Structure of Papers

Overview

- Abstract
- Introduction
- Methods
- Results
- Discussion
- Conclusion
- Appendix
- Figures
- Tables

Abstract

Abstracts should be interesting, concise, and forceful.

Favors simple, direct, highly-edited sentences

Abstract

You cannot assume people will know why your result is interesting*.

Convey the big picture, but without writing an introduction.

*You want the casual reader to decide "This is something worth knowing…"

Abstract

99% of your readers will *only* read the abstract.

Tell the essentials of the entire story.

Example Abstract: Hogg & Lang 2012

Exponential, de Vaucouleurs, and Sersic profiles are simple and successful models for fitting two-dimensional images of galaxies. One numerical issue encountered in this kind of fitting is the pixel rendering and convolution (or correlation) of the models with the telescope point-spread function (PSF); these operations are slow, and easy to get slightly wrong at small radii. Here we exploit the realization that these models can be approximated to arbitrary accuracy with a mixture (linear superposition) of two-dimensional Gaussians (MoGs). MoGs are fast to render and fast to affine-transform. Most importantly, if you have a MoG model for the pixel-convolved PSF, the PSF-convolved, affine-transformed galaxy models are themselves MoGs and therefore very fast to compute, integrate, and render precisely. We present worked examples that can be directly used in image fitting. The MoG profiles we provide can be swapped in to replace the standard models in any image-fitting code; they sped up model fitting in our projects by an order of magnitude; they ought to make any code faster at essentially no cost in precision.

(1) States problem/issue

<u>Exponential, de Vaucouleurs, and Sersic profiles are simple and successful models for fitting two-dimensional images of galaxies. One numerical issue encountered in this kind of fitting is the pixel rendering and convolution (or correlation) of the models with the telescope point-spread function (PSF); these operations are slow, and easy to get slightly wrong at small radii.</u> Here we exploit the realization that these models can be approximated to arbitrary accuracy with a mixture (linear superposition) of two-dimensional Gaussians (MoGs). MoGs are fast to render and fast to affine-transform. Most importantly, if you have a MoG model for the pixel-convolved PSF, the PSF-convolved, affine-transformed galaxy models are themselves MoGs and therefore very fast to compute, integrate, and render precisely. We present worked examples that can be directly used in image fitting. The MoG profiles we provide can be swapped in to replace the standard models in any image-fitting code; they sped up model fitting in our projects by an order of magnitude; they ought to make any code faster at essentially no cost in precision.

(2) States Solution

Exponential, de Vaucouleurs, and Sersic profiles are simple and successful models for fitting two-dimensional images of galaxies. One numerical issue encountered in this kind of fitting is the pixel rendering and convolution (or correlation) of the models with the telescope point-spread function (PSF); these operations are slow, and easy to get slightly wrong at small radii. <u>Here we exploit the realization that these models can be approximated to arbitrary accuracy with a mixture (linear superposition) of two-dimensional Gaussians (MoGs). MoGs are fast to render and fast to affine-transform. Most importantly, if you have a MoG model for the pixel-convolved PSF, the PSF-convolved, affine-transformed galaxy models are themselves MoGs and therefore very fast to compute, integrate, and render precisely.</u> We present worked examples that can be directly used in image fitting. The MoG profiles we provide can be swapped in to replace the standard models in any image-fitting code; they sped up model fitting in our projects by an order of magnitude; they ought to make any code faster at essentially no cost in precision.

(3) Explains value of result

Exponential, de Vaucouleurs, and Sersic profiles are simple and successful models for fitting two-dimensional images of galaxies. One numerical issue encountered in this kind of fitting is the pixel rendering and convolution (or correlation) of the models with the telescope point-spread function (PSF); these operations are slow, and easy to get slightly wrong at small radii. Here we exploit the realization that these models can be approximated to arbitrary accuracy with a mixture (linear superposition) of two-dimensional Gaussians (MoGs). MoGs are fast to render and fast to affine-transform. Most importantly, if you have a MoG model for the pixel-convolved PSF, the PSF-convolved, affine-transformed galaxy models are themselves MoGs and therefore very fast to compute, integrate, and render precisely. <u>We present worked examples that can be directly used in image fitting. The MoG profiles we provide can be swapped in to replace the standard models in any image-fitting code; they sped up model fitting in our projects by an order of magnitude; they ought to make any code faster at essentially no cost in precision.</u>

Let's return to earlier abstract (1) States problem/issue

AFTER THE FALL: THE DUST AND GAS IN E+A POST-STARBURST GALAXIES

A. Smercina[1,2], J.D.T. Smith[2,3], D.A. Dale[4], K.D. French[5,6,#], K.V. Croxall[7], S. Zhukovska[8], A. Togi[9], E.F. Bell[1], A.F. Crocker[10], B.T. Draine[11], T.H. Jarrett[12], C. Tremonti[13], Yujin Yang[14], A.I. Zabludoff[6]

