Alexander Lvovsky

PHYS 597

Senior Physics Laboratory

Goals

Becoming an independent researcher

Student Learning (labs under guidance)

- detailed instructions
- prepared equipment
- known theory
- known results

PHYS 597
PHYS 598/599
MSc
PhD
Postdoc
Professor

Expert Learning (independent research)

- no instructions
- incomplete equipment
- no theoretical description
- unchartered territory

Why PHYS 597?

- Improve physics knowledge
- Learn the work of experimental physicist
  - conducting experiments
  - maintaining lab records
- “Metascience”
  - reading a research article
  - writing proposals (and getting them funded)
  - writing articles (and getting them published)
  - reporting your findings at a conference
- Becoming an independent scientist
  - independent thinking
  - literature study
  - problem solving
  - problem finding
  - etc…

Outline of these lectures

- Logistics
- Writing proposals
- Lab notes
- Research articles
  - Reading
  - Peer review
  - Writing
- Oral presentations
- Oral interview
- Writing a strong grant application

Logistics

Welcome to PHYS 597

Lectures
Sept. 12 – Sept 14 (2 lectures),
Presentations in November-December

Instructor
Alex Lvovsky
LVOV@ucalgary.ca
SB319
403 220 4124
Office hours: by appointment

Absent: September 25-26
October 4-13, 20

Course home page: http://ucalgary.ca/~lvov/597

Labs
Dates and times: Sept. 13/14 – Dec 5/6; MW 14:00 – 16:50 / TR 14:00 – 16:50.
Location: ES basement (ES002)
Coordinator: Patrick Irwin - aphyslab@ucalgary.ca

TAs
Eugene Moiseev <e.s.moiseev@gmail.com>
Shreyas Jalnapurkar shreyas.jalnapurkar@ucalgary.ca

These slides:
Credit to Prof. Wolfgang Tittel
Posted on the course web page

Grading overview

Lab proposals (3): 15%
Lab notes and performance: 10%
Lab reports (3): 45%
Oral interviews (2): 10%
Oral presentation and discussion: 20%

More information about all components, incl. grading, will be given in class

Lab proposal (each student): a proposal (1-2 double-spaced pages) outlining the proposed plan for the experiment. Due on the day of the 3rd session of the respective experiment.

Lab notes (each group) A lab notebook containing a chronological record of activities, procedures and measurements. Due the day after the last session of the respective experiment. All lab notes are to be submitted to the Senior Lab. A drop box has been set up in ES002 for this purpose.

Lab performance (each student): Each student will be evaluated on his/her lab performance (level of effort, diligence, effectiveness).

Lab report (each student): a formal report (two journal pages) of the motivation for the work, the work performed, the results obtained, and the conclusions drawn. Due on Friday after the last session of the respective experiment

Oral presentation (each student): The presentation covers the first or second lab.

Interview (each student): you must answer verbal questions of the instructor and "defend" your report.

- All lab proposals and reports are to be submitted in electronic form (PDF) and by email to your TA and to Dr. Lvovsky.
- There is a penalty of 10% per business day for all late work. A report that is more than 5 days late will not be accepted (zero points).

Lab schedule

- **22 lab sessions** in total
- First lab: Sept 13/14
  - Intro to labs, safety briefing, choose partner, make list of preferred topics
- Each **group of two students** performs **3 experiments**, each during 7 lab sessions

Lab	Group	Lab sessions	Proposal due	Notes & Report due	Note
Orien-tation	M/W	Sep. 13			1
	T/R	Sep. 14			
1	M/W	Sep. 18, 20, 25, 27, Oct. 2, 4, 11	Sep. 25	Oct. 13	
	T/R	Sep. 19, 21, 26, 28, Oct. 3, 5, 12	Sep. 26		
2	M/W	Oct. 16, 18, 23, 25, 30, Nov. 1, 6	Oct. 23	Nov. 9	2
	T/R	Oct. 17, 19, 24, 26, 31, Nov. 2, 7	Oct. 24		
3	M/W	Nov. 15, 20, 22, 27, 29, Dec. 4, 6	Nov. 22	Dec. 8	3
	T/R	Nov. 16, 21, 23, 28, 30, Dec. 5, 7	Nov. 23		

[1] Preparatory session to select partner and preferred topics

[2] No labs on October 9-10 (Thanksgiving)

[3] No labs on November 13-14 (reading days)

Possible lab topics

Experiment	Complexity	Coherence*
Michelson Interferometer and FT Spectroscopy	medium	high
Charge-to-mass ratio of the electron	low	high
Pulsed NMR	high	medium
Laser absorption spectroscopy of rubidium	high	high
Single photon two slit interference	low	high
Laser light and the He/Ne laser	medium	medium
High-resolution gamma-ray spectroscopy	low	low
Calculation of Bolzmann's constant from random noise	medium	high
Superconducting quantum interference device (SQUID)	high	medium
Speed of light	high	high
Ramsauer-Townsend effect	low	medium
Rubidium radio-frequency absorption	high	low
Cosmic ray telescope / lifetime of the muon	medium	high
Quantum analogs	high	low
Fourier methods	medium	low

*How clear is the manual? Are the goals well-defined? Is the material comprehensible with your knowledge? How understandable is the apparatus? How consistent are the results with theoretical predictions?

- Each group must do at least one high-complexity experiment and no more than one low-complexity experiment.
- A short description of each experiment is available on the course web page.
- A "manual" will be available at the start of each experiment.

A special mission: a parametric down-conversion lab

- A new setup, constructed in summer 2017
- Topics:
  - Parametric down-conversion
  - Single-photon interference
  - Polarization entanglement
  - Remote state preparation
  - Bell inequality
- Your job
  - Perform all experiments and **write a high quality manual** for future students
  - One lab covers the entire semester
  - Work in close contact with the TA (Eugene) and instructor (Alex)
  - The manual will account for 55% of your grade. You still need to write a proposal (5%) and report (15%), pass an oral interview (5%) and give a talk (20%).

Proposals

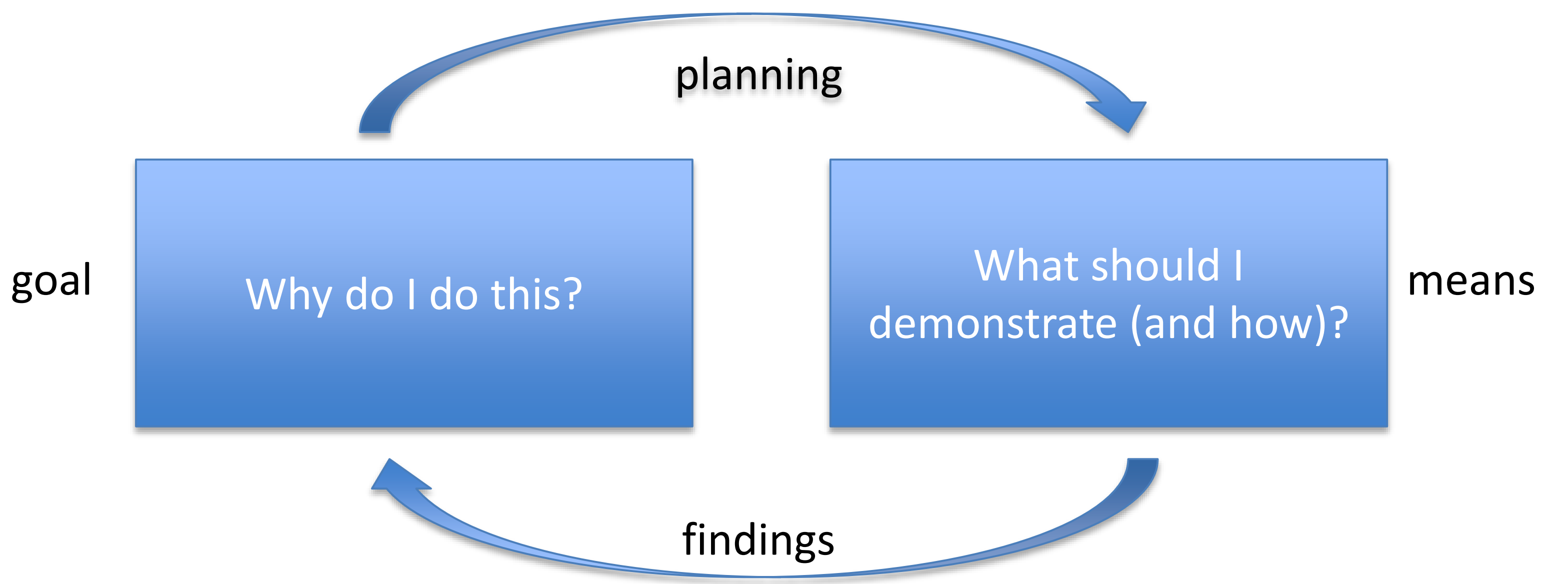
"Toy" and "Adult"

Research Proposals
Significance

-A scientific study is generally directed, i.e. there should not only be a “what”, but also be a clear “why” (the goal)

- The goal (the motivation for your research) affects the “what”, and thereby the new findings.

