

# How to Present Scientific Results

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# Planning for Your Presentation

- What is the primary message/result you want to convey?
- Who is your audience?
- What is your allotted speaking time?
- What is your stage (e.g., informal seminar)?
- General advice and considerations

# What is Your Primary Message?

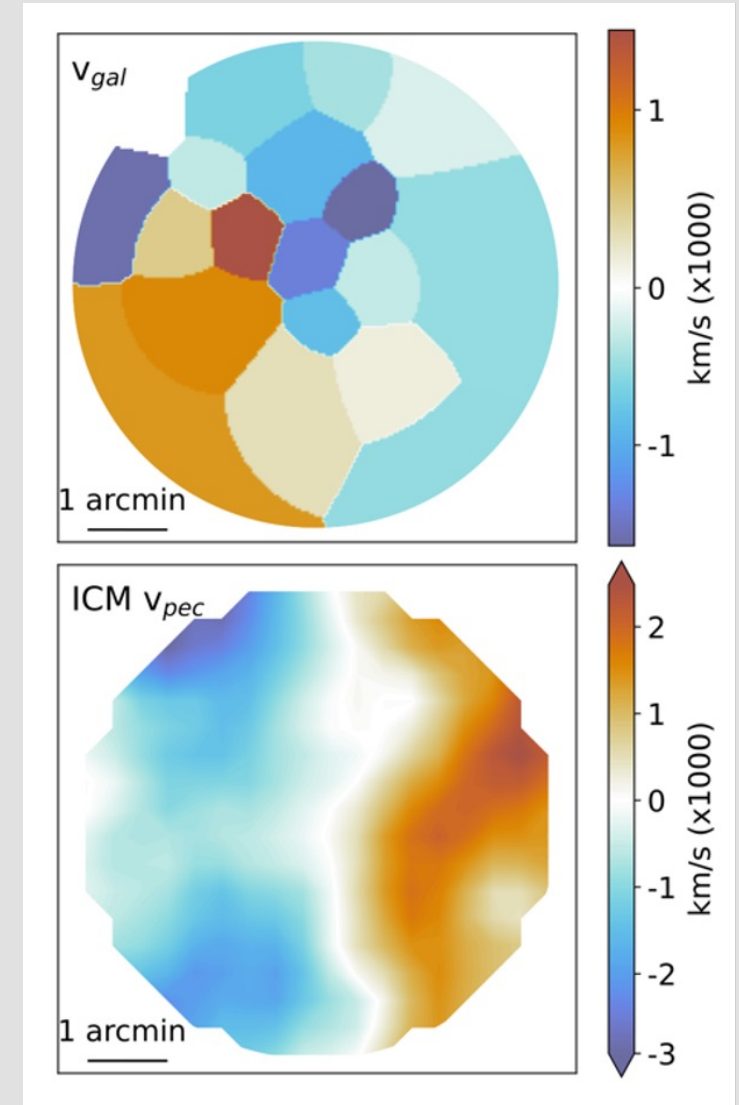
- This should *always* be your starting point!
- Everything you present should relate to a set of 1-3 critical points that you want the audience to understand by the end of your talk
- You should repeat these points throughout your talk
  - Do not assume that the audience is engaged with your talk 100% of the time!
  - They may be distracted by an email, fatigued from a long session, etc.
  - At the very least, this message should be conveyed near the start and near the end of your talk
- It can be effective to use your final slide solely to list the “take home points” you have identified for a particular talk

# Who is Your Audience?

- This should *always* be your starting point!
- A talk for a general audience will be *much* different from a talk to a group of experts
  - Do you need to introduce background material for the audience to have sufficient context on the topic you are presenting?
  - Will the audience be interested in technical details, or will this sort of discussion cause you to “lose” the room?
  - Is there a wide range of audience members? Such as a colloquium?
- In a conference setting, who will be presenting prior to your talk?
  - If the previous presenter is already going to provide background material on your topic, there is no need to repeat that information

