WRITING PHYSICS PAPERS 101

Publish or Perish

reading about physics writing

- M. Alley, *The craft of scientific writing*, 3rd Ed., Springer New York, 1996.
- B. Goss Levi: *Some simple rules of writing* http://www.research.att.com/kbl/APS/dec97/rules.html
- D. Mermin: *What's wrong with this prose?* Physics Today, May 1989, p.9
- D. Mermin, *What's wrong with these equations?* Physics Today, October 1989, p.9
- D. Mermin: *Writing physics* http://www.lassp.cornell.edu/~cew2/KnightLecture.html

OUTLINE

- Why are we writing papers?
- What physics journals there are?
- Structure of a physics article
- LaTeX 001
- Hints for effective writing
- Submit & fight

WHY ARE WE WRITING PAPERS?

- To communicate our original, interesting, and useful research
- To let others know what we are working on (and that we are working at all)
- To organize our thoughts
- To formulate our research in a comprehensible way
- To secure further funding
- To further our careers
- To make our publication lists look more impressive
- To have fun?
- Because we believe someone is going to read it!!!

WHAT PHYSICS JOURNALS ARE THERE?

Hard-science journals

Physical Reviews series

- ✓ Physical Review A
  pra.aps.org
  atomic, molecular, and optical physics
- ✓ Physical Review B
  prb.aps.org
  condensed matter and materials physics
- ✓ Physical Review C
  prc.aps.org
  nuclear physics
- ✓ Physical Review D
  prd.aps.org
  particles, fields, gravitation and cosmology
- ✓ Physical Review E
  pre.aps.org
  statistical, nonlinear, and soft matter physics
- ✓ Physical Review Letters (PRL)
  prl.aps.org
  breakthroughs in all areas
- ✓ Reviews of Modern Physics
  rmp.aps.org
  reviews in all areas

Applied Physics Series

- ✓ Journal of Applied Physics
  jap.aip.org
- ✓ Applied Physics Letters
  apl.aip.org

European Physics Journal Series

- ✓ EPJ A

  www.edpsciences.org/epja

  hadrons and nuclei

- ✓ EPJ B

  www.edpsciences.org/epjab

  condensed matter

- ✓ EPJ C

  www.edpsciences.org/epjc

  particles and fields

- ✓ EPJ D

  www.edpsciences.org/epjd

  atoms, molecules, and clusters

- ✓ EPJ E

  www.edpsciences.org/epje

  soft matter

- ✓ Europhysics Letters

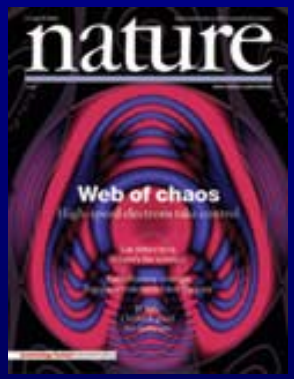
  www.edpsciences.org/epl

  all areas: breakthroughs

Nature and Science

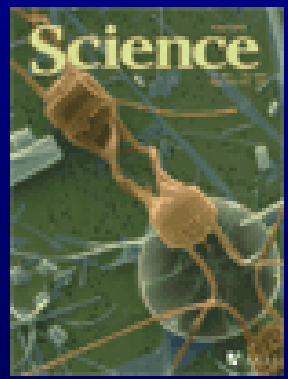
Nature

http://www.nature.com



Science

http://www.sciencemag.org



Soft-science journals

- ✓ Physics Today
  www.physicstoday.org
  official journal of APS, good review articles and reseach news
- ✓ Physics World
  physicsweb.org
  Institute of Physics, good review articles
- ✓ Scientific American
  www.sciam.com
  popular science articles
- ✓ American Journal of Physics
  ojps.aip.org/ajp
  pedagogical physics research articles

Impact Factors
how much is your article worth?

Institute for Scientific Information (ISI)

isi6.isiknowledge.com

Roughly average citation per article

ISI 2002 impact factors of selected physics journals

Nature	30.432
Science	28.956
Rev. Mod. Phys.	23.672
Adv. Phys.	13.952
Phys. Rep.	12.645
Phys. Rev. Lett.	7.523
Nucl. Phys. B	5.409
Phys. Today	5.000
Phys. Rev. D	4.358
Appl. Phys. Lett.	4.207
Phys. Rev. B	3.327
Phys. Rev. A	2.986
Phys. Rev. C	2.848
Phys. Rev. E	2.397
J. Appl. Phys.	2.281
EPJ E	2.188
EPJ B	1.741

Citations
how much is your article really worth?

isi6.isiknowledge.com

SPIRES HEP reference search:

www-library.desy.de/spires/hep/

Preprint Archives
free, fast, referee free

www.arxiv.org

xxx.lanl.org

STRUCTURE OF A PHYSICS ARTICLE

Short letters

PRL, APL, rapid communications, …
1-4 pages

- Title
- Abstract
- Homogeneous body includes introduction and acknowledgments
- 0-4 figures
- At most paragraph titles

Regular articles
4-500 pages

- Title
- Abstract
- Introduction
- Body sections
- Conclusions/Summary
- Acknowledgments
- References
- Appendices

Title

informative, catchy, concise

Semicolons?

