

Proposals for resources

I. Crafting a strong story.

1. Topic X is important and interesting.
2. But.
3. This is how we will address “But.”

For a one-page proposal,
this should be clear
within the first paragraph.

I. Crafting a strong story.

1. Topic X is important and interesting.
2. But.
3. This is how we will address “But.”

For a multi-page proposal,
this should be clear
within the first page.

Example:

1. Topic X is important and interesting.
2. But.

The use of Stellar Population Synthesis (SPS) models is ubiquitous in extragalactic astronomy. In these models, one adds together combinations of “simple stellar populations” (i.e., groups of stars with a single age and chemical composition) to produce the galaxy spectrum corresponding to an adopted star formation history. SPS models translate observed galaxy flux into meaningful physical properties like stellar mass, star formation rate, age, and metallicity (see recent review; Conroy 2013). In principle, deriving these critical astrophysical quantities from a given galaxy spectrum is a straight-forward minimization problem to identify the best-fit model. In practice, however, the degeneracies are significant, and one typically needs to adopt a host of simplifying assumptions about dust geometry, chemical enrichment, and the star formation history. As such, while SPS models provide profound physical intuition for understanding galaxy spectra when used in one direction (i.e., to predict how a given set of parameters will affect the emergent spectrum), whether or not they accurately represent the true galaxy properties is unclear, when used in the other direction (i.e., to infer physical parameters from observed spectra).

Paragraph #1

“Stellar Population Synthesis models are widely used & useful, but degenerate for interpreting galaxy spectra..”

Example:

1. Topic X is important and interesting.
2. But.

In spite of these challenges, previous work characterizing the broad properties of the galaxy population has been largely robust to uncertainties and systematics in spectral fitting, simply because properties of the galaxy population span many orders of magnitude in almost every parameter of interest. However, even factor of two uncertainties can significantly impact the shape and scatter of well-known galaxy scaling relations. Moreover, the current generation of IFU surveys (e.g., MaNGA (Bundy et al.); CALIFA (Sánchez et al.); SAURON (de Zeeuw et al.)) are pushing spectral fitting into new territory, where it must also analyze trends *within* individual galaxies, where internal variations are likely to be comparable to the degree of systematic error inherent in spectral fitting. This instills a sense of urgency; not only will current SPS codes fail to robustly characterize the properties of individual galaxies, but it will be nearly impossible to determine what the biases are *a priori* and how they will propagate through the models, which has profound consequences for the broader analysis of galaxy SEDs – both for spectra at $z = 0$ and for photometry at $z = 10$.

Paragraph #2

“Past work has been largely robust, but with IFU spectroscopy, uncertainties will dominate, to a degree we don’t understand.”

Example:

3. This is how we will address “But.”

With this proposal, we will use stellar population observations from Hubble Space Telescope imaging to develop and release a suite of “ground truth” star formation histories and coupled IFU spectra, to serve as a baseline for improving the accuracy, robustness, and assessment of uncertainties in widely used SPS models.

Paragraph #3

“If you approve this proposal, we’ll fix it.”

Example:

3. This is how we will address “But.”

With this proposal, we will use stellar population observations from Hubble Space Telescope imaging to develop and release a suite of “ground truth” star formation histories and coupled IFU spectra, to serve as a baseline for improving the accuracy, robustness, and assessment of uncertainties in widely used SPS models.

Reader has a clear statement of what the writer is planning on doing and why.

2. Defining your argument.

1. Topic X is important and interesting.
2. But.
3. This is how we will address “But.”

A proposal is best viewed as an *argument* that leaves the reader believing that #1 & #2 are true and that #3 is the best way forward.

2. Defining your argument.

Your proposal should make the case that the proposed research is:

- Important
- Feasible
- Efficient

<http://blogs.discovermagazine.com/cosmicvariance/2012/01/24/unsolicited-advice-xiii-how-to-craft-a-well-argued-proposal/>

- Important
- Feasible
- Efficient

This is set by
the story



- Important
- Feasible
- Efficient



Is there a convincing, direct path to the promised scientific result?