- In addition, the goal depends on the findings (it often evolves during a study), i.e. there is bi-directional feedback between the motivation and the measurement (outcomes)



Research Proposals
Purpose and outline

Purpose

- Understand the goals
- Learn the theoretical background
- Understand the challenges
- Summarize the resources, identify missing ones
- Plan and organize the experiment

Sections

Background/motivation:* state of the art, outstanding problems, why the whole investigation is important

Objectives: what do you want to achieve, what will be the impact of your result

Methodology: what you want to do and why

Timeline: what you want to accomplish per lab session.

References: see section “Research articles” for formatting

**The motivation can be re-used in the final lab report, but you may orient it differently once you have done all measurements*

Research Proposals
Background and motivation

General background of the field

Outstanding problem

What must be done to solve it

Since the inception of the first working silicon solar cell, a great deal of progress has been made in understanding the inner workings of crystalline PV materials. In parallel was progress in the area of noncrystalline semiconductor physics,[1] albeit at a much slower pace. The two fields overlapped upon the creation of 2nd generation PV technology which consisted of thin amorphous or polycrystalline films, such as, amorphous silicon (a-Si), cadmium telluride (CdTe) and copper indium gallium (di)selenide (CIGS). The experimental but promising 3rd generation PV technologies are also typically noncrystalline in nature. These state-of-the-art and future technologies have been explored mostly from the perspective of the well-established theories and concepts of crystalline semiconductor physics, and with great success. Yet, some important issues remain that significantly impede device efficiency and performance, such as the difficulty in scaling up from the lab cell to commercial size, increased degradation rates, anomalous current-voltage characteristics, and statistical variations between identical devices, to name a few. All of those effects are due to the disordered nature of the material.

The natural disorder in noncrystalline systems makes analytical models quite challenging. Over a span of three decades, the PI has made significant strides in understanding the physics of noncrystalline semiconductors through analytical methods. At this point numerical techniques are required to deepen this understanding and convey it to the PV community in an clear and useful format.

Given the disordered nature of thin-film PV, there exists a significant need for advanced PV device simulation. The prevalent thin-film PV device modeling software (called AMPS) is a one-

https://www.utoledo.edu/research/samples.html

Research Proposals
Objective

What do you want to achieve? What will be the impact of your result?

What they want to do

Expected benefit

Our objective is to develop the first three-dimensional numerical simulator of thin-film ***noncrystalline*** photovoltaic (PV) systems of any size scale; from microscopic samples to large arrays. We propose to conduct fundamental theoretical research on two fronts: (1) the physics of charge transport in noncrystalline PV materials; and (2) solving partial differential equations related to charge transport in disordered systems using numerical techniques, including finite element and Monte Carlo methods. The simulator will allow for the creation of compound single-cell devices by specifying individual material properties and the interconnection of several of those single-cell devices into large area PV modules (of ~ 1 m linear size) and arrays of many such modules with all of their inherent nonuniformities.

https://www.utoledo.edu/research/samples.html

Research Proposals Methodology

What specifically you want to do and why? What are the challenges and how will you address them? Why do you choose these specific methods?

Challenge and how to address it

The down-conversion will occur in a linear cavity, similarly in a 10-mm periodically-poled KTP crystal. Both type I and type II down-conversion will be tested, as well as both frequency-degenerate and frequency non-degenerate configurations. Both signal and idler waves will be resonated in the cavity, but not the 397.5 nm pump wave. Because the source is expected to operate below threshold, the cavity length cannot be stabilized directly to the emitted wave; instead, it will have to be stabilized to a weak resonance of the pump. The bandwidth of the each frequency mode of the source will be determined by the OPA length and the output coupler and is expected to be around 10 MHz.

Lab Proposals
Requirements

Template available on the course web page.

Length: strictly no more than 1 journal page.

The proposal starts with a title, lists the contributing authors (you plus your partner – put your name first), and indicates when it has been written. Recall that each student has to write a proposal.

Motivation: Why do you want to do this experiment?

- ~~Outstanding problem~~
- Historic significance
- Significance of the phenomenon for its field
- Applications in technology
- Generalization to other fields of physics

Methodology: What do you want to do?

- Description of planned experiment
- Expected challenges and ways to overcome them
- Timeline
- Milestones
- ~~Deliverables~~

Lab Proposals
Example timeline

The *Timeline* section describes what you want to accomplish per lab session.

Lab #	Plans
1	Understand objectives and methodology. Source all equipment.
2	Set up and align apparatus. Focus light into rubidium gas chamber. Draft proposal.
3	Determine voltage setting in Helmholtz coils required to cancel the earth magnetic field.
4	Vary the voltage applied to the Helmholtz coils to generate a well defined magnetic field and measure the absorption profile.
5	Apply an RF magnetic field to the Rb sample. Repeat the last measurement from session #4 using different RF frequencies.
6	Begin data analysis, including the analysis of experimental errors.
7	Complete lab report with TA input

Lab Proposals
Grading scheme

The marking scheme for proposals is below.

	Very poor (F)	**Poor (D)**	**Satisfactory (C)**	**Good (B)**	**Excellent (A)**
	0 %	40%	60%	80%	100%
Structure					
Quality of writing					
Content + physics					
Grammar, spelling, format					
Subtotal					

Your TA will grade your proposal. You will receive a single letter grade. When calculating the final course grade, the proposal grade will be converted to percentage points as outlined above.

Lab notes

Lab Notes – Why?

- Allow you remembering later (tomorrow, in a month from now) what you did (e.g. when writing a report/paper, or when replying to a referee)
- Allows future students to understand what has happened before
- Protects your priority

Lab notes - How

- use ink or a ball-point pen, not a pencil (so you cannot be accused of falsifying)

- date the work and include page numbers

- describe briefly what the task is that you are going to focus on and sketch setup

- record all measurement setups, measurement procedures, results, ideas regarding what may have been wrong – anything that you may not want to (or can!) repeat later and that may be relevant

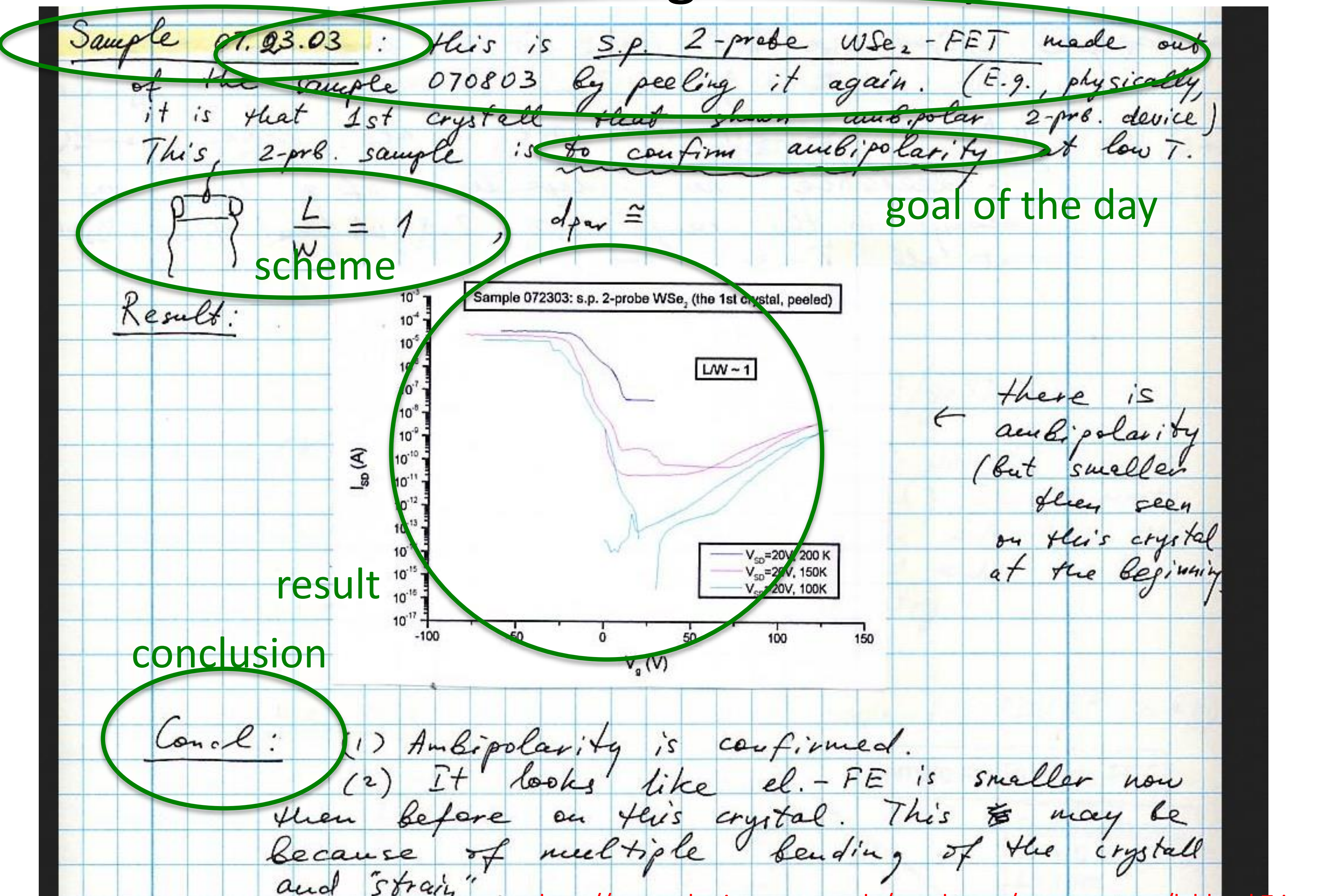
- include computer printouts, printouts from spectrometers etc. Clearly describe what they show

