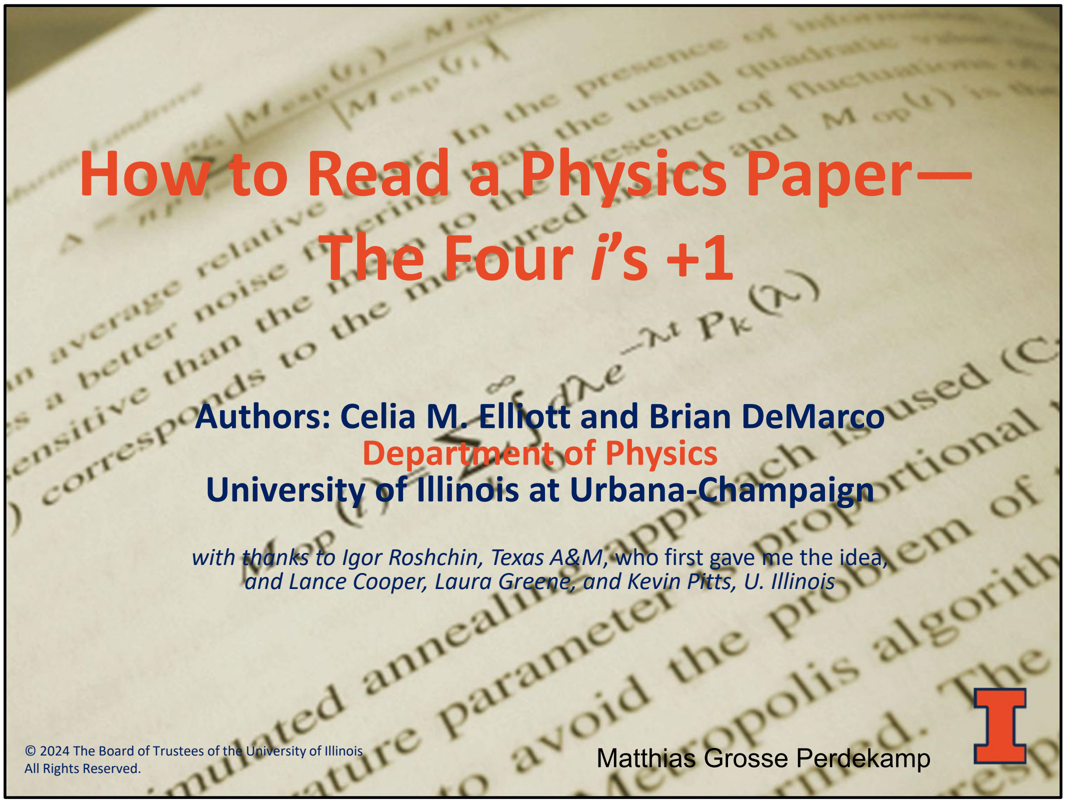


In this talk, we'll look at how scientists read journal articles—which generally is not to begin at the beginning and read every word through to the end. We'll consider why this unconventional reading style is advantageous and how you can use it to identify papers that are worth the time and effort to read thoroughly.

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Why read papers, and what kind?

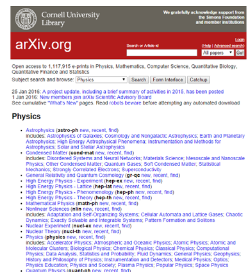
Peer-reviewed **papers are the primary means of communication in physics**

Three broad categories:

- **High profile (first time) results**
- **Detailed methods & results**
- **Review: synthesis by expert(s)**

Preprints (not peer reviewed)

- **Most current research**



- **arXiv**
- **ChemRxiv**
- **OSF Preprints (all disciplines)**
- **ESS Open Archive (earth & space)**

2

Earth & Space Science Open Archive—American Geophysical Union; also contains posters presented at major meetings

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

How do you decide on what to read?