- Important
- Feasible
- Efficient

The proposed work must be *the best way* to address the questions raised by the story

Defining your argument.

- Important
- Feasible
- Efficient

The reviewer must believe that
every single one of these is true.

Defining your argument.

- Important

- Feasible
- Efficient

The reviewer must believe that
every single one of these is true.

- Important
- Feasible
- Efficient

How do you
judge this?

Is there an actual question to be answered?

Will other lines of study change if the
question is answered?

Will the answer change what other people
decide to work on?

**Do not shy away from making
these explicit for your audience of
“smart non-experts”**

Is there an actual question to be answered?

**Will other lines of study change if the
question is answered?**

**Will the answer change what other people
decide to work on?**

Ways to show “importance”

“Hot Topic”

Sometimes, you get lucky and
it's obvious

For example, it's a good year to work
on gravitational wave sources

Ways to show “importance”

“Hot Topic”

But, can also demonstrate by showing that there is a lot of literature back-and-forth going on

(i.e., a hot topic in your subfield may not be obvious to a non-expert, but can be demonstrated)

Ways to show “importance”

“Novelty”

Never been:

- Observed
- Detected
- Measured

Ways to show “importance”

“Clear, preferably binary, results”

Straight-forward “path to science”

- Yes or no?
- This model or that one?
- Exists or doesn’t exist?

Ways to show “importance”

“Clear, preferably binary, results”

Even better if multiple possible outcomes are useful

(i.e., interesting upper limits or non-detections).

Ways to show “importance”

“Qualitatively new regime”

Is this a different kind of
experiment than could ever have
been done before?

Ways to show “importance”

“Qualitatively new regime”

- Order of magnitude increase in sample size or detection limit
- Systematic study vs “mish-mash” in the literature
- New, unique approach that opens up parameter space (speed, new selection criteria, novel analysis tools that fix stuff)

Ways to show “importance”

“A Really Cool Story”

Sometimes an idea or puzzle is just *really really* cool, and people will want to know the answer, as long as it’s not too expensive.

2. Defining your argument.

- Important
- Feasible
- Efficient

The reviewer must believe that
every single one of these is true.

Ways to show “feasibility”

It's hard to beat a test case

- Sample data from the archive
- Simulations
- Example from the literature
- Example from pilot study
- Benchmarks

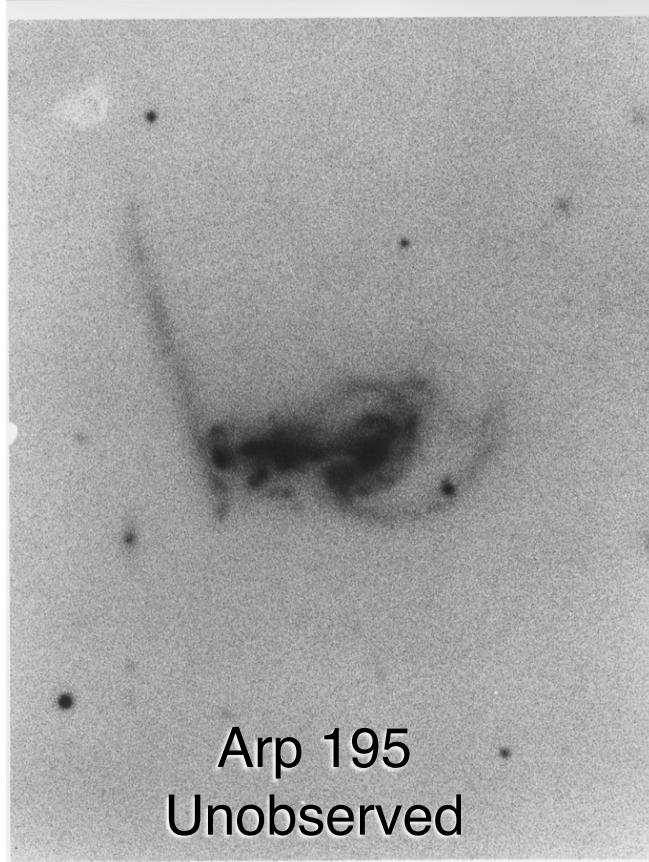
Ways to show “feasibility”