ABSTRACT

The traditional picture of post-starburst galaxies as dust- and gas-poor merger remnants, rapidly transitioning to quiescence, has been recently challenged. Unexpected detections of a significant ISM in many post-starbursts raise important questions. Are they truly quiescent and, if so, what mechanisms inhibit further star formation? What processes dominate their ISM energetics? We present an infrared spectroscopic and photometric survey of 33 SDSS-selected E+A post-starbursts, aimed at resolving these questions. We find compact, warm dust reservoirs with high PAH abundances, and total gas and dust masses significantly higher than expected from stellar recycling alone. Both PAH/TIR and dust-to-burst stellar mass ratios are seen to decrease with post-burst age, indicative of the accumulating effects of dust destruction and an incipient transition to hot, early-type ISM properties. Their infrared spectral properties are unique, with dominant PAH emission, very weak nebular lines, unusually strong H_2 rotational emission, and deep [C II] deficits. There is substantial scatter among SFR indicators, and both PAH and TIR luminosities provide overestimates. Even as potential upper limits, all tracers show that the SFR has typically experienced a more than two order-of-magnitude decline since the starburst, and that the SFR is considerably lower than expected given both their stellar masses and molecular gas densities. These results paint a coherent picture of systems in which star formation was, indeed, rapidly truncated, but in which the ISM was *not* completely expelled, and is instead supported against collapse by latent or continued injection of turbulent or mechanical heating. The resulting aging burst populations provide a "high-soft" radiation field which seemingly dominates the E+As' unusual ISM energetics.

http://xxx.lanl.gov/pdf/1802.04798

(2) States approach

ABSTRACT

The traditional picture of post-starburst galaxies as dust- and gas-poor merger remnants, rapidly transitioning to quiescence, has been recently challenged. Unexpected detections of a significant ISM in many post-starbursts raise important questions. Are they truly quiescent and, if so, what mechanisms inhibit further star formation? What processes dominate their ISM energetics? We present an infrared spectroscopic and photometric survey of 33 SDSS-selected E+A post-starbursts, aimed at resolving these questions. We find compact, warm dust reservoirs with high PAH abundances, and total gas and dust masses significantly higher than expected from stellar recycling alone. Both PAH/TIR and dust-to-burst stellar mass ratios are seen to decrease with post-burst age, indicative of the accumulating effects of dust destruction and an incipient transition to hot, early-type ISM properties. Their infrared spectral properties are unique, with dominant PAH emission, very weak nebular lines, unusually strong H_2 rotational emission, and deep [C II] deficits. There is substantial scatter among SFR indicators, and both PAH and TIR luminosities provide overestimates. Even as potential upper limits, all tracers show that the SFR has typically experienced a more than two order-of-magnitude decline since the starburst, and that the SFR is considerably lower than expected given both their stellar masses and molecular gas densities. These results paint a coherent picture of systems in which star formation was, indeed, rapidly truncated, but in which the ISM was *not* completely expelled, and is instead supported against collapse by latent or continued injection of turbulent or mechanical heating. The resulting aging burst populations provide a "high-soft" radiation field which seemingly dominates the E+As' unusual ISM energetics.

(3) States findings

ABSTRACT

The traditional picture of post-starburst galaxies as dust- and gas-poor merger remnants, rapidly transitioning to quiescence, has been recently challenged. Unexpected detections of a significant ISM in many post-starbursts raise important questions. Are they truly quiescent and, if so, what mechanisms inhibit further star formation? What processes dominate their ISM energetics? We present an infrared spectroscopic and photometric survey of 33 SDSS-selected E+A post-starbursts, aimed at resolving these questions. We find compact, warm dust reservoirs with high PAH abundances, and total gas and dust masses significantly higher than expected from stellar recycling alone. Both PAH/TIR and dust-to-burst stellar mass ratios are seen to decrease with post-burst age, indicative of the accumulating effects of dust destruction and an incipient transition to hot, early-type ISM properties. Their infrared spectral properties are unique, with dominant PAH emission, very weak nebular lines, unusually strong H_2 rotational emission, and deep [C II] deficits. There is substantial scatter among SFR indicators, and both PAH and TIR luminosities provide overestimates. Even as potential upper limits, all tracers show that the SFR has typically experienced a more than two order-of-magnitude decline since the starburst, and that the SFR is considerably lower than expected given both their stellar masses and molecular gas densities. These results paint a coherent picture of systems in which star formation was, indeed, rapidly truncated, but in which the ISM was *not* completely expelled, and is instead supported against collapse by latent or continued injection of turbulent or mechanical heating. The resulting aging burst populations provide a "high-soft" radiation field which seemingly dominates the E+As' unusual ISM energetics.

(4) Contextualizes results

ABSTRACT

The traditional picture of post-starburst galaxies as dust- and gas-poor merger remnants, rapidly transitioning to quiescence, has been recently challenged. Unexpected detections of a significant ISM in many post-starbursts raise important questions. Are they truly quiescent and, if so, what mechanisms inhibit further star formation? What processes dominate their ISM energetics? We present an infrared spectroscopic and photometric survey of 33 SDSS-selected E+A post-starbursts, aimed at resolving these questions. We find compact, warm dust reservoirs with high PAH abundances, and total gas and dust masses significantly higher than expected from stellar recycling alone. Both PAH/TIR and dust-to-burst stellar mass ratios are seen to decrease with post-burst age, indicative of the accumulating effects of dust destruction and an incipient transition to hot, early-type ISM properties. Their infrared spectral properties are unique, with dominant PAH emission, very weak nebular lines, unusually strong H_2 rotational emission, and deep [C II] deficits. There is substantial scatter among SFR indicators, and both PAH and TIR luminosities provide overestimates. Even as potential upper limits, all tracers show that the SFR has typically experienced a more than two order-of-magnitude decline since the starburst, and that the SFR is considerably lower than expected given both their stellar masses and molecular gas densities. These results paint a coherent picture of systems in which star formation was, indeed, rapidly truncated, but in which the ISM was *not* completely expelled, and is instead supported against collapse by latent or continued injection of turbulent or mechanical heating. The resulting aging burst populations provide a "high-soft" radiation field which seemingly dominates the E+As' unusual ISM energetics.

