interest
- Bonus: have you written or reviewed a proposal before? (yes / no / sort of)

# Who I am

- BS Caltech, PhD University of Hawai'i at Mānoa
- Postdoc at UC Riverside and UC Irvine (UC PPFP / CFP)
- Now at Caltech/IPAC, leading the Roman Space Telescope proposal team
- Research: galaxy mergers, AGN (structure, feedback, dual/binary), multi-scale and multiphase gas dynamics



# Why you might trust my opinion on this

*Writing, winning, losing, and reviewing*

## Observing

Keck (OSIRIS, KCWI/KCRM, NIRC2, LRIS, MOSFIRE, DEIMOS), Lick/Shane (Kast), JWST (MIRI, NIRSpec), HST (WFC3/ACS), SMA, ALMA, JCMT, Gemini (NIFS)

## Funded by

NASA Jenkins and SAO pre-doc fellowships, UC Chancellor's postdoc fellowship, NASA ADAP, JWST, HST, NSF, NASA precursor

## Reviewing

IfA TAC (grad rep), NASA ADAP (chair), NSF AAG/AAPF, HST, Swift (deputy chair), JWST (chair), UC Keck TAC (3-year term), JPAC, external reviews

# Why this module exists

- Broader-impact activity of my NSF award (#2536603)
- I care about Lick as both a research and an education institution
- Inspired by Prof. Virginia Trimble to contribute to this workshop series
- Proposal writing and reviewing is rarely taught formally, and not on every campus
- Last year: two sessions plus a homework proposal. Your feedback: too much during a workshop. This year: one session, no homework.



# What you'll get out of today

## A reviewer's-eye view

How panels actually read, discuss, and rank proposals

## A checklist

What the strongest proposals consistently do

## Real examples

Side-by-side anonymized proposals that were funded vs. not

## A little practice

A live mini-panel. No writing required.

PART 1

# Why proposals matter

*Who reads them, and what they're deciding*

0:12 – 0:25  (13 min)

# Proposals are everywhere in a research career

## Telescope proposals

observing, archival, theory

## Fellowship applications

grad, postdoctoral, early career

## Job applications

PhD program, postdoc, faculty / staff

## Funding applications

federal grants, foundations

*Clear, succinct writing is key!*

# The reader's situation

*Why this shapes how you should write*

- Oversubscription is the norm: more good science than time or money
- Reviewers read many proposals, often in addition to their day job
- Many of them are not experts in your exact subfield
- The early read decides a lot: a proposal must be easy to champion
- You are not graded on effort. You are ranked against other strong proposals.

# A proposal is an argument, not a summary

- Claim: here is an important question and why now
- Evidence: why this approach / data / person can answer it
- Plan: concrete, feasible, and matched to the goal
- Return: what we will know afterwards that we don’t know today

*The same structure works for telescope time, fellowships, and grants.*

PART 2

# Anatomy of a proposal

*The components, and what each one must accomplish*

# The basic components and expectations

## Science justification

- Compelling science case
- Well thought-out experiment, including the sample
- Demonstration of successful return
- May include an analysis plan

## Technical justification

- Sensible setup: instrument, mode, exposure time for the target S/N, observing sequence
- Info needed for observation planning, and why
- Backup plans (for classical observing)
- The plan must accomplish the science goals

# The science case in five moves

*A skeleton you can bend to any proposal*

**1**

## Hook

Why should anyone care?

**2**

## Gap

What is unknown or contested?