It's hard to beat a test case

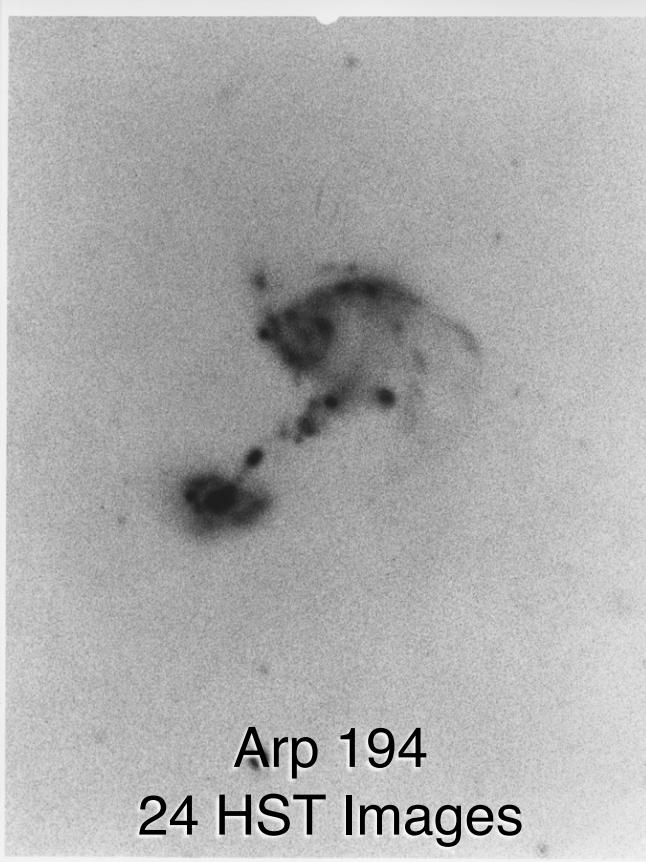
Figures showing what the data would look like are super effective.

Makes the hypothetical concrete.

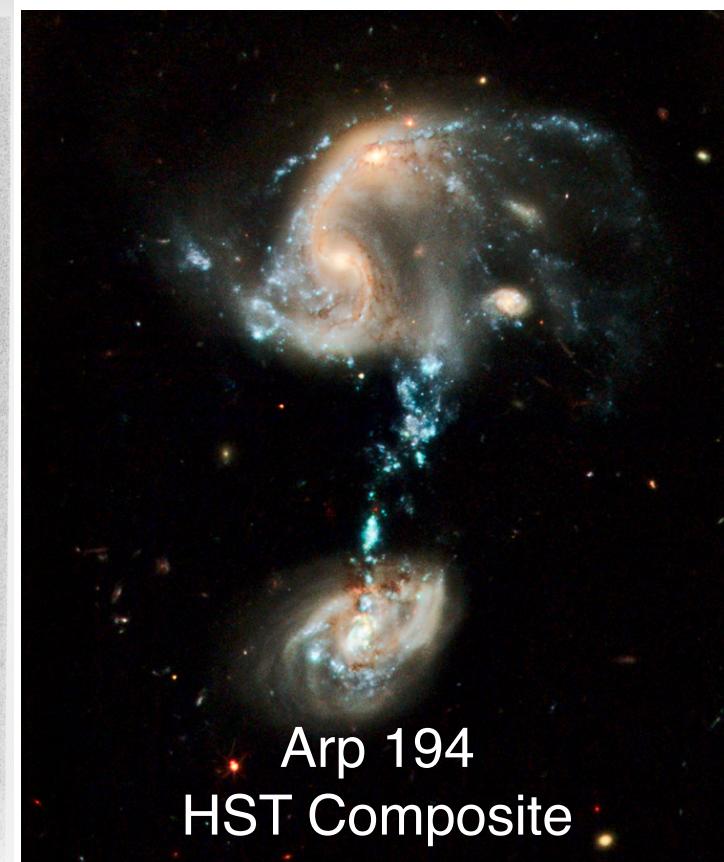
Ways to show “feasibility”