What about the other abstract?

ABSTRACT

By analysing a sample of galaxies selected from the HI Parkes All Sky Survey (HIPASS) to contain more than 2.5 times their expected HI content based on their optical properties, we investigate what drives these HI eXtreme (HIX) galaxies to be so HI-rich. We model the H I kinematics with the *T*ilted *R*ing *F*itting *C*ode TiRiFiC and compare the observed HIX galaxies to a control sample of galaxies from HIPASS as well as simulated galaxies built with the semi-analytic model DARK SAGE. We find that (1) H I discs in HIX galaxies are more likely to be warped and more likely to host H I arms and tails than in the control galaxies, (2) the average H I and average stellar column density of HIX galaxies is comparable to the control sample, (3) HIX galaxies have higher H I and baryonic specific angular momenta than control galaxies, (4) most HIX galaxies live in higher-spin haloes than most control galaxies. These results suggest that HIX galaxies are H I-rich because they can support more H I against gravitational instability due to their high specific angular momentum. The majority of the HIX galaxies inherits their high specific angular momentum from their halo. The H I content of HIX galaxies might be further increased by gas-rich minor mergers.

Does not tie to a science question. The "investigation" is very self-referential ("why is my sample like this"?)

What about the other abstract?

ABSTRACT

By analysing a sample of galaxies selected from the HI Parkes All Sky Survey (HIPASS) to contain more than 2.5 times their expected HI content based on their optical properties, we investigate what drives these HI eXtreme (HIX) galaxies to be so HI-rich. We model the H I kinematics with the *T*ilted *R*ing *F*itting *C*ode TiRiFiC and compare the observed HIX galaxies to a control sample of galaxies from HIPASS as well as simulated galaxies built with the semi-analytic model DARK SAGE. We find that (1) H I discs in HIX galaxies are more likely to be warped and more likely to host H I arms and tails than in the control galaxies, (2) the average H I and average stellar column density of HIX galaxies is comparable to the control sample, (3) HIX galaxies have higher H I and baryonic specific angular momenta than control galaxies, (4) most HIX galaxies live in higher-spin haloes than most control galaxies. These results suggest that HIX galaxies are H I-rich because they can support more H I against gravitational instability due to their high specific angular momentum. The majority of the HIX galaxies inherits their high specific angular momentum from their halo. The H I content of HIX galaxies might be further increased by gas-rich minor mergers.

This a reasonable conclusion, but doesn't tie into a larger question/issue.

What about the other abstract?

ABSTRACT

By analysing a sample of galaxies selected from the HI Parkes All Sky Survey (HIPASS) to contain more than 2.5 times their expected HI content based on their optical properties, we investigate what drives these HI eXtreme (HIX) galaxies to be so HI-rich. We model the H I kinematics with the *T*ilted *R*ing *F*itting *C*ode TiRiFiC and compare the observed HIX galaxies to a control sample of galaxies from HIPASS as well as simulated galaxies built with the semi-analytic model DARK SAGE. We find that (1) H I discs in HIX galaxies are more likely to be warped and more likely to host H I arms and tails than in the control galaxies, (2) the average H I and average stellar column density of HIX galaxies is comparable to the control sample, (3) HIX galaxies have higher H I and baryonic specific angular momenta than control galaxies, (4) most HIX galaxies live in higher-spin haloes than most control galaxies. These results suggest that HIX galaxies are H I-rich because they can support more H I against gravitational instability due to their high specific angular momentum. The majority of the HIX galaxies inherits their high specific angular momentum from their halo. The H I content of HIX galaxies might be further increased by gas-rich minor mergers.

Its impact is also lost because it's followed by a couple more (somewhat random) sentences that blunt it being in a stress position.

How to construct a *Nature* summary paragraph

Annotated example taken from *Nature* 435, 114–118 (5 May 2005).

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words "**here we show**" or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (This example is 190 words without the final section, and 250 words with it).

During cell division, mitotic spindles are assembled by microtubule-based motor proteins[1,2]. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family[3]. Hypotheses for bipolar spindle formation include the 'push–pull mitotic muscle' model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules[2,4,5]. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at ~20 nm s^{-1} towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at ~40 nm s^{-1}, comparable to spindle pole separation rates *in vivo*[6]. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.

Abstract

In short, it is worth investing in substantial, careful editing of your abstract to maximize its impact

If the abstract is the *only* thing that someone reads about your work, will they appreciate it?

A few more points about abstracts:

Warning:
If a result isn't in the abstract, it's lost forever.

Thanks a LOT, ADS.