**3**

## Question

The specific, testable question

**4**

## Experiment

The data/sample that answers it

**5**

## Return

What we'll know afterwards

*Test: could a smart non-specialist read only paragraph one and tell you what you're proposing?*

# The technical justification: prove it will work

- Trace the chain: science goal → required measurement → S/N → exposure time → setup
- Show your math (or the ETC inputs): target brightness, seeing, airmass, binning
- Justify every instrument choice: why this mode, why not a cheaper alternative?
- Request the time you need, no more and no less
- Classical observing: give a backup plan for weather and conditions

# Don’t forget the “small” sections

- Special requirements and scheduling constraints
- Duplications with other programs (and how this one differs)
- Joint requests and supplementary observations
- Publications from previous allocations on this facility
- Budgets, where applicable

*Reviewers use these to judge whether you are a careful, reliable investment.*

# Know your audience

*General panel or specialist panel? Strike a balance.*

## Generalist reader

- Define jargon and acronyms once
- Lead with the big picture
- Figures that stand alone

## Specialist reader

- Show you know the literature
- Be precise about methods and uncertainties
- Anticipate the obvious objection

PART 3

# How the panel reads your proposal

*Time Allocation Committees and review panels*

# How a panel review works (more or less)

- Typically 6–10 reviewers per panel, facilitated by a chair
- Most or all panelists read each proposal and give preliminary scores, which set the initial ranking and allow triage
- Each proposal gets a primary and 1–2 secondary reviewers
- Primary: summary, strengths, weaknesses. Secondary: adds to strengths and weaknesses
- Discussion, then re-grading
- Final ranked list; open discussion around the “resource line”
- Written reviews go back to proposers

# What the primary reviewer must do in ~3 minutes

- Summarize what you propose and why it matters
- Defend its strengths to colleagues who haven't read it closely
- Explain its weaknesses honestly
- So: make the summary easy to write. A clear first paragraph is a gift.

*Write the sentence you want the primary reviewer to say out loud.*

# Break

10 minutes

*Stretch, grab water, look away from the screen.*

PART 4

# Case studies: what worked and what didn’t

*Anonymized proposals and the panel’s verdicts*

# How we'll do the case studies

- Paired excerpts from real proposals (mine)
- You see the excerpts first. Vote in chat: which would you fund, and why?
- Then we'll discuss what made the difference
- Success and failure both included

*Everything shown is from my own proposals.*

# Case studies: one program, four attempts

*My own NSF AAG proposals, 2020 → 2023*

## 2020

**Not funded**

- Keck/OSIRIS sample of 36 mergers
- 3 broad, open-ended questions
- Broader impacts: UCI mentoring program
- No timeline or deliverables table

## 2021

**Not funded**

- Sample of 37 systems
- Questions trimmed to 2
- Broader-impacts text ~96% similar to 2020

## 2022

**Not funded**

- Adds Seyfert control sample
- ~1/3 of sources have JWST data
- Broader-impacts text ~90% similar to 2020

## 2023

**Funded**

- 33 mergers: Keck/KCWI+KCRM data in hand, plus JWST
- 3 numbered objectives, deliverables boxes, year-by-year table
- Broader impacts rewritten around Lick

*Same program. What changed was the evidence and how it was packaged.*

# Case 1: Science objectives

*Which objectives would you rather fund? (vote in chat: A or B)*

## Proposal A

**2 Intellectual Merit: Science Objectives and Proposed Work**

1. How does the merging process influence outflow properties?
   ▶ Determine spatially resolved outflow properties for a large sample of mergers at different interaction stages
   ▶ Analyze sample of 33 nearby (U)LIRGs with large-scale optical Keck/KCWI + VLT/MUSE observations of ionized and neutral gas
2. How effectively do outflows couple to the multiphase ISM?
   ▶ Compare hot ionized and neutral gas properties from the optical observations to the warm and cold molecular component from JWST + ALMA
   ▶ Trace gas properties as function of distance, compare with FIRE-2 merger simulation suite
3. What is the main driver for AGN feedback?
   ▶ Measure ionized gas and stellar kinematics for control sample of 29 nearby Seyferts with Keck/KCWI + VLT/MUSE data
   ▶ Compare results with those from the merger study to assess feedback dependence on AGN properties or merger dynamics

## Proposal B

We propose a combined observational and theoretical approach to address these key questions:

- How much gas is entrained in outflows and how does its fate depend on the ISM in the host galaxy?
- How does feedback impact the fuel out of which stars form as galaxies interact and perturb the molecular gas distribution?
- How do the different gas temperature-density regimes interchange, subsequently affecting star formation, as winds permeate the galactic host?