Why not, if it helps, though some consider them bad taste.

Abstract

concise, direct, informative

Passive or active voice?

I prefer passive, though in longer abstracts an occasional active assertion may be enlivening.

Abstracts are now more important than ever due to the increasing large number of articles. One cannot read all the papers in each issue of PRL, not even in ones own field. Abstracts should state major findings, even some specifics (numbers, formulas showing basic trends).

examples

VOLUME 83, NUMBER 6 PHYSICAL REVIEW LETTERS 9 AUGUST 1999

Phonon-Induced Spin Relaxation of Conduction Electrons in Aluminum

Jaroslav Fabian and S. Das Sarma

Department of Physics, University of Maryland at College Park, College Park, Maryland 20742-4111

(Received 12 April 1999)

Spin-flip Eliashberg function $\alpha_S^2 F$ and temperature-dependent spin relaxation time $T_1(T)$ are calculated for aluminum using realistic pseudopotentials. The spin-flip electron-phonon coupling constant λ_S is found to be 2.5×10^{-5}. The calculations agree with experiments validating the Elliott-Yafet theory and the spin-hot-spot picture of spin relaxation for polyvalent metals.

PACS numbers: 71.70.Ej, 75.40.Gb, 76.30.Pk

VOLUME 82, NUMBER 7 PHYSICAL REVIEW LETTERS 15 FEBRUARY 1999

Theory of Sound Attenuation in Glasses: The Role of Thermal Vibrations

Jaroslav Fabian[1,2] and Philip B. Allen[2]

[1]*Department of Physics, University of Maryland at College Park, College Park, Maryland 20742-4111*

[2]*Department of Physics and Astronomy, State University of New York at Stony Brook, Stony Brook, New York 11794-3800*

(Received 13 October 1998)

Sound attenuation and internal friction coefficients are calculated for a realistic model of amorphous silicon. It is found that, contrary to previous views, thermal vibrations can induce sound attenuation at ultrasonic and hypersonic frequencies that is of the same order or even larger than in crystals. The reason is the internal strain induced anomalously large Grüneisen parameters of the low-frequency resonant modes. [S0031-9007(99)08429-X]

PACS numbers: 62.65.+k, 62.80.+f, 63.50.+x

Introduction

- Give the first impression about the paper
- Place the work into broader context
- Relate to other relevant research
- Say why is the work important, in plain language
- State major achievements/limitations
- State techniques/methods
- Describe organization of the paper

Phonon-Induced Spin Relaxation of Conduction Electrons in Aluminum

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PACS numbers: 71.70.Ej, 75.40.Gb, 76.30.Pk

Spin dynamics of itinerant electrons in metals and semiconductors is attracting increasing attention. Part of the reason for this interest is fundamental, arising from improved spin injection and detection techniques [1] which now allow precise measurements of spin transport, relaxation, and coherence properties. But much of the recent interest is also motivated by the exciting potential of using electron spin as a building block in nanoelectronics (dubbed "spintronics") where spin dynamics and transport is projected to be utilized in proposed novel device applications. The most ambitious such possibility is using electron spin as a qubit in a quantum computer architecture, but more modest proposals involving the use of spin injection and transport in new quantum transistor devices ("spin transistors") have also been made [1].

Electron spin already plays a fundamental, albeit passive, role in giant magnetoresistance-based memory devices. The current push for a better understanding of spin dynamics in electronic materials is, however, based on the hope that the electron spin could be used as an *active* element, where manipulation of spin in a controlled manner will lead to novel device applications which are not feasible in conventional microelectronics. This hope arises from two underlying concepts: the inherently quantum mechanical nature of spin (enabling the possibility of truly quantum devices which could not be envisioned within standard micro- or nanoelectronics), and, even more importantly, the inherently long relaxation or coherence time of spin eigenstates in metals and semiconductors (indeed, in a typical nonmagnetic metal at room temperature electron spins survive for hundreds of picoseconds; by comparison, momentum states live no more than femtoseconds). This Letter provides the first realistic quantitative calculation of the temperature dependent spin relaxation time (the so called T_1 relaxation time) in an electronic material, namely, metallic aluminum. The calculation, for reasons to be explained below, is surprisingly subtle and extremely computationally demanding; it has therefore never been attempted before, although the basic theory for the phenomenon goes back more than thirty-five years [2,3].