A few more points about abstracts:

It is frequently helpful to have a collaborator draft the abstract, so it's in a different voice

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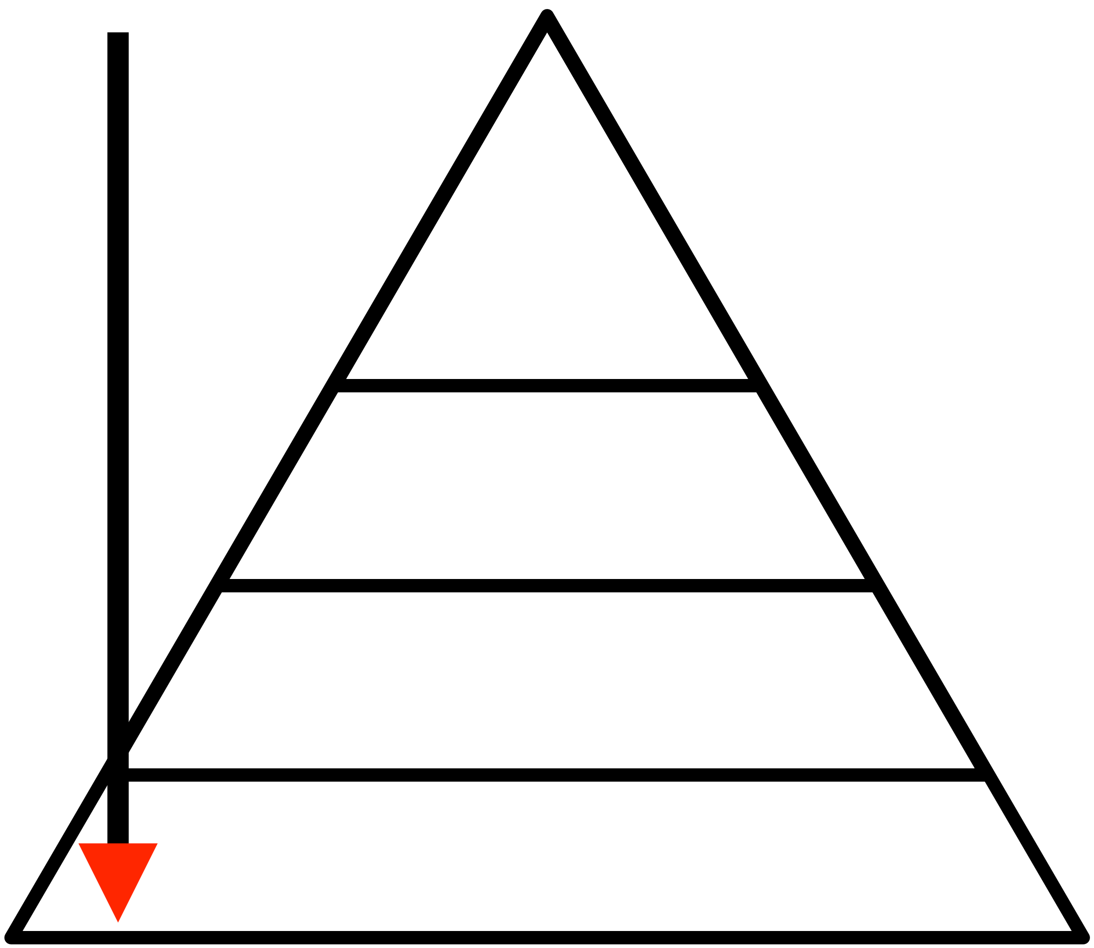
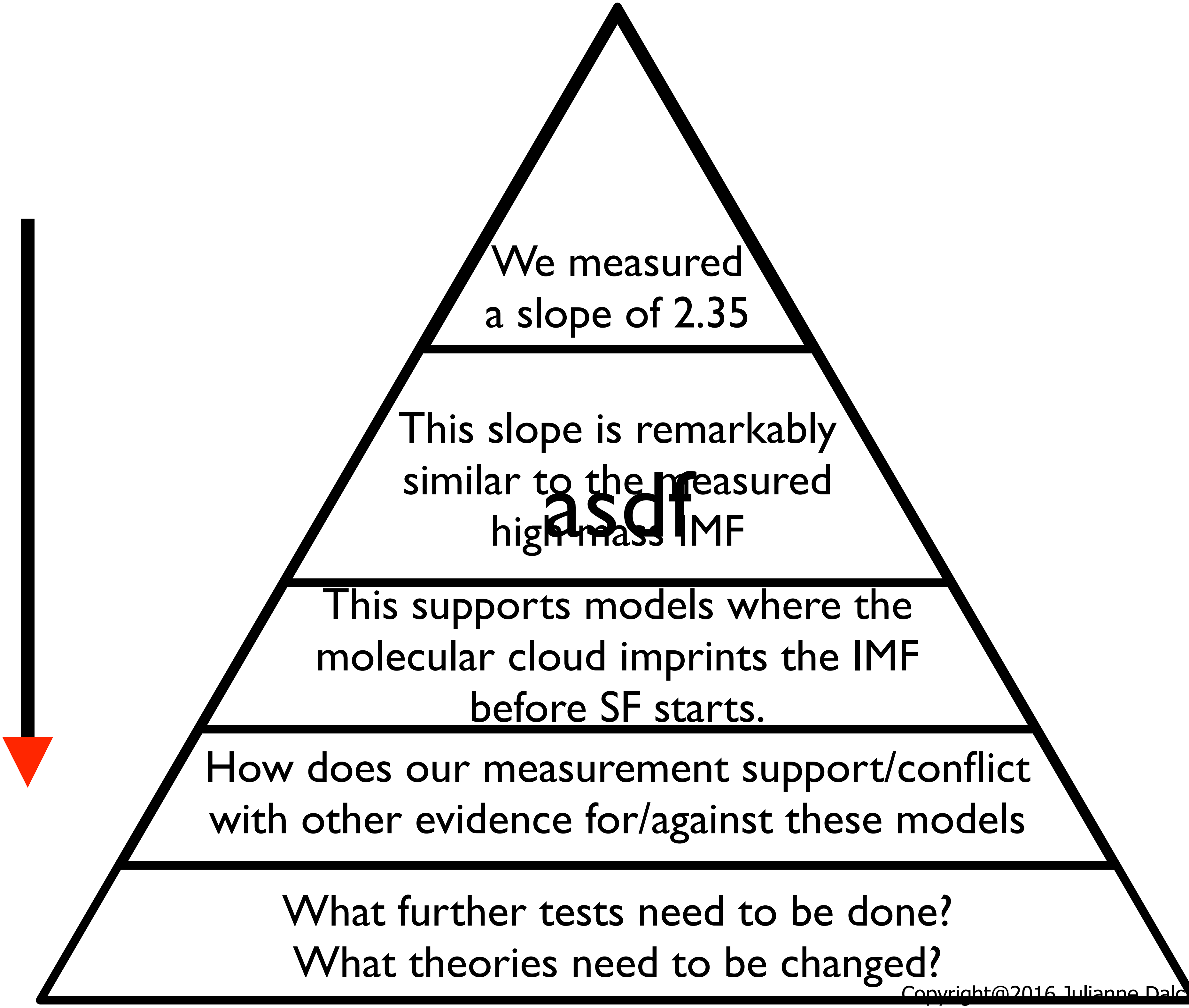
Discussions have almost the opposite structure as introductions