-include a short description of what measurement results are stored in a particular file (file names such as *Rb_spectro_setup_1_3mW_x-sweep.xls* are not sufficiently precise!), and in which directory

- add summaries whenever appropriate

- For PHYS 597: Use a separate lab book for each experiment. Soft-cover biology or chemistry lab books (available on campus) work well.

Lab Notes – good example

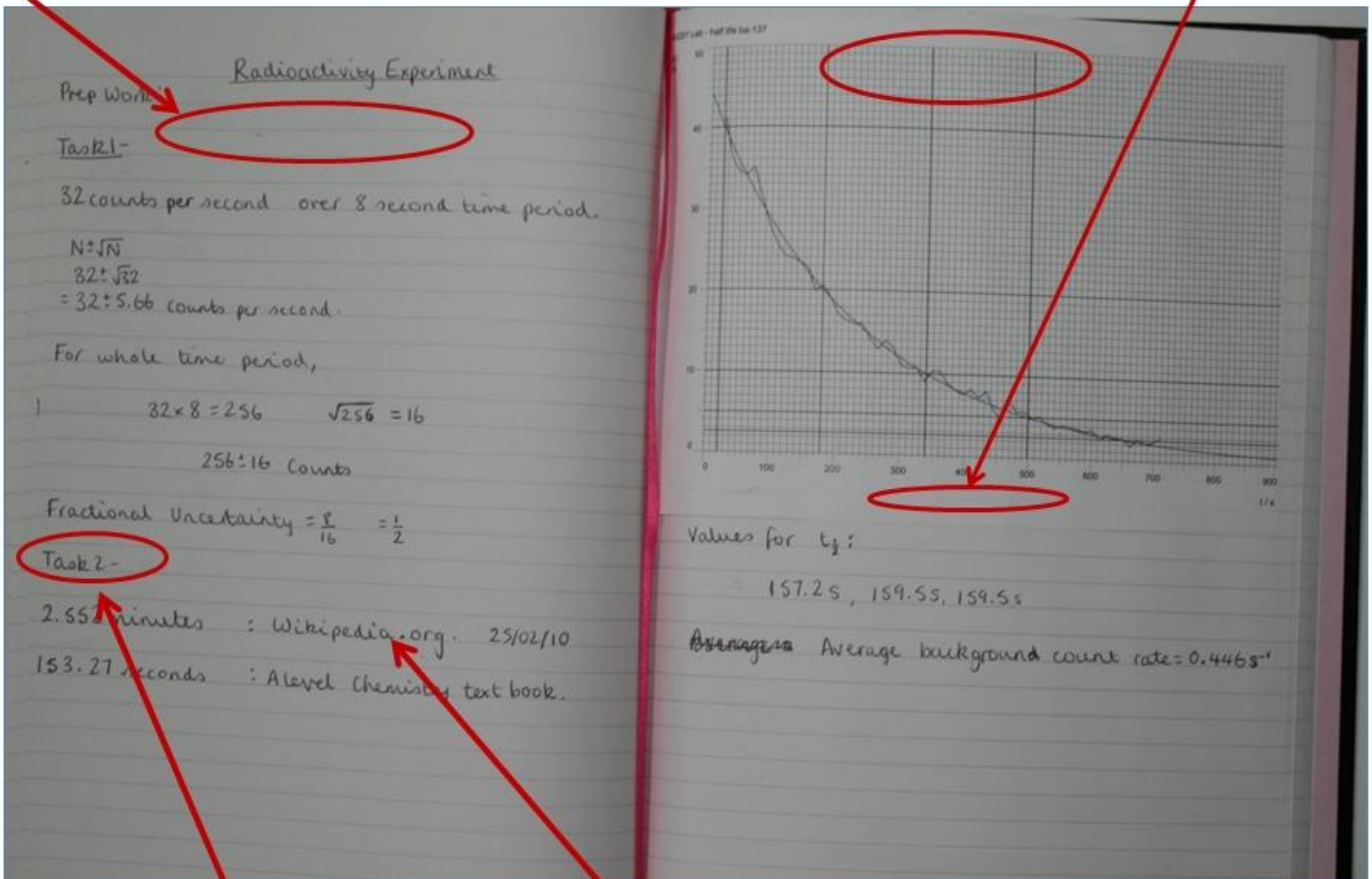


http://www.physics.rutgers.edu/~podzorov/groupmatters/labbook7.jpg

Lab Notes – bad example

No plan, date or lab partner

No title or labels



What on earth is task 2?

What is this reference about?

Lab notes - grading

Your TA will grade your lab book. The lab book for each experiment will count for a maximum of 3 points towards the final mark. The marking scheme is as follows:

	Max score
Description and diagram of experimental apparatus	1
Experimental observations (quantitative; all data included)	1
Experimental observations (qualitative; Non-numerical observations included)	1
Derivation, calculations, etc. included (no need to reproduce textbook/manual)	1
Neatness and organization	1
Notebook subtotal	**5**

The percentages of the max score will be evaluated by the TA using the following criteria

Criterion	Grade	Entries, experimental description and results
Very poor	<0%	Incomplete, incomprehensible, sloppy, disorganized, missing documentation
Poor	40%	Minimal or incomplete
Satisfactory	60%	Partially complete
Good	80%	Almost but not quite complete
Excellent	100%	Complete & organized

Research articles

Reading

Preparing for Research
Finding the *Why* and *What*

-You have to find information about what is already known. It is common that you have to read a lot of material from different sources. What are these sources?

Coherence

- Textbooks
- Monographs (books dedicated to a specific scientific problem)
- Review papers
- Articles in scientific journals and arXiv (www.arXiv.org)
- Theses
- Lab notes

Expertise

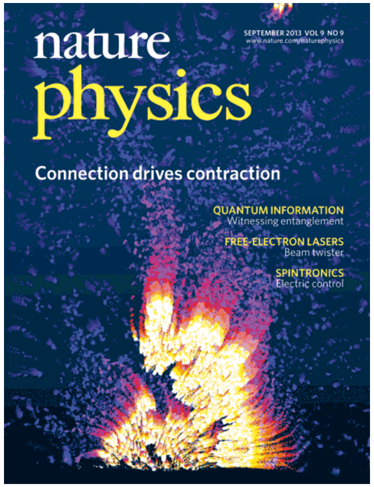
- Not all sources are equally trustworthy!
- Notation and definitions can be different, the same symbol does not necessarily describe the same thing

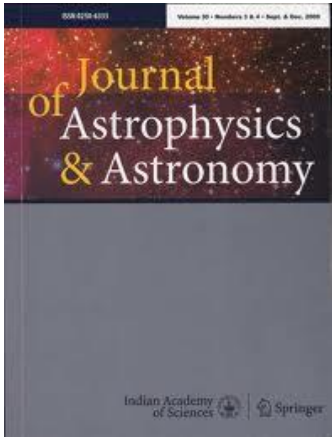
Reading scientific articles

Doing research involves reading articles published in scientific journals.

Which ones do you know?

Nature, Science, Nature Physics, Physical Review A-E, Physical Review Letters, Reviews of Modern Physics, New Journal of Physics, Optics Express, The Journal of Astrophysics and Astronomy…





Different journals target different audiences, and have different quality (impact, prestige)

Types of papers

- Letter
  - Short (3-5 pages)
  - Briefly describes a high-impact result
  - Aimed at a broader audience
  - Must be appealing
    - Wow! I did not expect that!
    - Wow! That is clever (and useful)!
  - Nature, Science, Phys. Rev. Lett., Optics Letters, Physics Letters…
- Long paper
  - Aimed at specialists who want to understand the details of a colleague's work
  - Studies a subject in detail
  - Phys. Rev., J. Phys, J. Opt…
- Review paper
  - Reviews a research field
  - Written by specialists who made significant contributions to the field
  - Very difficult to write, but prestigious
  - Rev. Mod. Phys., Nature, Science...