The mechanism behind spin relaxation in metals is believed to be the spin-flip scattering of electrons off phonons and impurities, as suggested by Elliott [2] and Yafet [3]. There are two physical processes to be considered. (A) The periodic, ion-induced spin-orbit interaction is modified by phonons [4]. Electrons scattering by the modified interaction can directly change their spin states. (B) Because of the spin-orbit interaction electronic Bloch states have both spin up and spin down amplitudes. The states can still be polarized by a magnetic field (so we can call them up and down) but because of the spin mixing, even a spin-independent interaction with phonons or impurities (which are assumed to be nonmagnetic) leads to a transition from, say, up to down, degrading any unbalanced spin population. (Note that the spin-orbit interaction by itself does not produce spin relaxation—what is needed is spin-orbit coupling to mix the up and down spins, and a momentum conservation-breaking mechanism such as impurities or phonons.) Although the above processes seem to provide a consistent picture of experimental findings, there has been to date no calculation of T_1 for a metal based on the Elliott-Yafet theory.

In this Letter, we calculate the phonon contribution to T_1 for aluminum providing the first quantitative justification of the theory. (Impurities in real samples contribute only a temperature independent background which can be subtracted from the measurement.) At temperatures T above 100 K, where experimental data are not available, our calculation is a prediction which should be useful for designing room-temperature spintronic devices that use aluminum. We also calculate the spin-flip Eliashberg function $\alpha_S^2 F(\Omega)$ which measures the ability of phonons with frequency Ω to change electron momenta *and* spins. This function, which is an analog of the ordinary (spin-conserving) Eliashberg function $\alpha^2 F(\Omega)$ [5], is important in spin-resolved point-contact spectroscopy where phonon-induced spin flips could be directly observed. (A recent effort [6] to detect phonon-induced spin flips in aluminum failed because of the overwhelming spin-flip boundary scattering in the sample.)

Aluminum belongs to the group of metals whose spin relaxation is strongly influenced by band-structure anomalies [7]. Monod and Beuneu [8] observed that while simple estimates based on the Elliott-Yafet theory work well for monovalent alkali and noble metals, they severely

0031-9007/99/83(6)/1211(4)$15.00

Body of the paper

Describe your findings in an organized, structured, and logical way

- Think about the organization ahead of actual writing
- Create informative headings helping easy orientation

Conclusions

- Give your article closure
- Summary of major results
- Prospects for future extensions
- Possible applications, relevance to other works, fields

Conclusions example

In summary, we have provided the first fully quantitative theory for the temperature-dependent spin relaxation rate in aluminum taking into account spin-orbit coupling and electron-phonon interaction within the Elliott-Yafet formalism using realistic pseudopotentials. Our theoretical results are in excellent agreement with the measured $T_1(T)$ in aluminum and for $T > 100$ K, where experimental results are currently nonexistent, our theory provides specific predictions for comparison with future experiments.

LaTeX 101

text, equations, figures, tables, references

LaTex

http://www.latex-project.org/

REVTeX 4

To compile Phys. Rev. Style documents

http://publish.aps.org/revtex4/

TeX archive network

http://www.ctan.org/ctan/

Compiling LaTex

- latex paper.tex % compile the file
- bibtex paper.tex % compile references (if.bib) exists
- latex paper.tex % compile again
- latex paper.tex % compile yet again
- dvips paper.dvi % create a .ps file
- gv paper.ps % view the .ps file

template for PRL

```
\documentclass[aps,prl,floatfix,twocolumn,footinbib]{revtex4}
\usepackage{epsfig}
\begin{document}

\title{Template}
\author{Jaroslav Fabian}
\affiliation{Institute for Theoretical Physics, Karl-Franzens
University, Universit\"atsplatz 5, 8010 Graz, Austria}
\author{Albert Newton}
\affiliation{Center for extraterrestrial research, Washington DC}
\begin{abstract}
A LateX template is provided to generate physics papers fast and
easy.
\end{abstract}\maketitle
```

inserting figures

```
\begin{figure}
\centerline{\psfig{file=fig.eps, width=1\linewidth}}
\caption{Template figure. Put your caption here}
\label{fig:1}
\end{figure}
```

writing equations

To place equations in line write $s_x=a+b$. Symbol \$ separates the math format.