Move from your specific result, to the larger implications


We measured
a slope of 2.35
This slope is remarkably
similar to the measured
high mass IMF
asdf
This supports models where the
molecular cloud imprints the IMF
before SF starts.
How does our measurement support/conflict
with other evidence for/against these models
What further tests need to be done?
What theories need to be changed?

Discussion

This is your chance to *explicitly* tell your story

Do not assume that your reader knows what to make of your result.

Discussion

Number one problem:
Rushing

Discussion

Make sure you take the time to explain the full implications of your result.

Discussion

Make sure you take the time to ~~explain~~ the full implications of your ^*understand* result.

Discussion

Number two problem:
Reluctance to "hold forth"

"It's obvious."
"It's boring."
"Everyone knows this."
"No one would care."

Discussion

If this is an issue, change your mental frame from "*holding forth*" to "*patiently teaching*"

Discussion

This is also the section where the reader can get the clearest view of how you think.

Discussion

Being clear, thorough, and balanced builds respect for you as a scientist

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Methods/Analysis

Three main goals.

Methods/Analysis

Goal One:
Give enough information that someone could reproduce your result*

*within reason.

Methods/Analysis

The level of detail should be higher where there are ambiguous choices

Which solar abundance pattern?
Which UV background model?
Which photometry version?

Methods/Analysis

The level of detail should be higher where the choices could easily affect the result

Example: *Which of the many SFR indicators did you adopt (each of which has different associated biases & timescales) and why?*

Methods/Analysis

Your work involved many choices.

Make sure you help the reader understand why you made specific choices.

Methods/Analysis

"We adopted the X prescription because it is insensitive to dust"

"The Y algorithm proved to be more robust to outliers than Z, based on our tests with mock data"

Methods/Analysis

Goal Two:
Contextualize information to build your reader's intuition

*within reason.

Methods/Analysis

Contextualize numbers whenever possible.

People remember quantities better by "feel" rather than by value*.

Don't make your reader do the work.

*e.g. "Milky Way mass" vs "10^{10} M_{sun}"

Methods/Analysis

"We adopted a cluster mass of 10^6 M_{sun}, comparable to that of Omega Cen"

"Model A's mass was 50% smaller than that of Model B (5×10^9 M_{sun} vs 10^{10} M_{sun})"

Methods/Analysis

Goal Three:

Build credibility

Methods/Analysis

You are signaling that you:

- Pay attention to details
- Think through implications
- Are careful
- Evaluate your own work critically & with skepticism

Methods/Analysis

- Pay attention to details
- Think through implications
- Are careful
- Evaluate your own work critically & with skepticism

Signaling these traits is equivalent to actually *doing* them. Which is *science*.

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Aside #1

The amount that you write should be proportional to:

- it's importance to your story.
- it's importance to the reader's understanding.
- ~~the amount of time you spent doing it or understanding it.~~

Aside #2

Do not hesitate to remind your reader of why you're doing something*.

This is particularly important in "drier" method sections

*although do not belabor it. Too much repetition can be irritating.