Arp 195
Unobserved



Arp 194
24 HST Images



Arp 194
HST Composite

This is what
we'll target

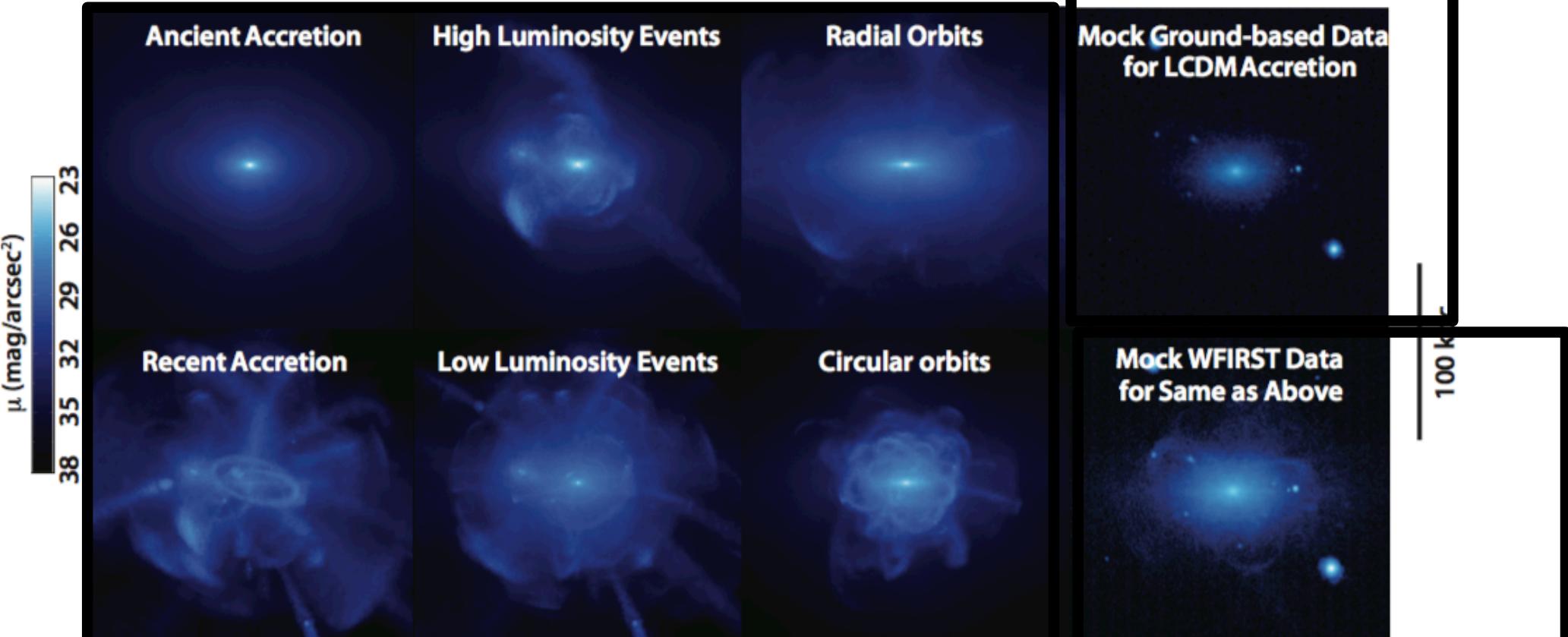
This has already
been observed

Wow! That's
going to look
great!