# Case 1: the verdict

## Proposal A • 2023 • Funded

- 3 numbered objectives, each = a question plus the data and actions that answer it
- Concrete numbers: 33 mergers, 29 control Seyferts, named instruments (KCWI, MUSE, JWST, ALMA)
- Each objective also gets a “Goal / Data / Deliverable” box later on

## Proposal B • 2020 • Not funded

- 3 open-ended questions ("How much gas is entrained…?")
- Nothing tells the reader what will be observed, how many, or what comes out
- The reader must read on to learn what will be observed, and how many

**Takeaway**

*A question is not an objective. Pair each question with the data and the deliverable that answers it.*

# Case 2: Preliminary results

*Which makes a stronger case for the full program? (vote in chat: A or B)*

## Proposal A

*"A clear demonstration of the power of combining these multiwavelength data sets can be seen in detailed single-case studies of Mrk 266 and Mrk 463. […] These single object results have significant implications for the origin of feedback and prominence of momentum and energy transfer for galaxies in transition. Extending these multiwavelength studies to a representative sample of galaxies at different stages of the merging sequence will elucidate our understanding of the role of feedback and the evolution of outflow dynamics in late-stage mergers."*

NSF AAG proposal, §1.3 (citations removed)

## Proposal B

*"Our latest case studies clearly demonstrate the power of combining multiwavelength data sets in VV 340, NGC 7469, and others. Our pilot study showcases a detailed resolved analysis of the gas and jet in LIRG VV 340, […] reveals a precessing jet-driven outflow that excites the high-ionization [Ne V] 14μm gas to at least 3 kpc beyond the nucleus and the low-ionization [O III] gas to at least 15 kpc beyond the galactic plane, removing star-forming gas at a rapid rate. On the other hand, large ionized AGN outflows traced by [O III] in NGC 7469 […] turn out not to have a profound impact on its surrounding star-forming ring due to wind geometry based on our JWST IFS observations. […] [E]nergetics of the multiphase winds have been quantified for only a handful of galaxies with limited AGN luminosities."*

NSF AAG proposal, §1.3 (citations removed)

# Case 2: the verdict

## Proposal A • 2020 • Not funded

- Leans on published single-object studies (Mrk 266, Mrk 463)
- The argument is “extend this to a sample, and it will elucidate the role of feedback”
- The gap is not tied to any new result from the team

## Proposal B • 2023 • Funded

- Leads with our latest pilot results: VV 340 and NGC 7469 with JWST and Keck data
- Two contrasting outcomes (a jet-driven outflow clearing gas vs. an outflow that barely touches the ring) show why a sample is needed
- Names the gap: energetics quantified for “only a handful of galaxies with limited AGN luminosities”

Takeaway

*Show your own pilot result, then let it expose the gap the full program fills.*

# Case 3: Management plan and deliverables

*Which plan would you trust to finish on time?  (vote in chat: A or B)*

## Proposal A

| Year | Tasks | Deliverables |
|---|---|---|
| 1 | ▸ Expand pilot study of the control sample to include existing and new observations for the remaining 19 Seyferts [GSR]<br>▸ Modify existing KCWI tools and infrastructure for MUSE data [GSR]<br>▸ KCWI+KCRM observing campaign wraps up [PI/PDR/GSR] | • Paper IV: Narrow-line Region Gas Kinematics in Seyfert Galaxies [GSR]<br>• *Ingest processed KCWI+KCRM data into the Keck Archive [PI]* |
| 2 | ▸ Analyze KCWI+KCRM data and measure outflow properties for the full merger sample (shock diagnostics, mass outflow rates, energetics) [PD]<br>▸ Generate photoionization and shock models using STARBURST99, MAPPINGS V, and Cloudy codes [PD]<br>▸ Prepare merger simulation suites [PI + Co-I Moreno] | • Paper I: Resolved optical diagnostics and properties of galactic-scale winds [PD] |
| 3 | ▸ Analyze multiphase gas combining Keck, ALMA, and JWST data for the full sample [PD]<br>▸ Compare multiphase outflow results to merger simulations [PI] | • Paper II: Multiphase Analyses of (U)LIRG Nuclear Activity [PD]<br>• Paper III: Constraining Feedback Models with Spatially Resolved Observations [PI] |