Impact factor

Often, the quality of a journal is judged through its impact factor: For a given year, the impact factor of a journal is the average number of citations received per paper published in that journal during the two preceding years. For example, if a journal has an impact factor of 3 in 2012**, then its papers published in 2010 and 2011 received 3 citations each on average.**

Reviews of Modern Physics: 45
Nature 38
Nature Physics 19
Phys. Rev. Lett 8
New Journal of Physics: 4
The Journal of Astrophysics and Astronomy: 0.3

Conclusion: Rev. Mod. Phys. is the best and the Journal of Astrophysics and Astronomy is not. Hmmm. Is this right?

Impact factor

Comparing impact factors easily leads to wrong conclusions:

- Review articles (or journals specialized in those) always receive more citations
- Journals that pick popular topics (Nature) receive a lot of citations
- A fantastic article published in a highly specialized journal that caters to a small group of researchers (e.g. Astrophysics) will never receive as many citations as an article on a topic that many people research
- The same holds for journals that publish across all fields (Phys. Rev. Lett.)

-> be careful when you compare

Other quality factors are the rejection rate, or the general reputation

How to read an article

What do you look at first?

- Title, Authors and Abstract should give you a good idea if it is worth reading more
- Introduction and conclusion gives more details about the motivation
- Figures are often sufficient for a specialist to understand the paper
- The main body is mostly technical
- More and more journals now allow for appendices / supplementaries, which include additional details

How to read an article
Title and abstract

An abstract, or summary, is published together with a research article, giving the reader a "preview" of what's to come. Abstracts may also be published separately. They allow other scientists to quickly decide if they they want to read the article in depth.

Selected for a Viewpoint in *Physics*
PRL **115,** 040502 (2015) PHYSICAL REVIEW LETTERS week ending 24 JULY 2015

Experimental Satellite Quantum Communications

Giuseppe Vallone,[1] Davide Bacco,[1] Daniele Dequal,[1] Simone Gaiarin,[1] Vincenza Luceri,[2] Giuseppe Bianco,[3] and Paolo Villoresi[1,*]
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(Received 13 April 2015; revised manuscript received 26 May 2015; published 20 July 2015)

title, authors, bla, bla

Quantum communication (QC), namely, the faithful transmission of generic quantum states, is a key ingredient of quantum information science. Here we demonstrate QC with polarization encoding from space to ground by exploiting satellite corner cube retroreflectors as quantum transmitters in orbit and the Matera Laser Ranging Observatory of the Italian Space Agency in Matera, Italy, as a quantum receiver. The quantum bit error ratio (QBER) has been kept steadily low to a level suitable for several quantum information protocols, as the violation of Bell inequalities or quantum key distribution (QKD). Indeed, by taking data from different satellites, we demonstrate an average value of QBER = 4.6% for a total link duration of 85 s. The mean photon number per pulse μ_{sat} leaving the satellites was estimated to be of the order of one. In addition, we propose a fully operational satellite QKD system by exploiting our communication scheme with orbiting retroreflectors equipped with a modulator, a very compact payload. Our scheme paves the way toward the implementation of a QC worldwide network leveraging existing receivers.

Background sentence (welcome in some journals)

What is done, main achievement

Impact statement

nature

www.**nature**.com/**nature**/authors/gta/Letter_bold_para.doc

How to construct a *Nature* summary paragraph

Annotated example taken from *Nature* **435**, 114-118 (5 May 2005).

*One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.*

*Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.*

*One sentence clearly stating the **general problem** being addressed by this particular study.*

*One sentence summarising the main result (with the words "**here we show**" or their equivalent).*

*Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.*

*One or two sentences to put the results into a more **general context**.*

*Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline, may be included in the first paragraph if the editor considers that the accessibility of the paper is significantly enhanced by their inclusion. Under these circumstances, the length of the paragraph can be up to 300 words. (The above example is 190 words without the final section, and 250 words with it).*

During cell division, mitotic spindles are assembled by microtubule-based motor proteins[1,2]. The bipolar organization of spindles is essential for proper segregation of chromosomes, and requires plus-end-directed homotetrameric motor proteins of the widely conserved kinesin-5 (BimC) family[3]. Hypotheses for bipolar spindle formation include the 'push–pull mitotic muscle' model, in which kinesin-5 and opposing motor proteins act between overlapping microtubules[2,4,5]. However, the precise roles of kinesin-5 during this process are unknown. Here we show that the vertebrate kinesin-5 Eg5 drives the sliding of microtubules depending on their relative orientation. We found in controlled *in vitro* assays that Eg5 has the remarkable capability of simultaneously moving at ~20 nm s^{-1} towards the plus-ends of each of the two microtubules it crosslinks. For anti-parallel microtubules, this results in relative sliding at ~40 nm s^{-1}, comparable to spindle pole separation rates *in vivo*[6]. Furthermore, we found that Eg5 can tether microtubule plus-ends, suggesting an additional microtubule-binding mode for Eg5. Our results demonstrate how members of the kinesin-5 family are likely to function in mitosis, pushing apart interpolar microtubules as well as recruiting microtubules into bundles that are subsequently polarized by relative sliding. We anticipate our assay to be a starting point for more sophisticated *in vitro* models of mitotic spindles. For example, the individual and combined action of multiple mitotic motors could be tested, including minus-end-directed motors opposing Eg5 motility. Furthermore, Eg5 inhibition is a major target of anti-cancer drug development, and a well-defined and quantitative assay for motor function will be relevant for such developments.

How to read an article
Introduction

Introduction.—Quantum information protocols may require short links, as in the case of quantum computing, or very long ones, as for the realization of quantum key distribution (QKD) in which two parties generate a secret key for data encryption [1–6]. Such parties may be connected by optical cables [7–9], or by free-space optical links [10]. However, point-to-point fiber links are limited to a few hundred kilometers due to optical attenuation. Free-space links on ground are similarly limited, due to the curvature of the Earth and to atmospheric attenuation and turbulence. The development of quantum repeaters may extend such limits at the cost of introducing a remarkable complexity. On the other hand, free-space satellite links would allow the realization of a global quantum communication network as fostered in several continental information-and-communication-technology roadmaps [11,12]. Indeed, QKD [1–6], quantum teleportation [10], and entanglement swapping [13]—as well as the measurement of Bell inequalities in a relativistic scenario [14] and fundamental tests of quantum physics [15]—require quantum communication (QC) over long distances and, in particular, along satellite links. Moreover, these protocols can be further developed exploiting higher-dimensional Hilbert spaces [5,6].

Brief introduction to the broad subject

Review of other approaches

Advocating their approach

How to read an article
Figures

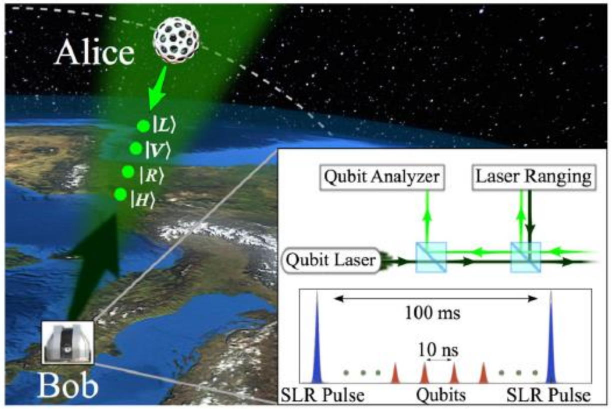

FIG. 1 (color online). Scheme of the satellite QKD demonstration. Qubit pulses are sent at a 100 MHz repetition rate and are reflected back to the single photon level from the satellite, thus mimicking a QKD source in space. Synchronization was performed by using the bright SLR pulses at a repetition rate of 10 Hz.