Learn about a new development in your area:

- **Focus on <u>results</u> in PRL or PRA (BCDE)- like journals**
- **New formalism or methods are in <u>methods</u> & <u>formalisms</u> (or in the supplement)**

Learn something new **(physics is interconnected):**

- **Start with review papers, books, and theses**
- **First focus on broad understanding**
- **Then pick up on details concerning the physics, methods, and results!**

3

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

A screening and reading method

The four *i's (+1)*

Importance

Iteration

Interpretation

Integration

4

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

The first *i*: *importance*

Does the paper contain information (methods, results, conclusions) that has implications for your research?

- **Read the title and the abstract**
- **Look at the author list and their affiliations**
- **Read the conclusions**
- **Look at the figures and captions**
- **Look at the references**

Is the paper worth reading? Study or go on?

Observation of Bose-Einstein Condensation in a Dilute Atomic Vapor

M. H. Anderson, J. R. Ensher, M. R. Matthews, C. E. Wieman,* E. A. Cornell

A Bose-Einstein condensate was produced in a vapor of rubidium-87 atoms that was confined by magnetic fields and evaporatively cooled. The condensate fraction first appeared near a temperature of 170 nanokelvin and a number density of 2.5×10^{12} per cubic centimeter and could be preserved for more than 15 seconds. Three primary signatures of Bose-Einstein condensation were seen. (i) On top of a broad thermal velocity distribution, a narrow peak appeared that was centered at zero velocity. (ii) The fraction of the atoms that were in this low-velocity peak increased abruptly as the sample temperature was lowered. (iii) The peak exhibited a nonthermal, anisotropic velocity distribution expected of the minimum-energy quantum state of the magnetic trap in contrast to the isotropic, thermal velocity distribution observed in the broad uncondensed fraction.

M. H. Anderson, J. R. Ensher, M. R. Matthews, C. E. Wieman, JILA, National Institute of Standards and Technology (NIST), and University of Colorado, and Department of Physics, University of Colorado, Boulder, CO 80309, USA.
E. A. Cornell, Quantum Physics Division, NIST, JILA-NIST, and University of Colorado, and Department of Physics, University of Colorado, Boulder, CO 80309, USA.
*To whom correspondence should be addressed.

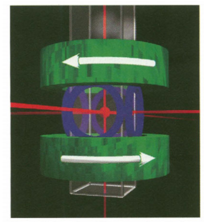


Fig. 1. Schematic of the apparatus. Six laser beams intersect in a glass cell, creating a magneto-optical trap (MOT). The cell is 2.5 cm square by 12 cm long, and the beams are 1.5 cm in diameter. The coils generating the fixed quadrupole and rotating transverse components of the TOP trap magnetic fields are shown in green and blue, respectively. The glass cell hangs down from a steel chamber (not shown) containing a vacuum pump and rubidium source. Also not shown are coils for injecting the rf magnetic field for evaporation and the additional laser beams for imaging and optically pumping the trapped atom sample.

5

Scientists are busy, and far more papers are published every year than anyone could reasonably be expected to read.

The first step is to determine whether a paper is worth your time, i.e., determine its importance to your research.

Note that your purpose for reading a paper (and hence your focus) may vary from paper to paper. In some cases, you'll want to concentrate on the methods or techniques described, to determine if they could be adapted for your project, and you won't care about the authors' specific results or conclusions.

Looking to see who wrote the paper is an important data point, but certainly not the only one. If someone whose affiliation is in a department of industrial engineering has written a paper announcing some world-shattering discovery in quantum measurement theory, you would rightly treat that paper with more skepticism than a paper written by Tony Leggett. However, young people and new people make important discoveries all the time, and some very good work is done in what might be considered unexpected places (e.g., Ernst Ising [Ising model] spent his whole career in the United States [after fleeing Nazi Germany] at Bradley University in Peoria, Illinois).

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Second *i*: *iterate*

1. Skim the article and identify its structure
   Many (not all) physics papers:
   Introduction, Methods (brief), Results, Discussion, sometimes Methods (again) Conclusions, References
2. Find main points of each section
3. Generate questions: <u>active reading</u>
4. Read to answer those questions
5. Iterate!
   Turn on your skepticism filter and take notes as you read!