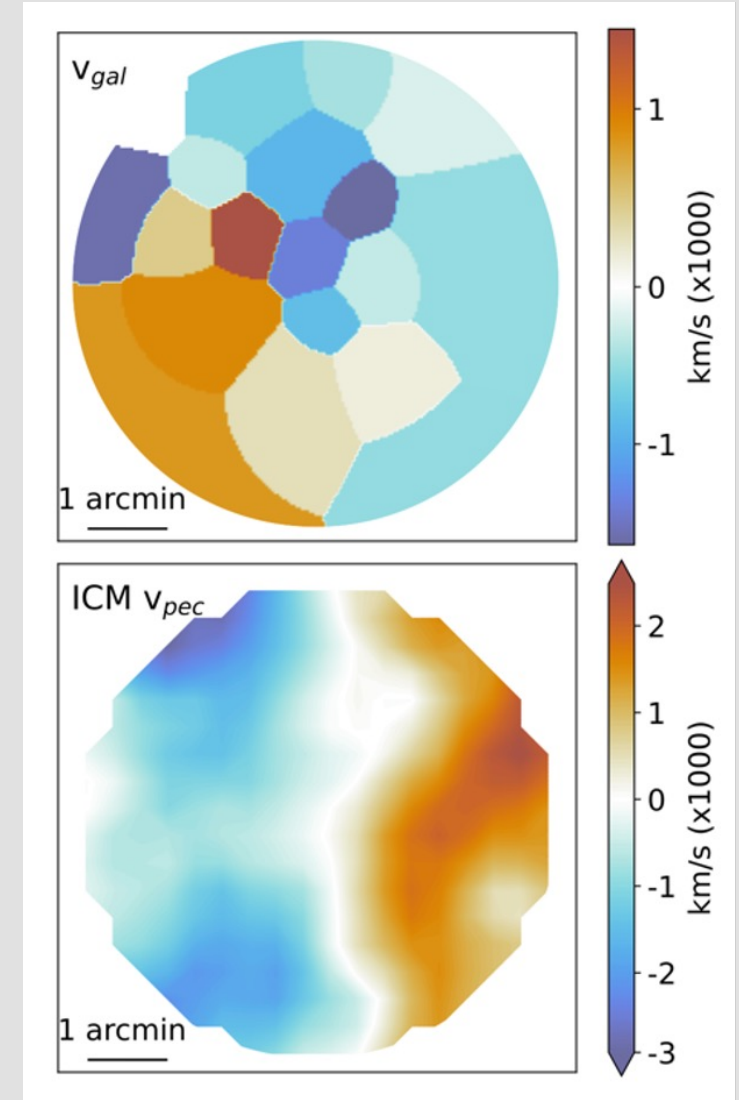
# Example – Message and Audience

- Consider Emily Silich’s discovery of a velocity-space decoupling of gas and dark matter in the merging cluster MACS J0018.5
- The critical message points are:
  - We have made the *first direct measurement* of gas and dark matter velocity decoupling
    - The figure helps emphasize this message
  - From simulations, we understand *how* this decoupling occurs
- The material supporting these points will differ significantly based on audience