Fig. 1. Setup

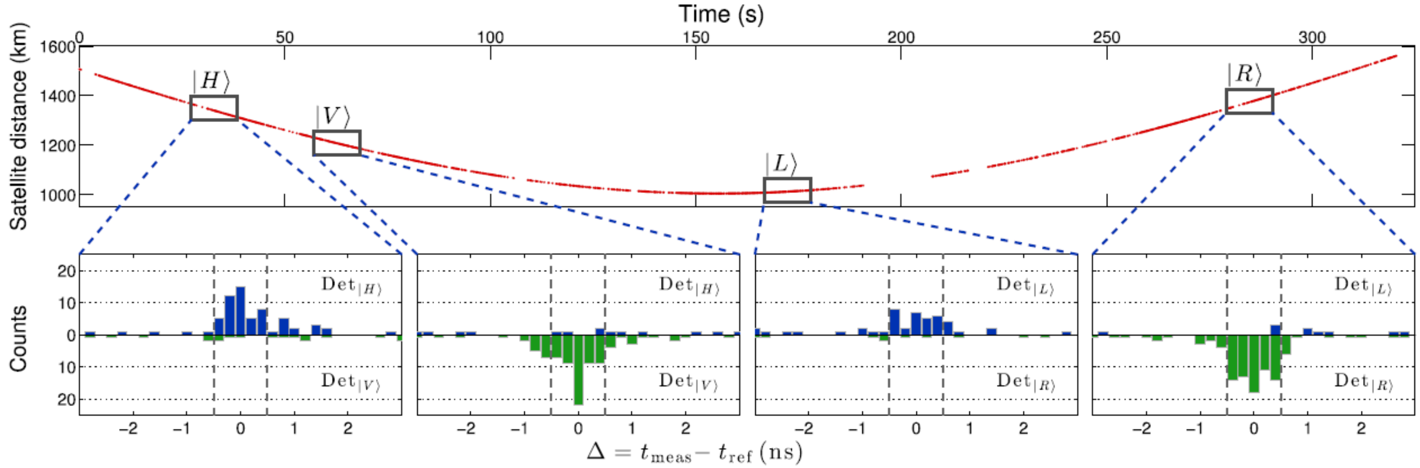

FIG. 2 (color online). Qubits return. (Top panel) Larets trajectory measured by the 10 Hz SLR pulses. The four selected 10 s intervals correspond to four different polarization input states. (Bottom panel) The four histograms report the obtained counts at the receiver for each single photon detector in a function of the measured detection time t_{meas}, demonstrating an average estimated QBER of $6.5\% \pm 1.7\%$. The signal on the two detectors is blue for H/L polarization and green for V/R. Vertical gray dashed lines represent the 1σ selection interval around the expected time of arrival t_{ref}. Lower counts in the $|L\rangle$ state are due to a lower duty cycle caused by the shorter distance of the satellite compared to the other three states.

Fig. 2. Results

How to read an article

Figures

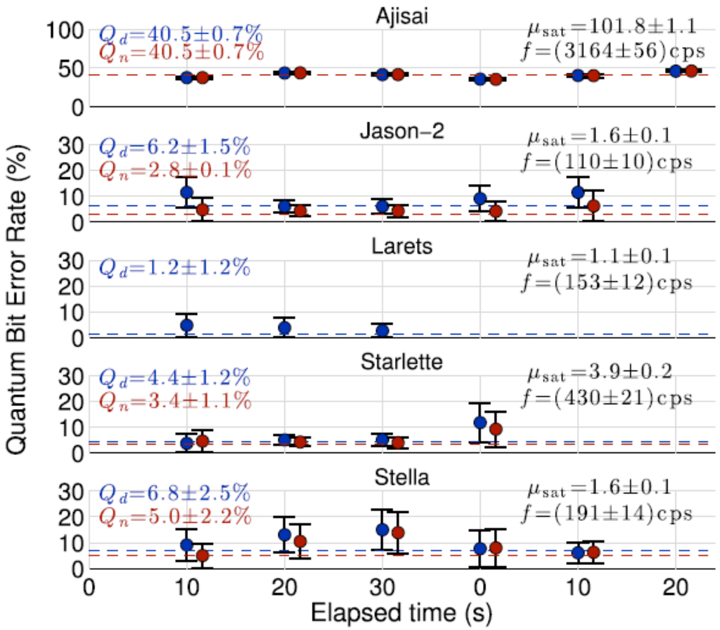

FIG. 3 (color online). QBER of the received signals. We fixed the sent polarization to $|V\rangle$ and measured in two orthogonal polarizations, $|H\rangle$ and $|V\rangle$. For each satellite we show the bare QBER (blue dots) and the QBER calculated after the background subtraction (red dots). Error bars represent Poissonian errors. Dashed lines represent Q_d and Q_n, the bare and background subtracted QBER for the whole satellite acquisition. For Larets we observed no detection in the wrong state, and we did not estimate the QBER with background subtraction. The coating of Ajisai retroreflectors depolarizes the qubits, while the other satellites preserve the photon polarization. We also indicate the mean detection rate and the average photon number per pulse at the satellite.

Fig. 3 and 4.
More results

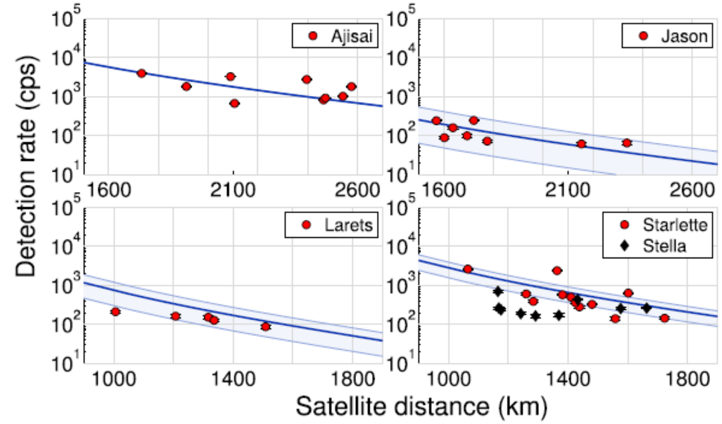

FIG. 4 (color online). Detection rates and link budgets. Points represent the return detection rates of the qubits for different satellites along the orbit, compared with the prediction of the link budget provided by Eq. (1) (the continuous line). Error bars account for Poissonian errors only, while the shaded area comes from the available uncertainties of the satellite cross sections Σ. Uncertainties in the orbital parameters and beam pointing affect the trend of the return rate beyond the shot noise. The twin satellites Stella and Starlette show different behavior despite similar characteristics, but in line with the SLR statistics that could be explained by a wearing of the Stella CCR coating.

- 3-5 figures for a letter paper
- Font size: slightly smaller than text, same as caption
- Captions: informative! Made so that a specialist need not reed the paper itself

arXiv

- Typically, submit to arXiv.org when submitting to a journal
- Virtually no review
- Makes your result known right away
- Establishes a priority

Cornell University Library

We gratefully acknowledge support from the Simons Foundation and member institutions

arXiv.org > quant-ph > arXiv:1410.3466

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All papers Go!

Quantum Physics

Nearly-linear light cones in long-range interacting quantum systems

Michael Foss-Feig, Zhe-Xuan Gong, Charles W. Clark, Alexey V. Gorshkov

(Submitted on 13 Oct 2014)

In non-relativistic quantum theories with short-range Hamiltonians, a velocity v can be chosen such that the influence of any local perturbation is approximately confined to within a distance r until a time $t \sim r/v$, thereby defining a linear light cone and giving rise to an emergent notion of locality. In systems with power-law ($1/r^{\alpha}$) interactions, when α exceeds the dimension D, an analogous bound confines influences to within a distance r only until a time $t \sim (\alpha/v)\log r$, suggesting that the velocity, as calculated from the slope of the light cone, may grow exponentially in time. We rule out this possibility; light cones of power-law interacting systems are algebraic for $\alpha > 2D$, becoming linear as $\alpha \to \infty$. Our results impose strong new constraints on the growth of correlations and the production of entangled states in a variety of rapidly emerging, long-range interacting atomic, molecular, and optical systems.

Comments: 5 pages, 3 figures, and Supplemental Material
Subjects: **Quantum Physics (quant-ph)**; Quantum Gases (cond-mat.quant-gas); Atomic Physics (physics.atom-ph)
Journal reference: Phys. Rev. Lett. 114, 157201 (2015)
DOI: 10.1103/PhysRevLett.114.157201
Cite as: **arXiv:1410.3466 [quant-ph]**
(or **arXiv:1410.3466v1 [quant-ph]** for this version)

Published later in a journal

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Research articles

Peer review

Peer reviewed journals – What, Why & How?

- Editors of peer reviewed journals send submitted manuscripts to scientists working in related fields for feedback. These ‘peers’ generally publish in journals of similar quality
- Peer review attempts to ensure that published papers are correct and suitable for the particular journal
- Most reviews are single blind (the authors don’t know the referees). Other procedures exist as well (e.g. double blind review) or are being discussed (community based review)
- Depending on the quality of the journal, 1-3 referees are consulted in the first round (there are sometimes more rounds with additional referees)

Peer review process

Code: ………
Title: ………
Authors: ………

Received 06 Februrary 2002

Dear Dr. Lvovsky:

We would appreciate your review of this manuscript, which has been submitted to Physical Review A. This message is the COMPLETE REFERRAL. No hardcopy will be sent unless requested.