Aside #3

Do not abandon the principles of paragraph structure

- Topic sentence.
- Supporting detail.
- Closing sentence should help signal next topic sentence.

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Conclusions

In the era where most
papers are skimmed,
a bulleted list of results is
a good idea.

If this is the only thing that is read,
will you be satisfied with what the
reader learned?

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Appendices

These are good places to put useful information that would otherwise interrupt your story

Appendices

But, if you're putting in an Appendix, evaluate if that information needs to be present at all.

Tradeoff between "completeness & posterity" vs "lard"

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Figures

Many papers are only "read" via the figure captions.

(Think "CApheine")

Figures

Every caption should include the *explicit conclusion* you want the reader to draw.

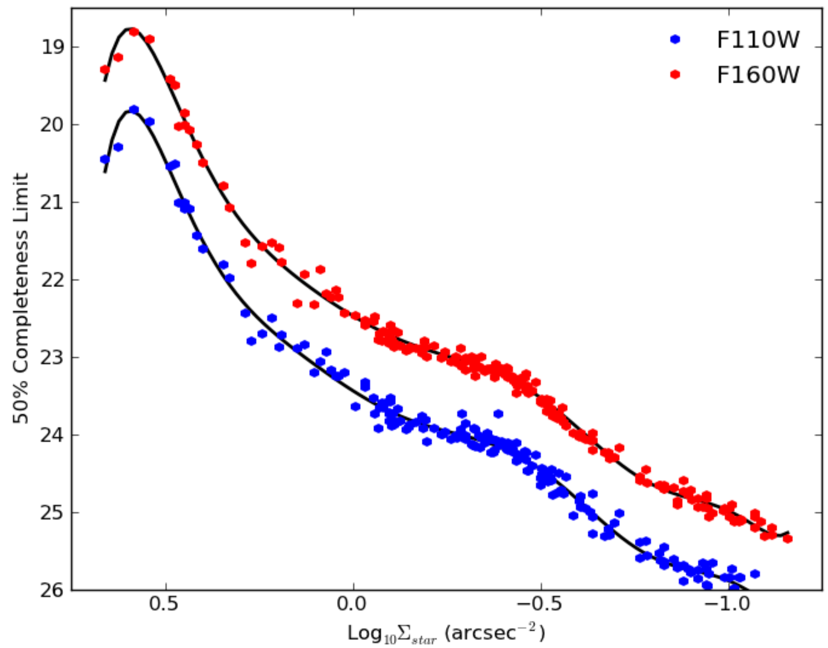


FIG. 4.— The depth of the photometry as a function of radius. The blue and red points show the 50% completeness limit m_{50} as a function of $\log_{10}$ of the local stellar surface density in bright RGB stars, for the F110W and F160W filters, respectively. The solid lines show 10th order polynomial fits to the data, used to interpolate to an appropriate limiting magnitude at each position in the galaxy. The PHAT photometry is crowding-limited, and thus the limiting magnitude is a strong function of the local stellar surface density. The apparent roll-off in the inner disk (at high surface densities in the left side of the plot) is an artifact of the extraordinarily high crowding levels in the inner bulge, which lead to biases in the photometry; while we include these regions for completeness here, we do not actually analyze their A_V distributions.

First part describes the “logistics”

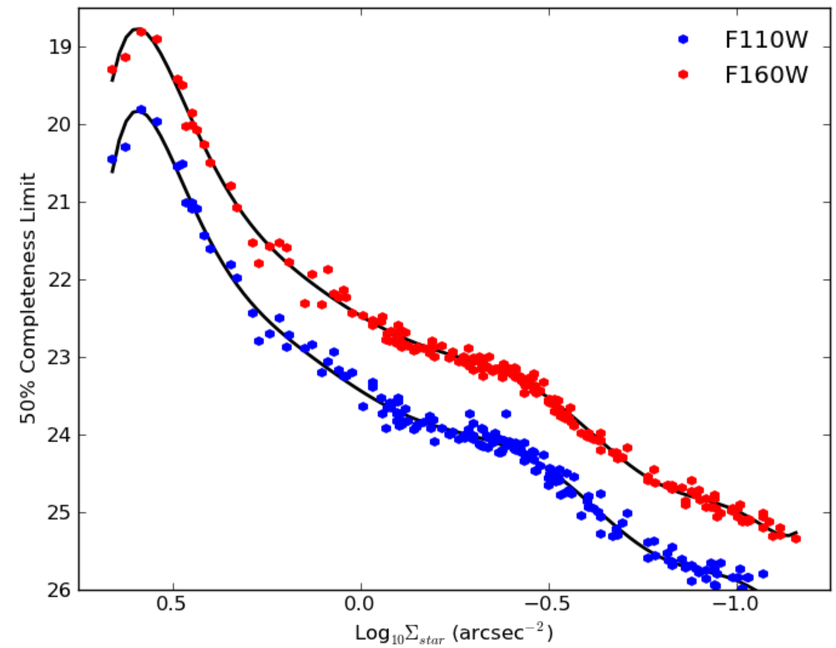


FIG. 4.— The depth of the photometry as a function of radius. The blue and red points show the 50% completeness limit m_{50} as a function of $\log_{10}$ of the local stellar surface density in bright RGB stars, for the F110W and F160W filters, respectively. The solid lines show 10th order polynomial fits to the data, used to interpolate to an appropriate limiting magnitude at each position in the galaxy. The PHAT photometry is crowding-limited, and thus the limiting magnitude is a strong function of the local stellar surface density. The apparent roll-off in the inner disk (at high surface densities in the left side of the plot) is an artifact of the extraordinarily high crowding levels in the inner bulge, which lead to biases in the photometry; while we include these regions for completeness here, we do not actually analyze their A_V distributions.