6

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Second *i*: *iterate* *(continued)*

Take the paper apart, section by section, and identify the key ideas

Highlight anything you don't understand

Cross-check the narrative with the figures and tables

Go back and re-read your highlighted sections; refer to the references or supplementary info

Repeat until you thoroughly understand the parts of interest to you

7

Don't get bogged down in your initial reading. Make a note of something you don't understand (underline it, highlight it, put a ☹ or a ★ in the margin next to it), but keep reading.

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

The third *i*: *interpret*

Put the paper aside and write down the key ideas in your own words

Check what you've written against the paper; have you correctly represented the information and emphasis of the original paper?

Are there parts that you still don't understand?
(go back to *iteration*)

Do you agree with what the authors have said?
Have they provided sufficient detail and supporting evidence? (Again: turn on your skepticism filter)

8

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

The final *i*: *integrate*

Evaluate how the information presented in the paper fits with what you already know

Does it contradict something that you believe?

Does it raise new questions that you should investigate?

Does it describe a method that you could use?

Is it something that you should refer to in the future? (If so, how are you going to keep track of it?)

The four *i's of mindful reading*

9

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

+1: Storing information for future access

Devise a system to keep track of what you read

- Store pdfs of important papers on your computer, (i.e., create your own library)
- Categorize the papers in some sensible way
- Name papers in a way that can jog your memory

Many software solutions are available
(https://en.Wikipedia.org/wiki/Comparison_of_reference_management_software)

Popular choices (some supported by the Library)

- Mendeley, Zotero, RefWorks, EndNote

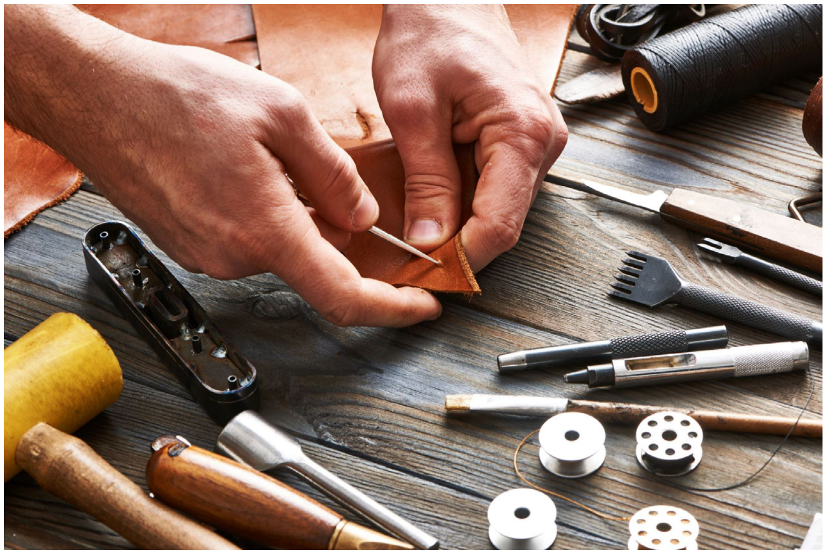
Consult your adviser and senior students in your group and get their recommendations

10

In addition to entering the bibliographic information for a paper in your citation manager, think about keeping a separate “reading” notebook, where you keep additional notes/questions/observations about the paper. Then in the citation manager, record the notebook number and page number where you have additional notes about the content of the paper.

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Now for the practical bits...