Ways to show “feasibility”

Ben Williams’ proposal to study nearby galaxies w/ WFIRST

The ground
can’t do it

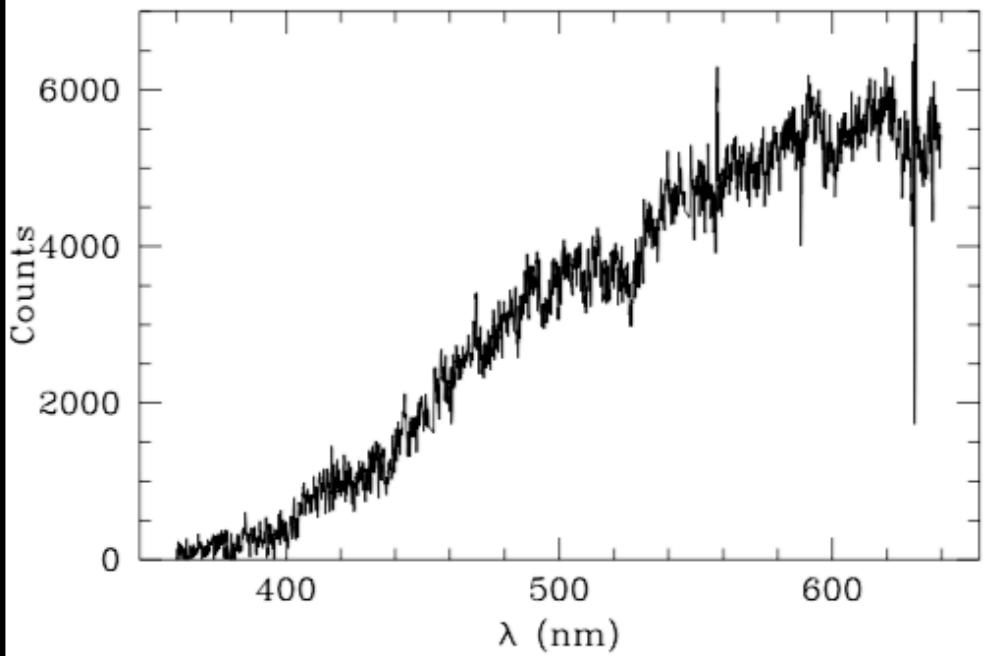


Simulations indicate there
should be variety that
reflects different physics

Wow! That’s
going to look
great!

Ways to show “feasibility”