Comments from the editor specific to this manuscript:

We enclose your previous report and the response from the author(s). We would appreciate your opinion.

We ask that you download the manuscript in PDF (217K bytes) or PostScript format from:

Please look at the following memo(s) as you prepare your report:
http://forms.aps.org/referee/rvwstndrds-pra.asc

Thank you for your help.

Sincerely yours,

Margaret Malloy
Associate Editor

____
ABSTRACT:

………
____
____

Title, author and abstract are included to allow the potential referee to rapidly find out if he is suitable to review the manuscript.

Reviewer's form

I. Based on the above, please judge the manuscript regarding its:

1) Impact on the specific field:

very low ( ) ( ) ( ) ( ) ( ) very high

2) Impact on physics research:

very narrow ( ) ( ) ( ) ( ) ( ) very broad

3) Degree of innovation:

very low ( ) ( ) ( ) ( ) ( ) very high

4) Validity:

not valid ( ) ( ) ( ) ( ) ( ) valid

5) Readability for a nonspecialist:

not accessible ( ) ( ) ( ) ( ) ( ) very accessible

II. Your detailed report:

begin_report (use as much space as is needed):

end_report

Additional remarks to the editors only:

****

Would you be willing to review the paper again? ( )yes ( )no

Could you suggest alternative referees?

III. Brief Recommendation:

a) Publish in PRL as written or after minor revision. ....( )
b) Reconsider for PRL following revision. ....( )
c) Perhaps reconsider for PRL after extensive revision. ....( )
d) Do not reconsider for PRL. ....( )

e) Publish in Physical Review with little or no revision. ....( )
f) Submit to Physical Review after substantial revision. ....( )
g) Submit to another journal. ....( )
h) Do not publish in any journal. ....( )

IV. Additional recommendations for Physical Review:

Inclusion of detailed advice in your report is helpful to the editors of the Physical Review and to the authors. Please do not use a recommendation to publish in the Physical Review to soften a rejection from PRL. If the Physical Review is a suitable venue, which journal is best?

PRA( ) PRB( ) PRC( ) PRD( ) PRE( )

Which article type?

Rapid Communication( ) Regular Article( ) Brief Report( )

Negative report: example

Re: LR11379
Complete characterization of squeezed vacuum propagation under electromagnetically induced transparency
by Eden Figueroa, Mirko Lobino, Dmitry Korystov, et al.

Dr. Alexander I. Lvovsky
Dept. of Physics + Astronomy
University of Calgary
Calgary, Alberta T2N 1N4
CANADA

Dear Dr. Lvovsky,

The above manuscript has been reviewed by our referees.

A critique drawn from the reports is enclosed. On this basis, we judge that the paper is not appropriate for Physical Review Letters, but might be suitable for publication in another journal, possibly with some revision. Therefore, we recommend that you submit your manuscript elsewhere.

Yours sincerely,

Brant M. Johnson
Associate Editor

Report of Referee A -- LR11379/Figueroa

This manuscript presents an experimental and theoretical investigation to characterize the propagation of a squeezed vacuum state through a Rb vapor under the conditions of electromagnetically induced transparency. The authors emphasize that theirs is a through exploration, in contrast to previous work which did not include a comparison of theoretical model with experimental data.

Brief summary of paper

This is a very interesting experimental paper, but I cannot recommend publication in PRL - the paper represents an incremental advance over the published work from these authors and other workers in the field; there is no quantitative measurement of the agreement between theory and experiment. This paper would be better placed in a more specialist journal.

Opinion and argumentation

Suggestions for changes:

Figure 1. The x-axis of part (a) should be detuning, not frequency.

Figure 1, part (c) and figure 4. No error bars are provided. As one of the main selling points of this work is the "high precision" with which the simple theoretical model explains the experimental spectra, it is vital for the reader to have an estimate of the statistical noise. No comparison of theory and data is complete without a meaningful discussion of the uncertainty in measurement.

Suggested changes (optional for a negative report)

Positive report: example

Re: LZ11646
Memory for light as a quantum process
by M. Lobino, C. Kupchak, E. Figueroa, A.I. Lvovsky

Dear Dr. Lobino,

The above manuscript has been reviewed by one of our referees. We ask you to consider the enclosed comments from the report.

While we cannot make a definite commitment, the probable course of action if you choose to resubmit is indicated below.

( ) Acceptance, if the editors can judge that all or most of the
criticism has been met.

(X) Return to the previous referee(s) for review if available.

(X) Submittal to new referee(s) for review.

With any resubmittal, please include a summary of changes made

and a brief response to all recommendations and criticisms.

Yours sincerely,

Report of Referee A -- LZ11646/Lobino

"Memory for Light as a Quantum Process" demonstrates a high-quality characterization of an EIT quantum memory using weak classical pulses to characterize the multi-mode nature of the losses in the quantum memory. The authors demonstrate the storage and retrieval of a weak classical pulse with homodyne detection.
Despite rather low classical storage efficiency (Fig 2c and also visible in the Wigner amplitudes) the authors find quite high quantum fidelities. This rather explicit demonstration of quantum storage and the characterization of both the classical properties and the full quantum tomography make this result interesting and accessible to a broad community. Therefore, I believe this manuscript should be published in Physical Review Letters.

Before this manuscript is published, I have a few questions and issues which I would ask the authors to address. First, I found the description of the Chi matrix not terribly clear. While I can guess at a physical explanation of what th Chi matrix is - at least in the photon number basis - it would be worth providing both a little more intuition as to what figure 3 means and also more explicit conclusions drawn from the results represented in that figure.

……………………………

In summary, I think that this is solid result, worthy of publication in Physical Review Letters that as a reader, I would like to understand a little better. I appreciate the authors' work in presenting as many steps in the experimental results as they have.