This is how single equations are written between lines:

```
\begin{equation}
\delta s=\int_0^1
\gamma_{2,be}\cosh(w_b/L_{nb})s_{0b}\exp(qV_{be}/k_BT)dq.
\end{equation}
```

This is how multiple equations are written:

```
\begin{eqnarray} \label{eq:2}
a&=&\sum_{i=1}^{\infty}, \\
b&=&\log(x).
\end{eqnarray}
```

sections

```
\section{\label{sec:Intro} Introduction}
 In this section …

\section{\label{sec:model} Model}
We discuss the model introduced in Sec. \ref{sec:Intro}. The details
are shown
In Fig. \ref{fig:1}. Our work is published in Ref.
\cite{Newton2000:PRL}.
```

references

```
\bibliographystyle{apsrev}
\bibliography{references}
```

Separate file reference.bib contains references in the following format:

```
@Article{Newton2000:PRL,
      author = "I. Newton",
      title  = "On falling apples",
      journal= "Phys. Rev. Lett.",
      volume =  "00",
      year   =  "2000",
      pages  =  "1-5"
}
```

finish

\end{document}

HINTS FOR EFFECTIVE WRITING

something about style

disclaimer

I am not a native English speaker and I am not a creative-writing professional. Everything that follows should be taken as my best attempt to teach my students intricacies and idiosyncrasies of physics writing, based on my own experiences and on reading inspiring literature. I claim no responsibility to the damage inflicted on students by following my advice too closely and producing unintelligible and grammar offensive research articles. Beware of my grammar hints. I am especially offensive to the articles ("the", "a", "an", and the worst of all, none, "..."). I feel absolved by being a Slavic language (read: article-free) native speaker.

Hint 1

Pick a published paper you like and try to emulate its structure and style

Learn from eminent physics writers

Some of my favorite physics writings are:

- S. Weinberg: Relativity and Cosmology
- Feynman, Leighton, Sands: Feynman Lectures in Physics
- Landau and Lifschitz: Course in Theoretical Physics (*)

(*)I would not recommend emulating the style of L&L in research papers, unless you can emulate their physics.

Hint 2

Understand what you write, be clear

- Distance yourself from the writing to see it unbiased
- Logic must flow
- Ask a colleague if in doubt that writing may be incomprehensible

useful point: Do not write "The energy increases with pressure", but "The energy increases with increasing pressure", to be clear, since one can often mean the opposite ("At low fields the rate decreases" can mean that the rate increases with *decreasing* fields, but one never knows.)

Hint 3
structuring into ideas
=
structuring into paragraphs

- Place clue sentences in the beginning
- Read the paragraph and rewrite it if the logic does not flow

Hint 4
Write in active voice

I show that the process occurs

These results show that …

(NO: It is shown by these results that …)

- Be concise, precise, and direct
- Stay focused

Hint 5
Be consistent

If there is an allowed ambiguity, stick to your choice throughout the paper:

For example: "We take five configurations for the macrostate. Each microstate is defined by …" Either pick microstate or configuration, some may get confused. Similarly with grammar. For example, if you describe an experiment in the past sense, do not switch randomly to the present one.

Hint 6
No offense

Avoid if possible words like

- Clearly
- Obviously
- As is well known
- Of course

Hint 7
Read the guidelines

- Early in your professional life read the guidelines for authors to the journal you write for. Adhere to the most relevant points in future writings.

Hint 8
Do not overdo

- Footnotes
- In-line equations
- References
- Figures
- Latin phrases
- Acronyms

Hint 9
referring

- Include only equations, figures, tables, and references that you refer to
- Carefully define every term in equations
- Define all the lines and symbols in figures
- Each figure and table comes with a caption
- Number all equations
- All nontrivial statements should be explained or referenced

Hint 10
Revise 5-10 times

- Spell check
- Grammar check
- Check for flow
- Shorten
- Give the paper to a colleague for opinion
- Stop revising after a revision eliminates a previous revision, or if you are revising 10th time. There is little chance you will improve anything.

Final hint

Do not put too much emphasis on writing. It is a tool to communicate your research, no less and no more.

An average paper is cited perhaps 4 times, and read perhaps 7 (4 plus 2 referees plus 1 random reader) times. You need to balance your time. I know of terribly written articles that are cited 500 and more times. In the end, it is the idea that you present, and not the form of the presentation, that will be remembered.

Single authors: I or we?