Simulated spectrum



How well you can measure things with the expected SNR

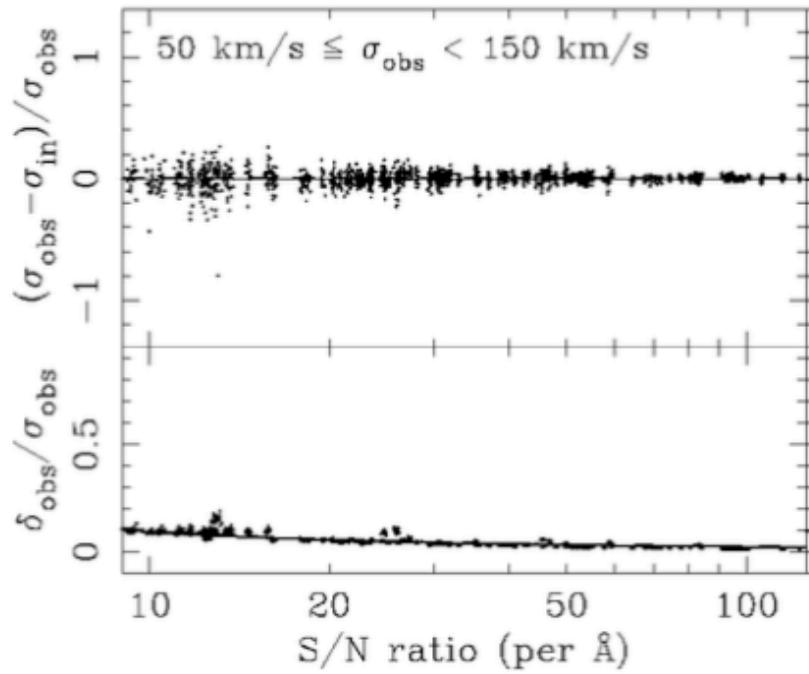


FIGURE 2: Simulated spectrum of a $10''$ region of the thick disk, for a 1-night Gemini observation (left) and the resulting accuracy of velocity dispersion measurements as a function of $\text{SNR}/\text{\AA}$ (right). The SNR of this observation ($\gtrsim 15/\text{\AA}$) would be sufficient to measure the rotational velocity and velocity dispersion to better than 5% within ~ 10 radial bins across the galaxy. Sky subtraction and flat-fielding uncertainties have been included, and the underlying spectrum was assumed to be comparable to an elliptical galaxy at $v_r = 5000 \text{ km/s}$. The right panel is taken from Kelson et al. (2002) and uses simulations to demonstrate the accuracy with which σ can be measured for a given $\text{SNR}/\text{\AA}$.

My NSF CAREER proposal from when I was a baby faculty member...

2. Defining your argument.

- Important
- Feasible
- Efficient

The reviewer must believe that
every single one of these is true.

Ways to show “efficiency”

Are obvious alternatives viable?

- Why can't you use a different facility? (i.e., why Keck when you have APO?)
- Why this approach when other methods are commonly used?

Ways to show “efficiency”

- Why can't you use a different facility? (i.e., why Keck when you have APO?)

“These observations would take 2 weeks on a 4m class telescope”

“Only this instrument has the needed combination of blue-sensitivity and FOV”
- Why this approach when other methods are commonly used?

“Unlike FIRE, this code includes on-the-fly radiative transfer needed to properly calculate thermodynamics”

“Although transits are the most efficient way to detect large numbers of planets, they are biased against X”

Ways to show “efficiency”

Panels *always* ask “Could you ask for less?”

- Why not a smaller sample?
- Why not less exposure time?
- Why not less \$\$\$ (tied to effort — i.e., why 2 years of support rather than 1)

Ways to show “efficiency”

- Why not a smaller sample?

“Assuming Poisson statistics, we need X stars to measure the rate to 20%, which is needed to distinguish models A and B.”

- Why not less exposure time?

“All viable models predict that the QSO will have a luminosity of at least X. To reach a SNR=10 detection limit (needed to measure Y), we require at least Y hours per source”

- Why not fewer \$\$\$?

Give a detailed work plan that maps out the effort, so that it’s clear that a project will take the full duration of funds

Refining your argument.

- Important
- Feasible
- Efficient

You and your collaborators need to do a *brutal* assessment of every weakness, and make plans for how you will shore them up.

A strategy I use:

- Selling points
- Potential weaknesses
- Possible figures

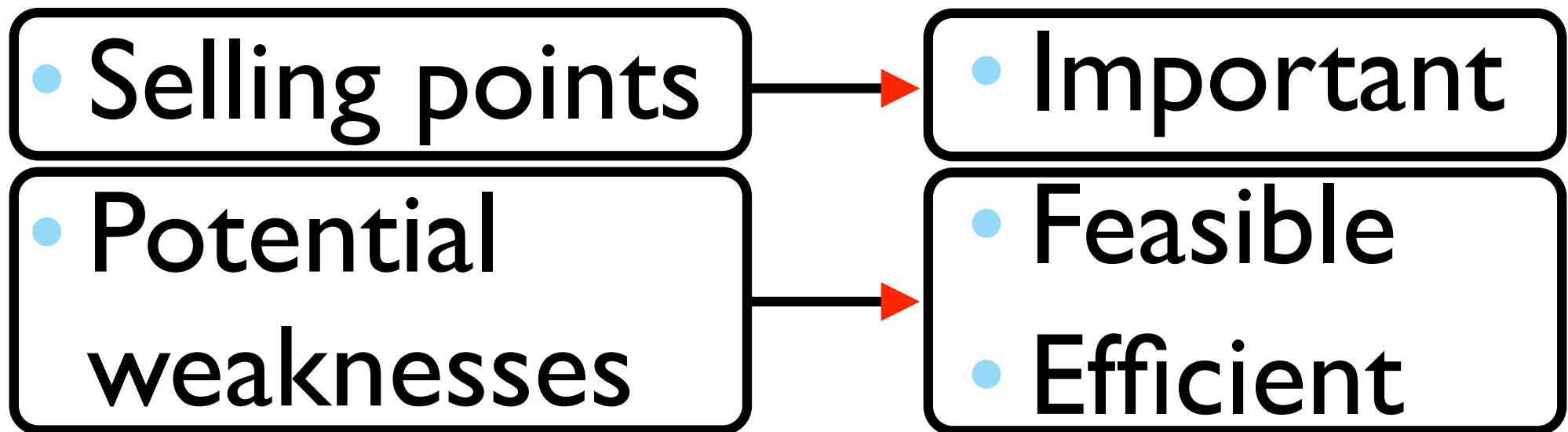
I start an ascii file where I brainstorm every possible selling point, every possible criticism, and possible figures.