The second part gives *what the reader should learn*

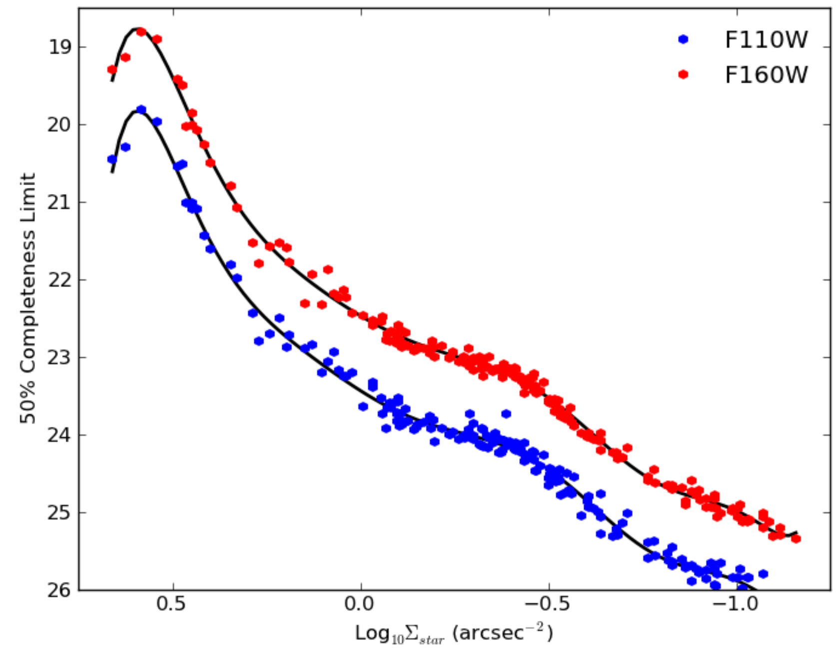


FIG. 4.— The depth of the photometry as a function of radius. The blue and red points show the 50% completeness limit m_{50} as a function of $\log_{10}$ of the local stellar surface density in bright RGB stars, for the F110W and F160W filters, respectively. The solid lines show 10th order polynomial fits to the data, used to interpolate to an appropriate limiting magnitude at each position in the galaxy. The PHAT photometry is crowding-limited, and thus the limiting magnitude is a strong function of the local stellar surface density. The apparent roll-off in the inner disk (at high surface densities in the left side of the plot) is an artifact of the extraordinarily high crowding levels in the inner bulge, which lead to biases in the photometry; while we include these regions for completeness here, we do not actually analyze their A_V distributions.