- I prefer I when addressing work done by myself:

  I show that…

- Using we is more formal and authoritative; it diffuses responsibility
- There can still be we, if inviting the reader to join the discussion:

  If we substitute A for B

  or

  If one substitutes A for B

Hints for effective writing

à la Barbara Goss Levi (*)

(*) http://www.research.att.com/kbl/APS/dec97/rules.html

1. Practice writing short summaries of longer articles

   (get the message out)
2. Combine writing with inspiring reading

   (emulate the style of your favorite writing)
3. Get rid of superfluous words

   (there is …, the fact that …)

4. Rewrite if it is not clear
5. Define your terms
6. Good writing is clear thinking

SUBMIT & FIGHT

Submission letter

Dear Editor,

We submit a manuscript entitled „Falling cats with jelly on the back: stable equilibrium versus instinct", by E. Schroedinger and A. Einstein, for publication in Physical Review Letters.

The manuscript considers the important problem of cats with a jelly spread on their back. The cats are left to fall free from a height of at least 50 cm, and observed in their fall. We have discovered that cats do not fall. Instead, they hover indefinitely. Our conclusions have far reaching consequences for both physics and biology. We are now pondering about what happens to the cats when they are entangled.

The importance of our work as well as far reaching consequences of our discovery justify our manuscript to be considered for publication in Physical Review Letters. Below we suggest physicists who should be qualified to referee our work.

Sincerely,

E. Shroedinger

A. Einstein

Suggested referees: N. Bohr (Copenhagen), L. Boltzmann (Graz), L. Landau (Charkov)

Referee reports

Re: Falling cats with jelly ...
By: E. Schroedinger and A. Einstein

Dear Dr. Schroedinger:

The above manuscript has been reviewed by our referee(s). On the basis of the enclosed critique, we judge that the work does not meet the special criteria of importance and broad interest required for Physical Review Letters. We also wish to emphasize that we take strong stance on the animal rights issue and we do not endorse experimenting with live animals, with our without jelly on their backs.

Yours sincerely,

E. Rutherford
Senior Editor

encl. Referee reports

Referee A

This paper presents an experimental treatment of combined effects of mechanical rotation and animal instincts. The treatment is sound, but cruel. I question the conclusions of the manuscript on the basis that the authors used only 1 cat which must have felt depressed about being thrown repeatedly from the Physics Department windows. As is known from the work of C. Darwin, depressed cats tend to hover in the air. The authors have failed to separate the effects of depression from those of mechanical rotation and biological instincts. Therefore I do not recommend the paper for publication in Physical Review Letters in the present form, although the subject itself is of great importance.

Referee B

The group of E. Schroedinger publishes reliable and interesting results (though I have some doubts about Dr. Einstein who tends to be off at times). The paper is well written, the results clearly stated. The subject is definitely of broad interest, as I have myself pondered about such things. The only question I have is whether the work is suitable for Physical Review Letters, or should be published in the „American Journal of Falling Cats"? I opt for the latter.

Resubmission letter

Dear Editor,

We resubmit our mansucript entitled „Falling cats with jelly on the back: stable equilbrium versus instinct", by E: Schroedinger and A. Einstein, for publication in Physical Review Letters.

We consider the criticism of the referees well meant, and in fact supporting publication in your journal. Referee A says „The treatment is sound..." and „...is of great importance." Referee B claims that the paper is well written and of broad interest. We address the few minor critical points in the enclosed response to the referees.

Since we have addressed ALL the referee comments, and since the comments themselves can be interpreted as positive, we strongly request that you publish our manuscript without further delay.

Sincerely,

E. Shroedinger

A. Einstein

Response to the referees

Response to referee A: We thank the referee for his or her thoughtful comments and for carefully reading our manuscript. We were not aware of the important research of C. Darwin on falling depressed cats. Taking into consideration that our cat could have indeed been depressed by both falling down so often and having jelly on the back, and so not wanting to really fall down, we have put the cat on an antidepressant (Whiskas Prozac) and let it fall several times again. We are happy to report that our original results stay unchanged. Unfortunately, the poor cat has died. Probably from an overdose of Prozac.

Response to referee B: We appreciate the referee's well thought comments and for suggesting an alternative journal for our manuscript. We have looked at several recent issues of AJFC to see if indeed this would be the appropriate place for our cat. Unfortunately, AJFC seems to publish only very technical papers on the subject, with little emphasis on the physics involved. We strongly believe that PRL is the most suitable journal for publishing our work.

Acceptance (rejection) letter

Re: Falling cats with jelly ...
By: E. Schroedinger and A. Einstein

Dear Dr. Schroedinger:

We are pleased to inform you that the above manuscript has been accepted for publication. You are requested to make a payment of $1000 toward the cost of disseminating your research results.

Yours sincerely,

E. Rutherford
Senior Editor