- Selling points
- Potential weaknesses
- Possible figures

These sections are close to
“word stacks”

Unprioritized bullet points that may or
may not make it into the final proposal

These categories map directly to the argument



Example of “Selling Points”

- AGB stars best probe of intermediate age SF (in absence of MS turnoff)
- AGB stars can dominate NIR light (critical for interpreting buildup of stellar mass over cosmic time),
- But, models of AGB not well calibrated outside of the MW, LMC, and SMC. Lack of data covering a range of metallicities and SFHs.
- AGB stars brightest NIR sources, so short exposures sufficient to detect them, making them ideal SNAP targets.
- Existing deeper archival optical data allows construction of CMDs with only 1 NIR filter, and comparison between SFHs derived from deeper data and that derived from AGB stars.
- Short exposures also get upper RGB stars, whose colors can be metallicity indicators for older populations (does full optical-IR range help separate AGB from RGB below the TRGB, and thus improve metallicities?).
- Calibration of TRGB for NIR work, which is where JWST will be working.
- Need NIR data to even know that AGB stars are there (can't get full census in the optical).
- If you go outside the local group, you can get the galaxies' entire AGB census in a single 40 pointing.

Example of “Potential Weaknesses”

- What about AO from the ground?
- Why this many targets? How many do you actually need?
- What about dust (i.e., is one NIR filter ok?)
- Are the models really in need of improvement?
- How can we claim to do galaxy science while simultaneously arguing the models aren’t up to it?
- Are the results confused depending on the fraction of O-rich vs C-rich AGB?

Example of “Potential Weaknesses”

- What about AO from the ground?
- Why this many targets? How many do you actually need?
- What about dust (i.e., is one NIR filter ok?)
- Are the models really in need of improvement?
- How can we claim to do galaxy science while simultaneously arguing the models aren’t up to it?
- Are the results confused depending on the fraction of O-rich vs C-rich AGB?

You need to ask these questions
before the reviewer does!

I then brainstorm how to mitigate the weaknesses

- What about AO from the ground?
 - Not many galaxies w/ bright guide stars
 - Exposure time longer because background (true?)
 - Need accurate mags over large areas to get large AGB samples
- Why this many targets? How many do you actually need?
 - Existing NIR CMDs very, very few, and this is direction JWST/WFIRST is going in, so need to characterize now
 - Estimate #'s of AGB stars as function of age from SFH?
- Etc...

This is an excellent form for getting input, early

- Selling points
- Potential weaknesses
- Possible figures

Circulate your ascii file to collaborators and mentors.

They can prioritize the first and help shore up the second.

Use this to pick your story

- Selling points
- Potential weaknesses
- Possible figures

You should pick a final, single story that naturally fits as many of the selling points as possible.

