Scientific Writing

Physics 6510/4410
Fall 2012
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These lectures are based on material from previous years, especially material from Profs. Eun-ah Kim and Kyle Shen.

References on Writing

• www.stanford.edu/~kcobb
The Science of Scientific Writing

If the reader is to grasp what the writer means, the writer must understand what the reader reads.

Science is often hard to read. Most people assume that its difficulties are born out of necessity, out of the extreme complexity of scientific concepts, data and analysis. We argue here that complexity of thought need not lead to impenetrability of expression: we demonstrate a number of rhetorical principles that can produce clarity in communication without oversimplifying scientific issues. The results are substantive, not merely ornamental: improving the quality of writing actually improves the quality of thought.

The fundamental purpose of scientific discourse is not the mere presentation of information and thought, but rather its actual communication. It does not matter how pleased an author might be to have converted all the right data into sentences and paragraphs; it matters only whether a large majority of the reading audience accurately perceives what the author had in mind. Therefore, in order to understand how best to improve writing, we would do well to understand better how readers go about reading. Such an understanding has recently become available through work done in the fields of rhetoric, linguistics and cognitive psychology. It has helped to produce a methodology based on the concept of reader expectations.

3 Lecture Series

1. Bare bones tutorial.
2. Practical how-to: From outline to abstract, figures, tables and paragraphs.
3. Rewriting at microscopic and macroscopic levels.
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How do you create a readable, or better yet, an exciting scientific report?
Basic Idea

Provide your reader with the information they’re expecting in the order they’re expecting it and in the form they’re expecting it.

Create an Outline

• Main message: state what you have to say in one sentence.
• Introduction
• Relevant theory
• Apparatus and methods with a diagram
• Analysis and discussion = your physics (2-4 figures)
• Conclusion

One bullet point for each paragraph
Abstracts

1. Why: the background.
2. What: the **question** asked.
3. How: the experiments done.
4. What: the **key specific (quantitative) results** found.
5. Meaning: **the answer** to the question asked. Your main message!
6. So what: The implications. (i.e., the kicker)

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Example PRL

**Polarization-Entangled Light Pulses of $10^5$ Photons**

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We experimentally demonstrate polarization entanglement for squeezed vacuum pulses containing more than $10^5$ photons. We also study photon-number entanglement by calculating the Schmidt number and measuring its operational counterpart. Theoretically, our pulses are the more entangled the brighter they are. This promises important applications in quantum technologies, especially photonic quantum gates and quantum memories.

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PACS numbers: 03.67.Bg, 03.65.Ud, 42.50.Dc, 42.50.Le
How to create an Outline

• Start a file with place-holders
• Think about the main message. Try typing it.
• “Analysis & discussion” section. Plan how to use figures.
• Revise the main message, if necessary.
• “Apparatus and Methods” section.
• “Conclusion” section.
• Revise the main message.
• “Introduction”. Tailor it around the message.
• “Theory”. Just enough for the logical flow.

Example:
Component of Science Case for CHESS renewal proposal.
Need 2-3 page description of a research program/facility that will occur during the next five-year funding cycle.

Consider Sum Frequency Generation (SFG) with optical and X-ray waves.

Jump to word document with outline
Outline ↔ Paragraphs

• Outline bullet point = topic sentence + stress point
• Structure of paragraph:
  – Topic sentence
  – Supporting material
  – Stress sentence.
Outline ↔ Figures and Tables

- Use big fonts for figure labels and legends (24 ~ 32 pt)
- Use vector images (pdf or ps) that scales, rather than bitmaps
- Use legends over text caption

Jump to word document with figures
Constructing a paragraph

• Each paragraph should be about one (and only one!) idea.
• Present the main idea of the paragraph as the first sentence: **topic sentence**.
• Follow with supporting information.
• First and last sentences are most noticeable. Make them **short and punchy**.

Gunning’s 10 principles for clear effective writing

1. Keep sentences short
2. Prefer the simple to the complex
3. Use the familiar word
4. Avoid unnecessary words
5. Put action in your verbs
6. Write as you talk
7. Use picturable terms
8. Tie in with reader’s experience
9. Make full use of variety
10. Write to express, not to impress