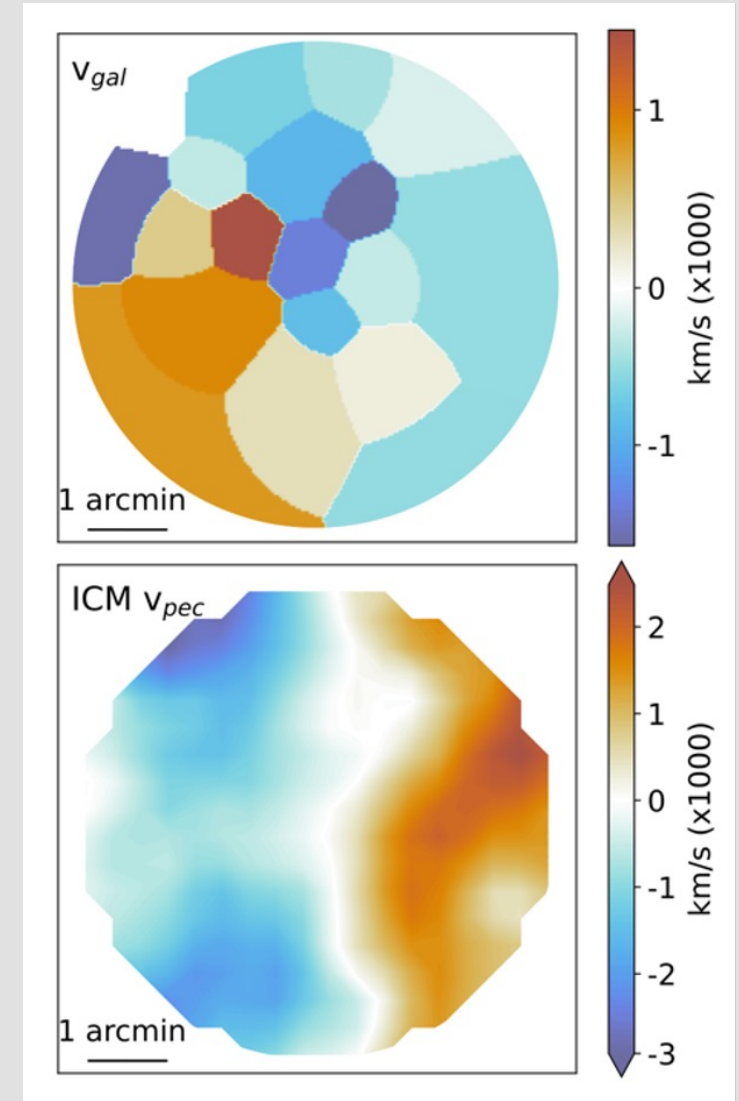
# Example – Message and Audience

- Case 1: A presentation at the intra-cluster medium theory conference
  - This audience is composed of experts who study cluster mergers
  - They want *details*
    - What analysis techniques were employed?
    - What tests for systematics have been performed?
    - How were the simulations initialized and evolved?
  - They don't need context or background
    - What is a cluster merger?
    - Why are mergers important?
    - What types of physics can we study with mergers?



# Example – Message and Audience

- Case 2: A presentation at the Keck Science Symposium
  - This audience includes everyone who uses Keck
    - Few if any of these folks study clusters, let alone mergers
  - They *need* context and background
    - What is a cluster merger?
    - Why are mergers important?
    - What types of physics can we study with mergers?
  - They aren't going to care about the details
    - What analysis techniques were employed?
    - What tests for systematics have been performed?
    - How were the simulations initialized and evolved?



# What is Your Allotted Speaking Time?

- Your allotted time dictates the depth to which you can present a given topic
  - Or the number of different topics you can present
- It is important to adjust your talk to fit within this time!
  - By far, the most common error is to have too much material
    - This usually results in the need to rush through a number of slides at the end
    - The slides that are rushed through often contain the most important messages
  - It is also possible to finish long before your allotted time expires
    - This can be ok, assuming you adequately conveyed your message
    - However, it often appears as if you were not prepared and/or you don't have an adequate amount of interesting material to present
- Rehearse your talk to ensure it fits as close to the allotted time as possible!



# What is Your Stage?

- What level of interaction with the audience is expected?
  - Will you be lecturing, and only taking questions at the conclusion?
    - In this scenario, it is important to make sure your presentation is sufficiently organized and descriptive for everyone to follow along
  - Will there be significant audience participation?
    - In this scenario, it can be good to have pauses associated with open-ended questions
- Will you be standing on stage behind a podium?
  - Or will you be seated at a table with your audience?
- Will you be using your computer, or one provided by a conference organizer?
- Will you have access to a laser pointer? Microphone?
- All of these possibilities should be considered when preparing your talk