11

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Here's one way to deconstruct a paper

Read the abstract and write down the main ideas you think the paper will present

PRL **107,** 117401 (2011) PHYSICAL REVIEW LETTERS week ending 9 SEPTEMBER 2011

Optical Response of Relativistic Electrons in the Polar BiTeI Semiconductor

J. S. Lee,[1,*] G. A. H. Schober,[2,3] M. S. Bahramy,[4] H. Murakawa,[5] Y. Onose,[2,5] R. Arita,[2,4]
N. Nagaosa,[2,4] and Y. Tokura[1,2,4,5]

The transitions between the spin-split bands by spin-orbit interaction are relevant to many novel phenomena such as the resonant dynamical magnetoelectric effect and the spin Hall effect. We perform optical spectroscopy measurements combined with first-principles calculations to study these transitions in the recently discovered giant bulk Rashba spin-splitting system BiTeI. Several novel features are observed in the optical spectra of the material including a sharp edge singularity due to the reduced dimensionality of the joint density of states and a systematic doping dependence of the intraband transitions between the Rashba-split branches. These confirm the bulk nature of the Rashba-type splitting in BiTeI and manifest the relativistic nature of the electron dynamics in a solid.

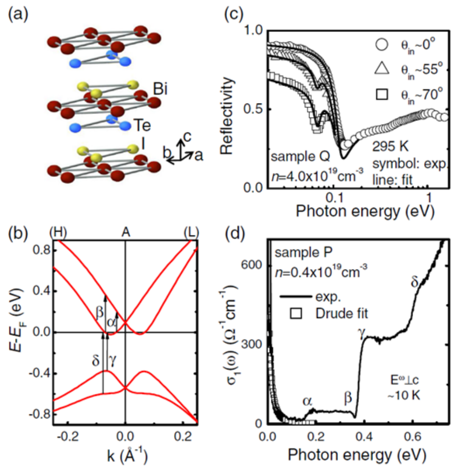
12

BiTeI bismuth tellurium iodide

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Next, look at the figures and tables

Write down a one-sentence description of each



J.S. Lee et al., Phys. Rev. Lett. **107**, 117401 (2011).

a) **Crystal structure of BiTeI; red is Bi, blue is Te, and yellow is I.**

b) **Band dispersion points in the *H* and *L* directions; possible optical transitions indicated by arrows with an index of *α, β, γ,* and *δ.***

c) **Reflectivity spectra were taken for one sample (*Q*) at different incident angles, as shown by variations in photon energy (eV).**

d) **Optical conductivity spectra were obtained by polarizing light directed normal to the *c* axis (solid line) and compared with a theoretical curve (open squares) based on the Drude model.**

13

Writing down a description of the figure will make you really *look* at the figure and understand it. Make a note of any questions you have about the figure.

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Next, read the first sentence of each paragraph

Highlight any sentences that you don't understand

Look at the sentences. Can you see a logical progression of ideas?

Summarize the logical argument in a short paragraph

14

In scientific writing, the first sentence in a paragraph is (should be) the topic sentence of that paragraph. Additional sentences in the paragraph should explain, amplify, give evidence for, add examples or counterevidence for, and summarize the first sentence.

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Go back to any sentences you highlighted

Study the corresponding paragraph—does it answer your questions?

If you still don't understand the sentence you highlighted, devise a strategy to figure out what it means

- Look up key words
- Find a review article on the topic
- Check the references
- Check for supplementary material
- Google the author's name to see if she has a research website

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Read the conclusions section

Have the authors supported their conclusions?

How do their conclusions fit in with what you already know?

Is there anything you don't agree with?

Is there anything that you still don't understand?

How can you resolve the issues?

16

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Figure out a way to keep track of this paper

Enter the bibliographic information into your citation manager

In your notes, clearly differentiate direct quotes from the paper and what you've paraphrased

Important: Develop your own method to deconstruct papers

17

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

To recap:

Importance—first determine if the paper is worth reading

Iterate—go back over sections of the paper until you understand it; consult other sources if necessary

Interpret—summarize the main points in your own words

Integrate—synthesize the ideas with what you already know and believe

Investigate a citation management system to keep track of what you read

18

Notes:

2023 © The Board of Trustees of the University of Illinois
All rights reserved.

Final words:

Pro tip: Scan the arXiv each week via RSS feed!

Physics ideas are <u>interconnected</u>—intentionally break out of you silo periodically and read something different

Strive for *mindful reading;* not a linear process, takes practice

cmelliot@illinois.edu 19

2023 © The Board of Trustees of the University of Illinois
All rights reserved.