## Proposal B

### 4 Management Plan, Timeline, and Deliverables

PI U will oversee the progress of the entire project as well as to supervise graduate student researcher Long's PhD thesis, undergraduate student researcher Hunt's senior thesis, and summer projects of other undergraduates (TBN). With deep expertise in Keck IFS data, luminous infrared galaxy mergers, feedback science, and leadership management and mentoring skills, she will primarily be responsible for the nuclear outflow analysis of the Keck OSIRIS data as follow-up to some of the published work from the KOALA survey (co-led by her and Medling). Hunt's senior thesis will involve adapting a MUSE-based python code GIST to apply to Keck KCWI data and generate 2D gas emission and kinematic maps. Future summer projects led by undergraduates will focus on generating model grids using STARBURST99 and MAPPINGS V codes to be used in our science

# Case 3: the verdict

## Proposal A • 2023 • Funded

- Year-by-year table of tasks and deliverables
- Every task tagged with an owner (PD, GSR, PI)
- Named deliverables: Paper I–IV and a data archive release

## Proposal B • 2020 • Not funded

- One dense paragraph of who does what
- Some personnel still “TBN” (to be named)
- Section is titled “Timeline and Deliverables” but gives no research timeline or list of deliverables

Takeaway

*Make the plan checkable in 10 seconds: who, what, by when.*

# Case 4 (if time): Broader impacts

*Which is more convincing? (vote in chat: A or B)*

## Proposal A

*"The Physics and Astronomy Community Excellence (PACE) initiative at UCI is an extensive mentoring organization led by graduate students for undergraduate and incoming graduate students. [...] Focusing on normalizing a holistic approach to success and strengthening our Physics and Astronomy community through trained mentors, the well-structured PACE program regularly holds a number of activities designed to support students in a variety of ways through their academic journeys."*

NSF AAG proposal, §3.1 (opening)

## Proposal B

*"While I had not participated in this workshop as a graduate student, I have come to appreciate Lick as both a research and educational facility when I joined the 2016 Lick AGN Monitoring Project (LAMP; PI: Barth) team as a joint UCR-UCI postdoctoral fellow. As the science lead of LAMP, I had the pleasure of managing what turned out to be a 100-night observing campaign [...]. In addition to quickly becoming an expert Lick observer myself as part of this campaign, I also managed the observing schedule for a team of ~60 observers including graduate and undergraduate students across many different institutions."*

NSF AAG proposal, §3.1

# Case 4 (if time): the verdict

## Proposal A • 2020 • Not funded

- Opens with the host department's mentoring program (PACE), not with the PI or the proposed activity
- Activities are generic; the text was ~90–96% reused in 2021 and 2022
- No participant numbers or reach

## Proposal B • 2023 • Funded

- Opens with the PI's own connection to Lick: she ran a 100-night campaign and a ~60-observer schedule there
- Names the need (workshop funding is dwindling), the scale (~20 students x 2 workshops a year, ~120 in 3 years), an evaluation plan, and who coordinates
- Rewritten from scratch: only ~35% text overlap with 2020

Takeaway

*Be specific and personal: why you, what exactly changes, for how many people.*

# What changed between 2020 and 2023?

| | |
|---|---|
| Questions → deliverables | Each question tied to data, a method, and an output |
| Claims → evidence | Own pilot results replaced a literature recap |
| Prose → structure | Boxes and tables the reviewer can skim |
| Generic → specific | Broader impacts rewritten around a real connection, real numbers, a real plan |