# General Advice – Practice!

- It may sound obvious, but practice is essential
  - Practice is helpful to the long-term development of your skills
  - It is also very helpful for improving the current talk you are giving
- What are some ways to practice?
  - I generally start by rehearsing alone
    - For the first couple run-throughs I aim to refine my wording and delivery for each slide
    - I then aim for a couple run-throughs focused more on calibrating the timing - is the overall time too long or too short? Are there particular slides that require more or less time?
  - If possible, I then try to rehearse in front of an audience
    - This can be friends, family, other students, etc.
  - It's often not possible, but rehearsing on the actual stage you will be using for the talk is the ideal way to prepare
    - At the very least, try to connect your computer to ensure compatibility, use the pointer, see the layout of the stage

# General Advice – Public Speaking

- Some people are naturally comfortable speaking in public, but most are not (myself included)
- It's ok to have stress and anxiety before and during a talk!
- The key is understanding how *you* typically feel, and then developing strategies to adapt to your particular situation
  - For example, one way that my body often reacts to the stress of giving a talk is to create “something caught in my throat”
  - I therefore know that I need to have some water available both before and during the talk, so that I can drink something to settle this reaction
  - Practice and repetition are essential
    - This is the only way to identify how you are going to react!
    - More practice also leads to feeling more comfortable, which reduces symptoms

# General Advice – Less is More!

- To determine the brightness of the thermal SZ effect we need to solve the Kompaneets equation (Kompaneets 1956)
- Following the approach of Zeldovich and Sunyaev (1969) we find that the distortion of the cosmic microwave background is

$$\Delta I_\nu \approx I_0 y \frac{x^4 e^x}{(e^x - 1)^2} \left( x \frac{e^x + 1}{e^x - 1} - 4 \right) \equiv I_0 y g(x)$$

- Where  $x$  is the dimensionless frequency and  $I_0$  is the CMB Intensity

$$x = h\nu/k_B T_{\text{CMB}} \approx \nu/56.8 \text{ GHz},$$

$$I_0 = \frac{2(k_B T_{\text{CMB}})^3}{(hc)^2} = 270.33 \left[ \frac{T_{\text{CMB}}}{2.7255 \text{ K}} \right]^3 \text{ MJy/sr},$$

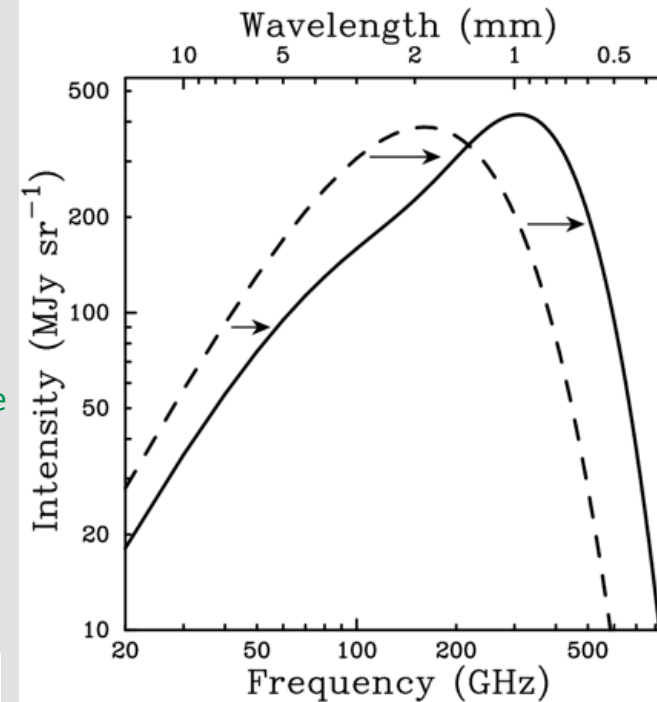
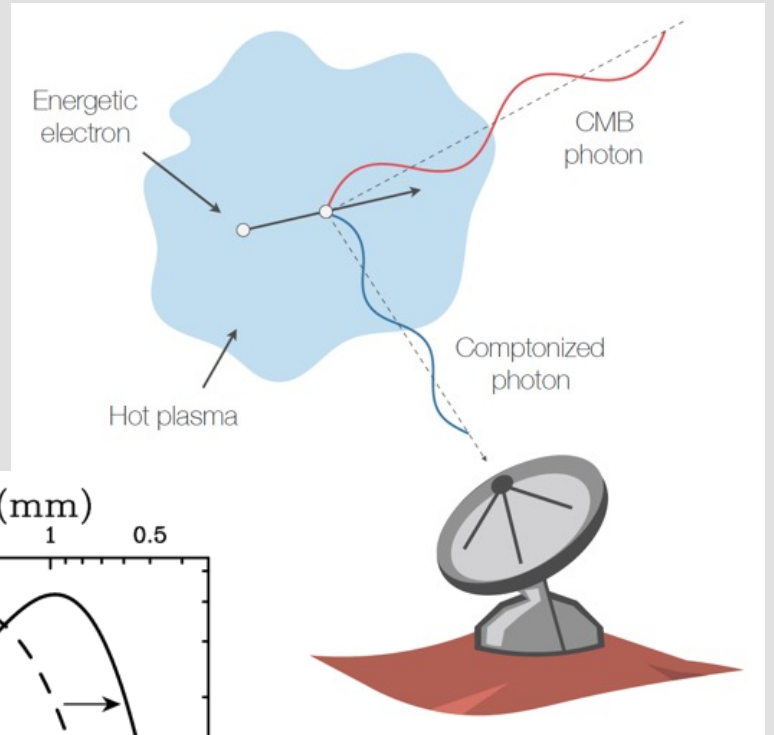
- Taking the derivative, we then get an expression in terms of temperature