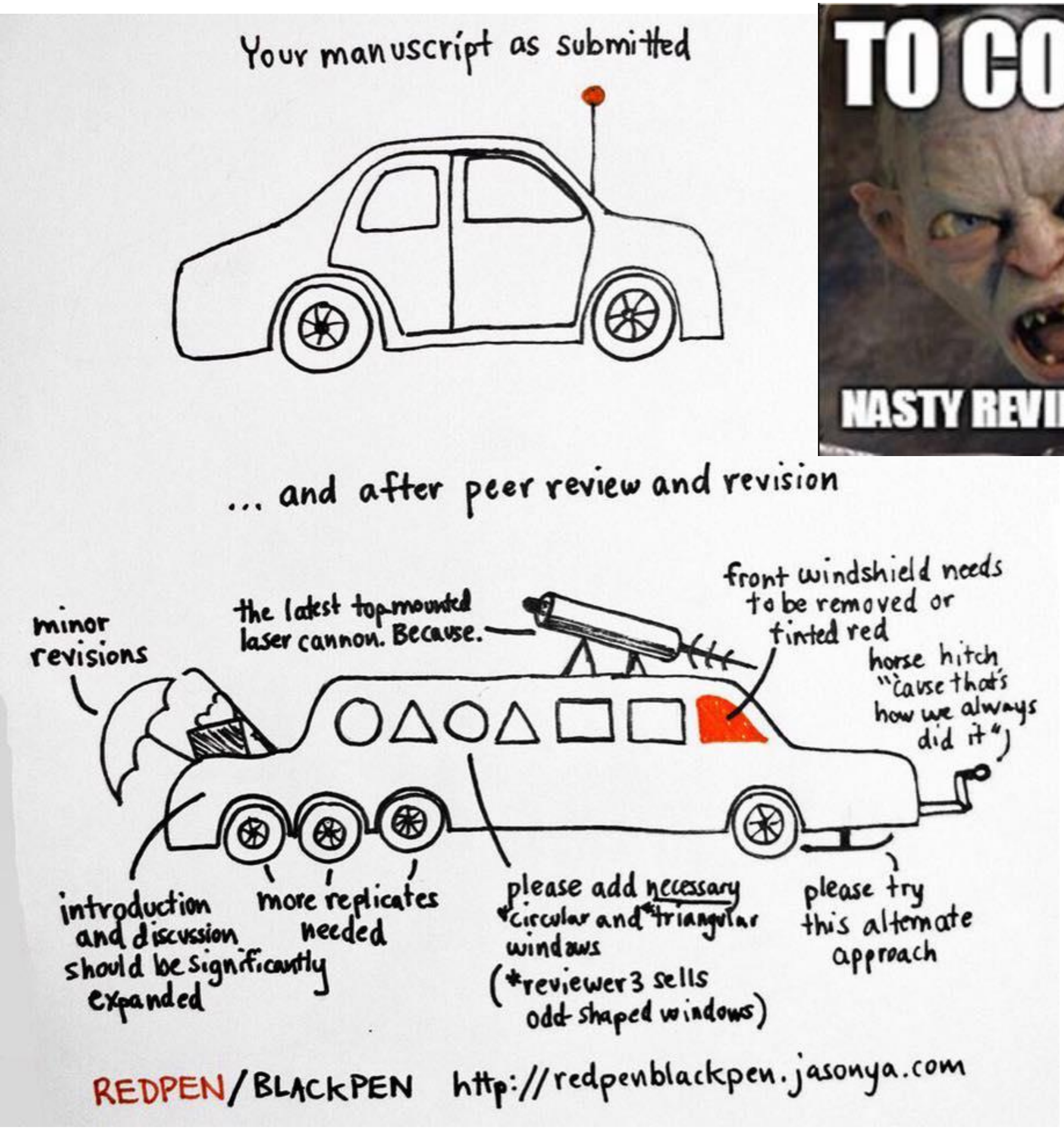
Brief summary of paper

Opinion and argumentation

Suggested changes

Summary of report

Replying to reviewers



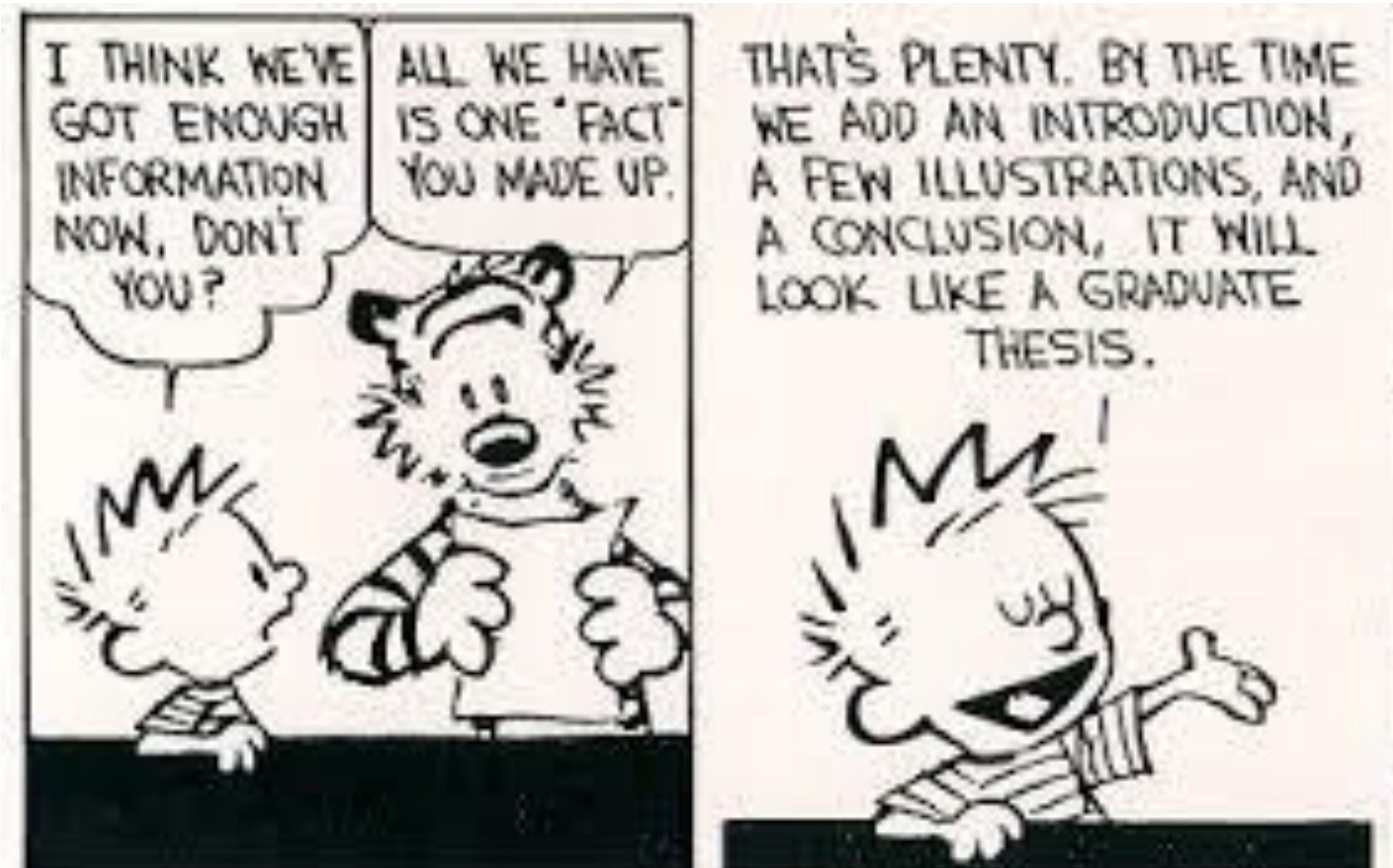
- Referees are typically PhD students and postdocs, not senior scientists.
- Their comments are not always intelligent and competent
- It is wise to comply with their demands if that helps to get your paper published

Courtesy of Redpenblackpen.

Research articles and lab reports

Writing

What to include?



What to include?

- **Title.** Make your title specific enough to describe the contents of the paper, but not so technical that only specialists will understand. The title should be appropriate for the intended audience.
- **Authors** (you) and **affiliations** (U of C). Follow the template.
- **Abstract**: Your abstract should be one paragraph (100-250) words, which summarizes the content of the paper. It must be self-sufficient, i.e. understandable without reading the article itself. Abstracts (except for Nature suite journals) don't include abbreviations or citations.
- **Introduction** (Motivation from proposal?): What is the general topic of your investigation? Why is it interesting? What does it build on (include the relevant literature). What did you show? One to four paragraphs should be enough.
- **Concept:** Explain the main idea of the work in a language that you yourself would have understood if you were not working on this experiment. Include a figure if necessary.
- **Theory (if necessary)**: Briefly describe the underpinning theory. Explain the meaning of formulas in words. Equations to which you want to refer to later need equation numbers. Make sure all symbols are defined.

---

[1] This section includes ideas from "WRITING A SCIENTIFIC RESEARCH ARTICLE", www.columbia.edu/cu/biology/ug/research/paper.html

What to include?

- **Experiment:** Describe the setup and the procedure used to take data. Include a figure depicting the setup. If the figure is copied from another source (discouraged!), cite the source.
- **Results and discussion**: Use graphs and tables if appropriate, but also summarize your main findings in the text. You don't have to include all the data you've acquired. Highlight the most significant results. How do these results relate to the original question? Do the data support your hypothesis? If your results were unexpected, try to explain why. Is there another way to interpret your results? What further research would be necessary to answer the questions raised by your results? How could you improve the results?
- **Conclusion**: End with a short paragraph that summarizes your conclusion, emphasizing why it is relevant.
- **Acknowledgements**: Acknowledge people and funding agencies that were part, or necessary for, your investigation
- **References**
- **Supplementary information:** often included with letter paper. A separate file, to be read only by experts. Includes theoretical calculations, detailed description of the setup, less significant data, etc. Not relevant to lab reports.

Figures: the setup

There are typically two figures in the report: setup and results.

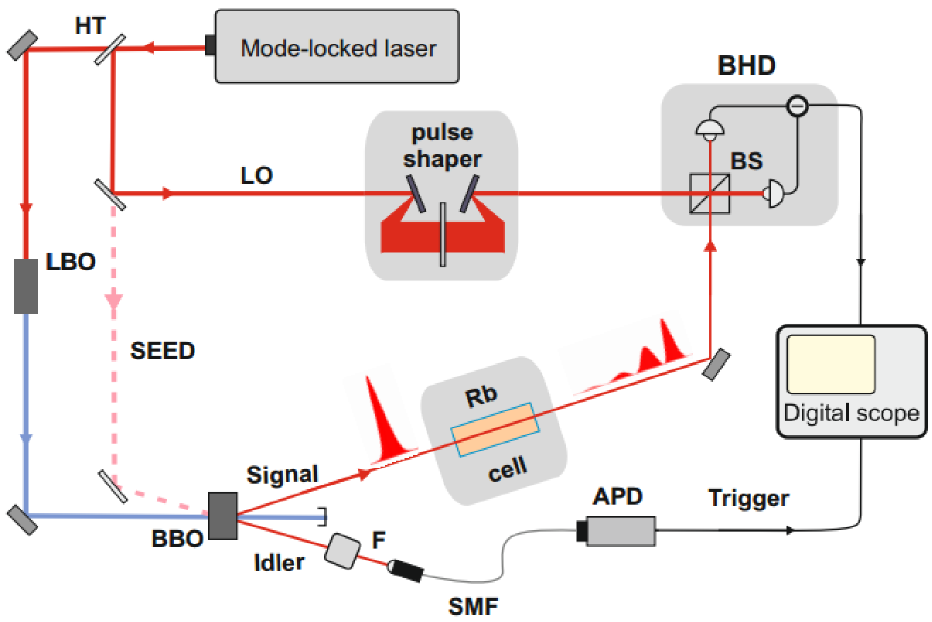


FIG. 1: (Color online) Experimental setup. Heralded single-photon pulses interact with a resonant Rb vapor and are analyzed by a balanced homodyne detector (BHD). A seed coherent pulse is used to provide reference classical pulses in the same spatiotemporal mode of the single photons. HT is a high-transmission beam-splitter, LBO is a lithium triborate crystal for second harmonic generation. All other symbols are defined in the text.