# Patterns in proposals that get funded

- A first paragraph that states the question and why it matters
- A clear logical chain from science goal to the data requested
- Feasibility is demonstrated, not asserted (S/N, sample size, preliminary data)
- Honest about risks, with a plan B
- Figures that carry the argument and are legible at a glance
- Carefully proofread and easy to skim

# Patterns in proposals that don’t

- Exciting science, but the technical case is vague or over-ambitious
- The question is buried: reviewers have to hunt for it
- A “more of the same” data request with no clear incremental payoff
- Sample or exposure time not justified
- Dense text, tiny figures, undefined jargon
- Ignoring page limits or call-specific rules

PART 5

# Mini-panel: you be the reviewer

# Your turn: a 10-minute mini-panel

- Read the two-page excerpt
- In chat or breakout: one person acts as primary, one as secondary
- Primary: 2-sentence summary + one strength + one weakness
- Secondary: add what the primary missed
- Then give a score: 1 (excellent) to 5 (poor)

# The proposal you're reviewing

*A NASA ADAP proposal (Astrophysics Data Analysis Program): funding to do new science with archival data. Authors are redacted.*

### 1 Scientific merit

Is the question important and clearly posed?

### 2 Relevance to ADAP

Does it make real use of archival data and benefit the community?

### 3 Feasibility

Will the plan and team deliver what is promised?

Score 1 (excellent) – 5 (poor). Primary: 2-sentence summary + one strength + one weakness. Secondary: add what the primary missed.

*Simplified criteria for this exercise.*

# Excerpt 1/3: Executive Summary

## Science Objectives and Impact

The primary science goal of this proposal is to provide a multiwavelength baseline for understanding the nature of obscured accreting supermassive black holes in high spatial resolution observations. This work will address how and when active galactic nuclei are triggered, and the role they play in regulating the structure and dynamics of gas in their immediate vicinity. Combining high-quality space-based data with adaptive optics-assisted ground-based archival observations from the Keck Telescopes, we will synthesize a set of the highest angular resolutions of observations afforded by current technology across the electromagnetic spectrum. The anticipated results will set a benchmark for the nuclear structure and dynamics surrounding central black holes in nearby merging galaxies — critical for understanding the growth and impact of active nuclei on the host galaxy at small physical scales.

## Relevance to NASA ADAP

Our proposed study takes advantage of the wealth of high resolution data in the various NASA-supported archives from a myriad of multiwavelength facilities, in particular those of Chandra, HST, and Keck, to leverage the utility and legacy of past X-ray observations of infrared galaxies. We propose to deliver calibrated images for the KOA, spatially-resolved SEDs, an automated archival query tool, and a visualization system that endeavor to maximize the scientific value of archival science. In line with the foremost mission of ADAP, the scientific and technical deliverables from this work will facilitate further studies utilizing the NASA archives, are aligned with NASA's mission to understand the origin of the universe, and will pave the way for interpreting imminent Early Release Science observations with the next NASA flagship James Webb Space Telescope.

# Excerpt 2/3: Approach and sample

We propose the novel use of an expansive set of the highest angular-resolution optical to submillimeter images currently afforded by state-of-the-art observing facilities in generating resolved, sub-kiloparsec clump-by-clump SEDs. Through combination with X-ray observations, we will address key questions on the growth of accreting SMBH and its interaction with the circumnuclear interstellar medium (ISM) as follows:

- Monitoring AGN Growth: When and how do AGN get triggered?
- Tracing AGN feedback: How do embedded SMBHs drive the structure and dynamics of gas in the circumnuclear regions?