$$\frac{\Delta T_{\text{CMB}}}{T_{\text{CMB}}} \approx y \left( x \frac{e^x + 1}{e^x - 1} - 4 \right) = y f(x).$$

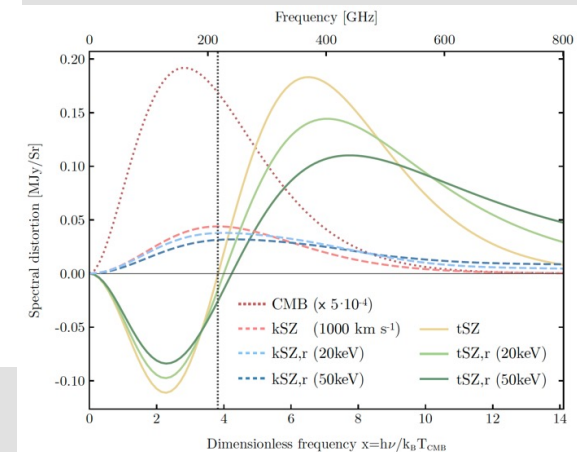
- And the Compton parameter  $y$  depends on the gas thermodynamics

$$y \equiv \int \frac{k_B T_e}{m_e c^2} d\tau_e = \int \frac{k_B T_e}{m_e c^2} n_e \sigma_T dl = \frac{\sigma_T}{m_e c^2} \int P_e dl.$$

Right: Schematic of the SZ effect from Mroczkowski et al. 2019  
Below: The CMB distortion from Carlstrom et al. 2002