“Calibrating models of AGB stars”

- AGB stars best probe of intermediate age SF (in absence of MS turnoff)
- AGB stars can dominate NIR light (critical for interpreting buildup of stellar mass over cosmic time),
- But, models of AGB not well calibrated outside of the MW, LMC, and SMC. Lack of data covering a range of metallicities and SFHs.
- AGB stars brightest NIR sources, so short exposures sufficient to detect them, making them ideal SNAP targets.
- Existing deeper archival optical data allows construction of CMDs with only 1 NIR filter, and ~~comparison between SFHs derived from deeper data and that derived from AGB stars.~~
- ~~Short exposures also get upper RGB stars, whose colors can be metallicity indicators for older populations (does full optical-IR range help separate AGB from RGB below the TRGB, and thus improve metallicities?).~~
- ~~Calibration of TRGB for NIR work, which is where JWST will be working.~~
- Need NIR data to even know that AGB stars are there (can't get full census in the optical).
- If you go outside the local group, you can get the galaxies' entire AGB census in a single ⁴⁶pointing.

You should
minimize and/or leave out
selling points that distract from
your story.

Why?

The reader (reviewer) may believe
that *anything you mention* is part of
your main story.

They will then mark you down for
not fully justifying something you
considered to be a minor aside.

Finally

- Selling points
- Potential weaknesses
- Possible figures

If your selling points aren't convincing, and/or the weaknesses are too many, consider scrapping the proposal.

Other tips

Features of compelling proposals

- “First”
- “Largest”
- “Only”
- “Most precise”
- “Complete”
- “Uniform”
- “New”

Making it easy on the reviewer

- Bullet points & lists
- Meaningful subsection titles
- Flow charts
- Explicit “path to science”
- Don’t rely on “in prep”- use figure instead
- Do not try to get around page limits
- Don’t overuse “crucial”, “urgent”, “critical”
- Use bold/italics judiciously (not too much)

Caution!

It is extremely difficult to teach
reviewers something that
contradicts standard wisdom

*Proposals that require completely
reorienting a reviewers world view are
challenging.*

Caution!

It is extremely difficult to teach
reviewers something that
contradicts standard wisdom

*Work with their existing schema!
Acknowledge it before you try to break
it.*

“It has become standard lore that X, but recently there has been growing evidence for Y”

Proposals for
supporting you

Fellowship proposals
are trying to support
future leaders

“Leader”

Someone who will
influence, shape, and
change the future of a field

“Leader”

This is *not* the same as
being the most
technically proficient,
or even the most
productive

So, your proposal should make you look like:

“Someone who will influence, shape, and change the future of a field”

Qualities to demonstrate leaderliness

- Clear vision of big picture
- Broad outlook, but depth of knowledge in core area
- Ability to craft a strategic plan that can impact a field
- Ambition and/or bravery
- Innovation

These are all skills you can cultivate!

- *Clear vision of big picture*
- *Broad outlook, but depth of knowledge in core area*
- *Ability to craft a strategic plan that can impact a field*
- *Ambition and/or bravery*
- *Innovation*

The act of finding stories and developing sound arguments goes 85% of the way there!

Writing is where much of this happens

- *Clear vision of big picture*
- *Broad outlook, but depth of knowledge in core area*
- *Ability to craft a strategic plan that can impact a field*
- *Ambition and/or bravery*
- *Innovation*

By writing well, you will *naturally* develop leaderliness.

So what does this
mean for concrete
actions?

Ingredients of a strong fellowship proposal

- Clear vision of big picture
- Broad outlook, but depth of knowledge in core area
- Demonstrating a strategic plan that can impact a field
- Ambition and/or bravery
- Innovation

Other ingredients of a strong fellowship proposal

- Well matched to timescale of fellowship (ambition ≠ foolish).
- But, with awareness of a longer time horizon.
- Good match between goals and resources.

Things to avoid

- Redoing your thesis
- Failing to look distinct from your Famous Advisor
- Creating a research program that would leave you in the same intellectual place in 3 years
- Lack of enthusiasm