The GOALS survey provides a complete sample of local (U)LIRGs that span various stages of the merging sequence, perfect for a detailed investigation of how SMBHs grow via mergers. For this study, we employ a selection based on availability of high-resolution data (< 0.5″/px) across the electromagnetic spectrum, taken with Chandra, HST, Keck, and ALMA. We note that while ALMA data analysis does not qualify for ADAP funding, it constitutes a secondary emphasis for the proposed work. The inclusion of this data set will significantly enhance the usefulness of the deliverables and scientific results for the wider extragalactic community while leveraging the utility and legacy of the NASA-supported data sets that are ADAP-compliant.

| **Telescope** | **Energy range** | **Detector plate scale** | **# of sources** |
|---|---|---|---|
| Chandra | 0.2–10 keV | 0.5″/px (ACIS) | 120 |
| HST | 435 nm, 814 nm | 0.05″/px (ACS) | 88 |
| Keck | 1–2.5 μm | 0.035–0.1″/spaxel (OSIRIS); 0.01–0.04″/px (NIRC2) | 52 |
| ALMA | 100–900 GHz | 0.03–0.5″/beam | 53 |
| **Subset of sources with all four data sets available:** | | | **22** |

*Table: Proposed multiwavelength data sets with resolving power*

# Excerpt 3/3: Plan and deliverables

## Timeline

**Year 1.** The archive query and the interactive visualization tools will be developed, writtened up, and shared. All the Keck data from the archive that were not taken as part of our KOALA campaign will be processed uniformly as were done in our previous publications. The multiwavelength data set will be assembled for resolution-matched SED maps after PSF deconvolution and aperture matching.

**Year 2.** Manuscript on resolved SEDs will be submitted. Analysis of Keck IFU and ALMA data cubes will involve generating line emission and kinematic maps, overlaid with optical and X-ray emission. Relevant gas properties will be computed while morphological and kinematic comparisons across the wavelengths will be quantitatively assessed. Any serendipitous discoveries on the most interesting object(s) regarding obscured AGN or multi-phase outflows will be reported immediately.

**Year 3.** High-z simulations of gas kinematics based on a representative set of local sources will be made available to the community. Analysis of the merger nuclei for the entire sample will be completed and submitted for publication.

## Deliverables: "Our results will provide the community with…"

- An archival query extension to the KOA and an interactive data visualization tool to broaden data-driven archival or survey science exploration;
- X-ray to submillimeter calibrated images and spatially-resolved (≤ 0.5″) SEDs of the inner kiloparsec regions of galaxy mergers that demonstrate the AGN-starburst interplay within bins of host properties;
- Bolometric luminosity and broadband spectral properties for clumps and double nuclei (with < 1 kpc separation) that might otherwise be unresolved by NuSTAR/Swift;
- Simulated high-z integral-field data cubes for 30-meter class telescopes that will help constrain the distance and projected separation at which robust signature of dual SMBHs can still be distinguished.

# Debrief

- What did the reviewers agree on?
- Where did scores diverge, and why?
- What single edit would most improve this proposal?
- How does it feel to read a proposal at speed?

WRAP-UP

# Practical tips and take-aways

*Checklist, take-aways, resources, and questions*

# Dos and don’ts

## Do

- Respect page limits and formatting rules
- Know the deadline (and time zone!)
- Read the call: rules, rubric, instrument availability
- Use professional language, proofread, make legible figures
- Ask a friend outside your subfield to read it

## Don’t

- Wait until the last day to write
- Assume the reader knows your jargon
- Hide the key question on page 3
- Overclaim feasibility
- Use AI tools in ways the call forbids, or submit text you can’t stand behind

# Take-aways

- A proposal is an argument for a busy, skeptical reader
- Make the question and the payoff obvious in the first paragraph
- Prove feasibility. Don’t just assert it
- Make the reviewer’s job easy
- Rejection is normal. Read the reviews, revise, and resubmit

# Feedback

- Short anonymous form: https://forms.gle/5G1zXwoVV3YT6J7k9
- What was most useful? What was not?
- Anything else that would make this better for next year's students?

# Thank you!

## Questions?

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