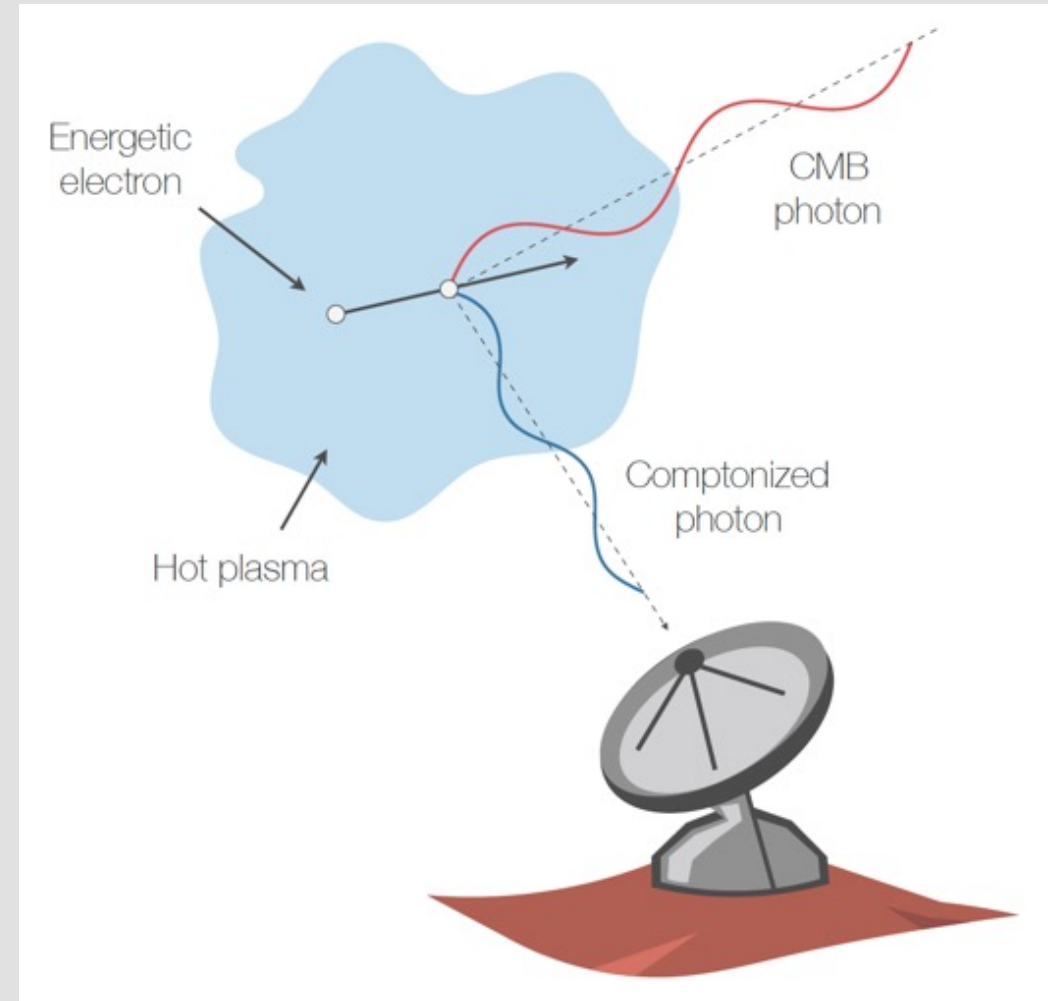


Right: SZ distortion showing different relativistic effects from Mroczkowski et al. 2019