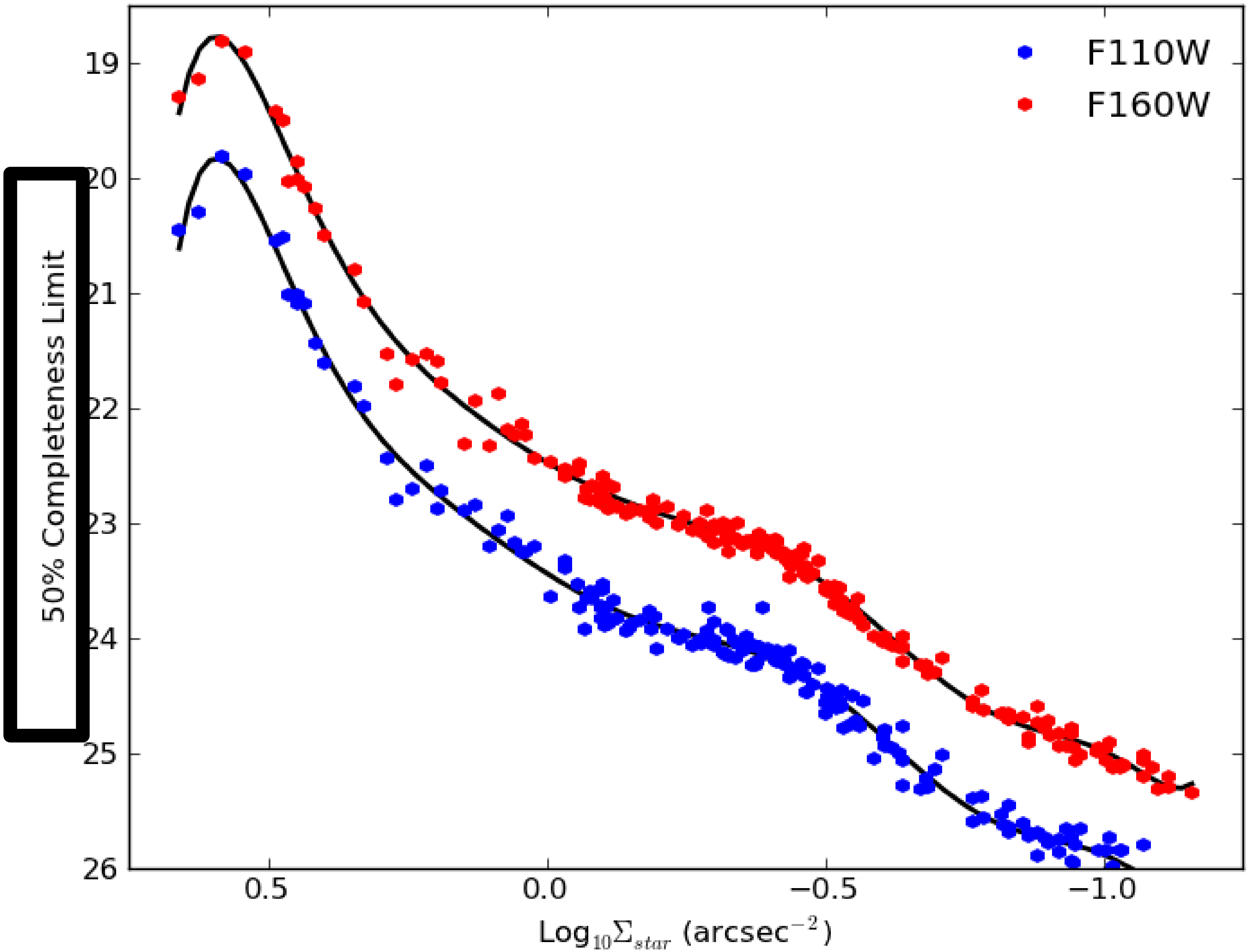
Figures

Use words in addition to symbols, in captions & axis labels

"α *versus* M_C"

is not as useful as

"*The IMF slope* α *versus the cluster mass* M_C"



This is more informative than m_{50}

Figures

Legends are good*.

The more of the figure that can be understood *without reading the caption*, the better.

*Though, clutter is bad. So, it's a tradeoff.

Figures

Ask:

"*Would this figure work well in a talk, without modification?*"

Some papers are more highly cited than others *solely* because they had the better figure for talks.

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Tables

Use table notes to define column headers, even if the definitions are elsewhere in the text

Random

1. Variables should be in math mode

2. Software routines in {\tt }

3. Describe routine by more than its name* — needs to stand test of time.

*e.g. "The PACKAGENAME implementation of an MCMC sampler""

Proposals
vs
Papers

Some similarities:
Both are all about
“the story”

Some similarities:
Both require awareness & management of "reader expectations"

But, differences in tone, goal, structure are substantial.

In a paper, the reader is already sold.

They read the abstract, and chose to keep going.

For proposals, the reader is reading a stack of 50-100.

They have to read them, whether they want to or not.

They are probably sick of reading proposals by the time they get to yours.

Or, if your proposal was first, they will likely have forgotten much of it by the end.

An Aside:

There's often weeks of delay between when they read your proposal, and when they discuss it with the committee.

An Aside:

So even if the reviewer understood your proposal the first time, they may have forgotten key information by the time it's discussed.

In a paper, the reader probably already knows something about your field.

For a proposal, you cannot count on the reader having any particular expertise. Or interest.

Nor can you count on them *not* knowing every single seminal paper in the field*.

*This is much less likely. Better to assume you're talking to a smart, non-expert.

In a paper, the reader would like to be convinced of your result.

In a proposal, the reader is looking for reasons *not* to be swayed.

For typical proposals, only 5-30% will be approved.

Proposal readers are looking for reasons to shunt you into the 70-95%.

Well that's depressing.

However, with some forethought and writing skill, you can probably make it into the top quarter.

Two major kinds of proposals:

- Proposals for resources
  - Telescope time
  - $$ for specific projects or activities
- Proposals for supporting you
  - Fellowship applications

Proposals for resources

At least 2/3 of proposal ideas qualify as "Good to do"

This isn’t enough.

Telescope time and $$$ are always more limited than the supply of good ideas from smart people

You need to move

from

"*Good to do*"

to

"*Must be done*"

This requires a *really* strong story.

Backed by a *really* strong argument.

Explained with impeccable clarity.

1. Crafting a strong story.

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

Same principles as in an introduction.

http://blogs.discovermagazine.com/cosmicvariance/2009/11/02/unsolicited-advice-x-how-to-frame-a-winning-proposal/

1. 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*.

1. 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*.

1. Crafting a strong story.

1. Topic X is important and interesting.

2. But.

3. This is how we will address "But."

It is helpful if #3 is in **bold** or *italics*. Reviewer cannot possibly be confused, and can easily go back to remind themselves what your goal was.

1. Crafting a strong story.

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

Your goal with #3:
Put words in the reviewer's mouth that they can parrot back to the committee.

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 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.

1. Crafting a strong story.

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

Run this story by peers and colleagues early.

If they’re anything less than enthusiastic, you must revise.

1. Crafting a strong story.

Note: "*The Story*" is distinct from "*The Presentation of the Story*".

If the story isn't compelling, *it doesn't matter how well it's presented!*