How to Read a Physics Paper—The Four *i*'s

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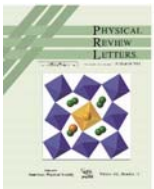
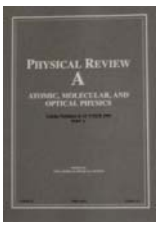
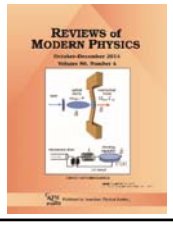
with thanks to Igor Roshchin, Texas A&M,
and Lance Cooper, Laura Greene, and Kevin Pitts, U. Illinois

Introduction

- **Peer-reviewed papers are the primary means of communication in physics**
  - **Official record**
- **Three broad categories**
  - **"letter": the results**
  - ~~**"long paper": the methods**~~
  - **"review": synthesis**

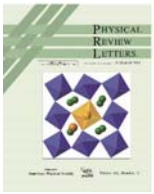






Introduction

- Peer-reviewed papers are the primary means of communication in physics
  - Official record
- Three broad categories
  - high profile
  - "bread & butter"
  - "review": synthesis



Philosophy

- Read to learn about developments in your area
  - Most important use of what follows in this talk
  - Not a linear process, it will take a while
- Read to learn about something new or for interest
  - Scan the arXiv each week via RSS feed!
  - Physics ideas are interconnected

What was your experience like?

A reading method

The four *i's*

Importance
Iteration
Interpretation
Integration

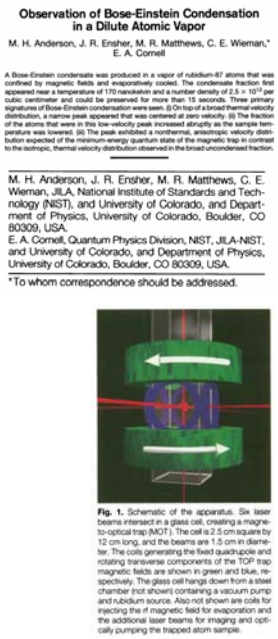
The first *i*: *importance*

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

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.

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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.

Second *i*: *iteration*

1. Skim the article and identify its structure
   Many (not all) papers:
   IMRD: Introduction, Methods, Results, Discussion
2. Find main points of each section
3. Generate questions: active reading
4. Read to answer questions
5. Iterate!

Take notes as you read!

Second *i*: *iteration*

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

The third *i*: *interpretation*

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?

The final *i*: *integration*

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?

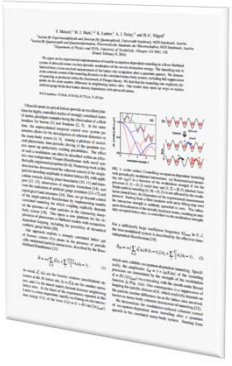
Does it describe a method that you could use?

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

QUIZ

How many hours does it usually take Prof. DeMarco to read a four-page paper and really understand it?

VS.



A. 30 minutes
B. 1 hours
C. 2 hours
D. 4 hours
E. 10 hours