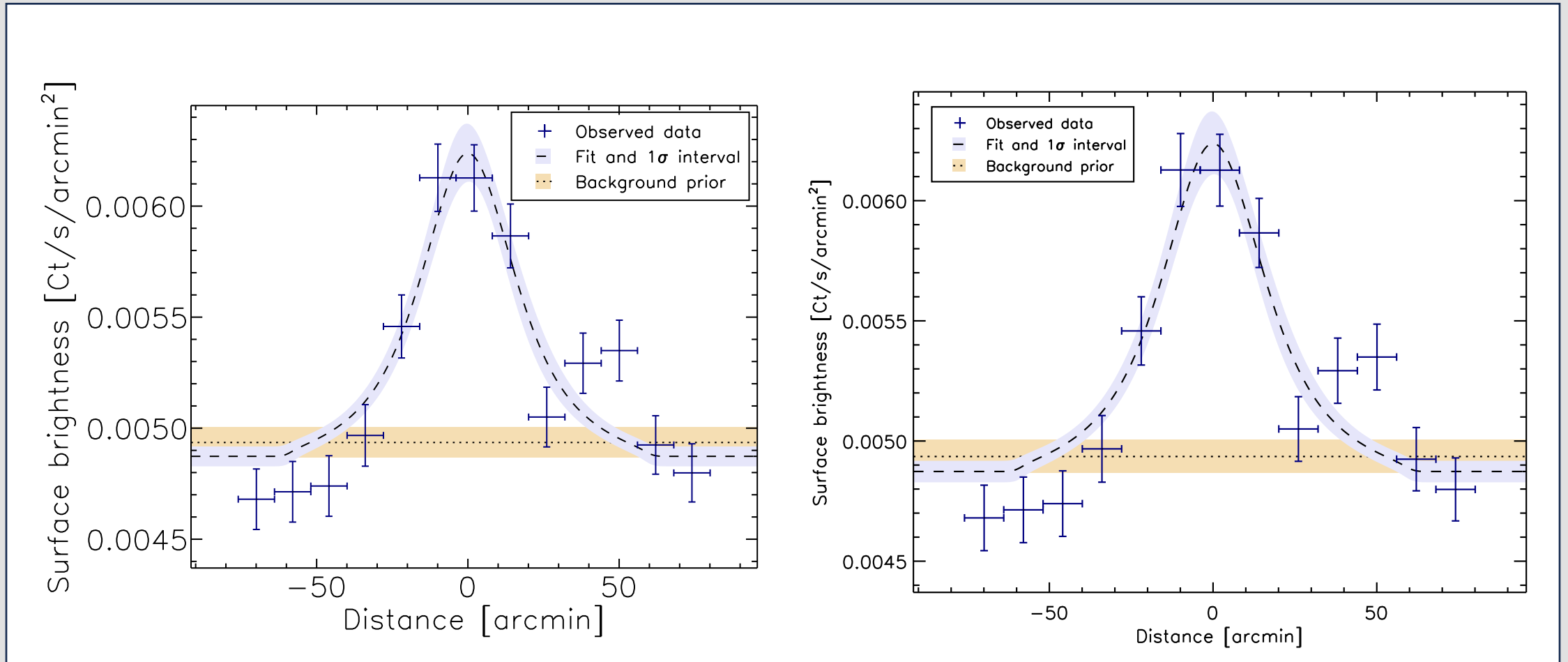
# General Advice – Less is More!

- The thermal SZ effect involves a CMB photon scattering with a high temperature electron
- The number of scatterings is proportional to the electron density along the line of sight
  - $N_{scat} \sim \int n_e * dl$
- The average energy boost per scattering is proportional to the electron temperature
  - $E_{boost} \sim T_e$
- The total signal is thus
  - $SZ \sim \int n_e * T_e * dl$



# General Advice – Readable Figure Fonts

- The font size used in paper figures is often too small for presenting



Simple example of a plot from Dietl et al. 2024

# General Advice – Stage Presence

- Engage the audience
  - Make eye contact and always face the audience
  - Do not read your notes/slides while looking down
  - Do not turn your back to the audience while you're speaking
- Use your pointer to highlight a given portion of a slide
  - Do not use the pointer for any other purpose
  - A common mistake is to keep the button on the pointer light depressed while speaking – this is a major distraction to the audience
- Avoid nervous actions – easier said than done!
  - Do not shuffle your feet, put your hands in your pockets, swing your arms, etc.
- Use the entire stage
  - Calmly moving within your space as you present helps keep the audience engaged
- Avoid boring monotone speech patterns
  - The audience will be more engaged if you are enthusiastic in your presentation

# General Advice – Watch Other Presentations

- One of the best ways to improve your presenting skills is to observe other presenters with a critical eye
  - If you observe something that is particular effective, then try to emulate it in your future presentations
  - If you observe something that detracts from the presentation, then try to avoid it in your future presentations
- Try to make this assessment for a range of presentation attributes
  - Slide layout and organization
  - The flow from introduction to body to conclusion
  - Stage presence
  - Overall delivery and speaking routine
- While some presentations are 100% excellent (and some are very poor throughout), most will contain some good and some bad
- During the course of this school, try to make note of the good and bad from all of the presentations you hear!



# Presenting Scientific Results – Key Takeaways

- **Start by defining *what* you want to convey to the audience**
- **Assess the audience to determine how best to convey this message**
- These two objectives must be achieved within the constraints of your venue
  - What is your allotted time?
  - What stage/equipment do you have access to?
- **Practice is essential**
  - Both for long-term improvement and for any specific talk
- **Observe others**
  - Emulate the techniques that are effective, and discard the ones that aren't