- Not only name parts of the apparatus, but also clarify the purpose of each part (either in the caption or the main text).
- Using a photo is not advisable.
- All elements of the picture must be identifiable and the reader must be able to understand what they are for.
- A professional figure + caption will allow an expert reader to skip the main text (not required in lab reports).
- All symbols must be no less than 1.5 mm (1 mm for sub/superscripts)

From: L. S. Costanzo et al., arXiv:1506.00523

Figures: the results

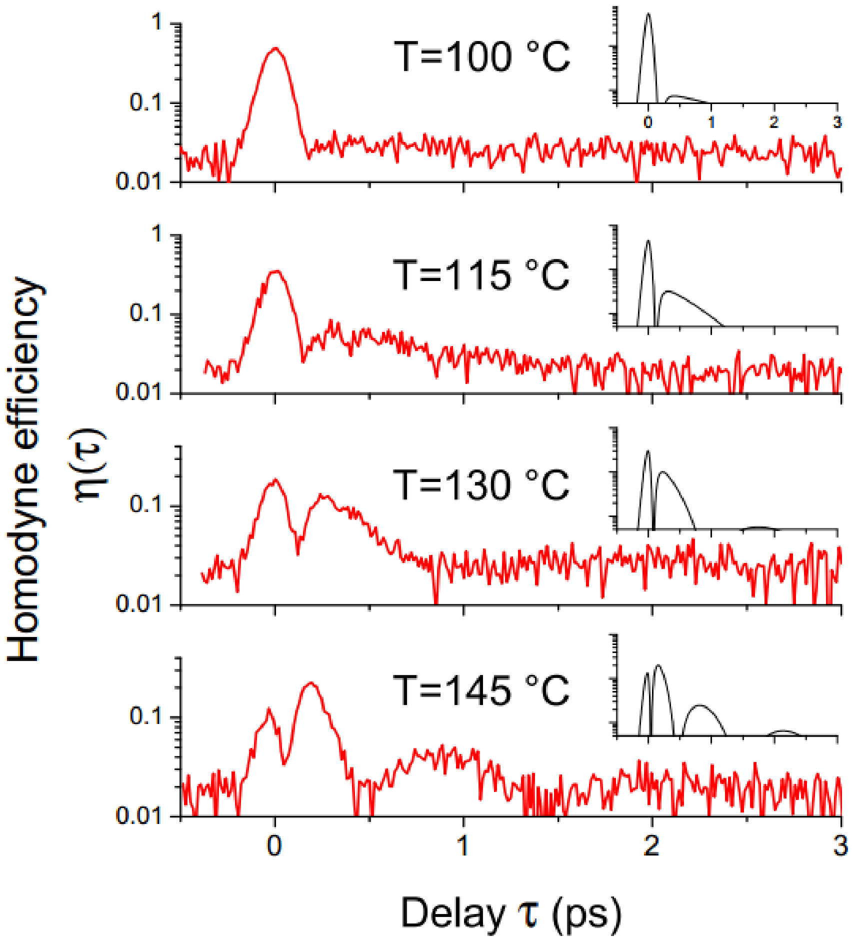


FIG. 3: (Color online) Measured homodyne efficiency curves (in logarithmic scale) as a function of the delay between the un-modulated LO pulses and heralded single photons that interacted with the Rb atoms in the cell. The temporal mode of the single photons is heavily distorted at sufficiently high cell temperatures. Theoretical intensity curves calculated with the same parameters of Fig. 2 are shown in the insets.

- The results figure may contain more than a single panel.
- To make a complex figure, first create individual plots using mathematical software, export them as EPS files, and then combine them into a vector graphics drawing tool such as CorelDraw, Adobe Illustrator or Inkscape (open source).
- The main plot should typically contain both a theoretical curve and experimental points.
- The theoretical curve must be clearly associated with an equation.
- All axes must be clearly labeled
- Units must be included whenever relevant

Equations and numbers

- Always use italic front ($$ in LaTeX, MathType/Equation Editor in MS Word) for *all* mathematical expressions
  - **Wrong:** v=L/t **Correct:** $v = L/t$
  - **Wrong:** -1 **Correct:** -1 (-1)
- The number of significant figures must reflect your uncertainty (roughly)
  - **Wrong:** $g = 9.81123 \pm 0.1\ \mathrm{m/s^2}$ **Correct:** $g = 9.8 \pm 0.1\ \mathrm{m/s^2}$
- For units, use a Roman (not Italic) font. Leave a space in front.
  - **Wrong:** $g = 9.81m/s^2$ (\$g=9.81m/s^2\$) **Correct:** $g = 9.81\ \mathrm{m/s}^2$ (\$g=9.81\$ m/s\$^2\$)
- Use large brackets with fractions
  - **Wrong:** $(\frac{\partial^2}{\partial t^2} - c^2 \frac{\partial^2}{\partial x^2})E(x,t) = 0$ **Correct:** $\left(\frac{\partial^2}{\partial t^2} - c^2 \frac{\partial^2}{\partial x^2}\right)E(x,t) = 0$

    \$\left(… \$\right)\$

References and citations

Make sure you add references to support your claims about the state-of-the-art, e.g

In the main text:

It has been predicted [1] that in atomic rubidium (Rb), … The transition in Rb from the electronic ground state to the first excited electronic state …

In the list of reference at the end of the paper:

[1] F. Muller and A. Smith, On nuclear Zeeman levels, Physics **1**, 356 (1983).

Authors (use et al. if n>4) *Title (often omitted)* *Journal name* *Volume (bold)* *Pages* *Year*

- Journal names are normally abbreviated, e.g. Physical Review A → Phys. Rev. A. See list at e.g. https://images.webofknowledge.com/WOK46/help/WOS/A_abrvjt.html
- Some recently published papers often have no page numbers any more. In this case, list the **article number** (e.g. [2] R. MacDonald and F. Muller, More on nuclear Zeeman levels, Physica A **169**, 65488 (2011).
- Include references in order of appearance.
- If an article has more than four authors, you can abbreviate the list of authors using, e.g., M. Smith *et al*., A treaty on even more, Journal of Physics **4**, 56498 (2012).
- Different journals have different rules regarding footnotes. According to *Physical Review* rules, footnotes must be formatted as references.

Lab reports
Format requirements

- Each student must complete his/her own report, while sharing data with a partner
- Use US letter size, 1 inch margins all around, two columns, 10 pt fonts, single spaced (template on the course web page).
- Follow the *Physical Review Style and Notation Guide* on the course web site
- The maximum length is two pages. A page full of text contains ~1000 words

Lab report requirements
Coherence and consistency

Set a certain goal/message/thesis you wish to convey by your paper. Pursue it throughout the paper.

- There can be several messages, but they have to relate to each other.
- The message is more important than the amount of material you present.
- The goal/message must involve quantitative physics. For example, you measure a quantity (that is of importance beyond the specific lab setup) or verify a certain physical law.

All parts of the paper must be relevant to that goal/message

o The abstract must state that goal, briefly describe the method and state the result.

o The introduction/motivation must describe why the goal is important and the concept of how you will achieve it.

o The theory section must be relevant to the goal – rather than a random set of equations related to the subject of the lab.

o The description of the experiment should make it clear why this apparatus is necessary to achieve your goal.

o The discussion of results must provide arguments in favor of your message

etc...

Lab report requirements
Readability

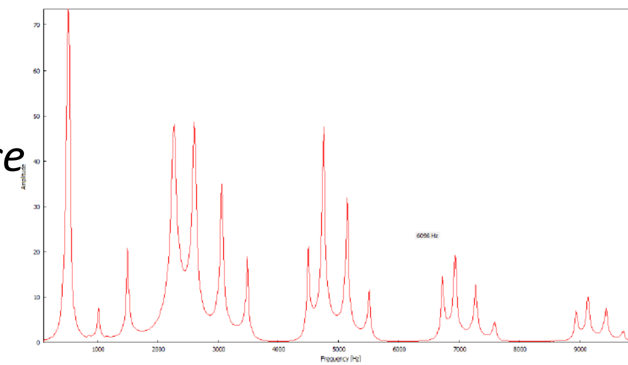
Make sure your reader understands you

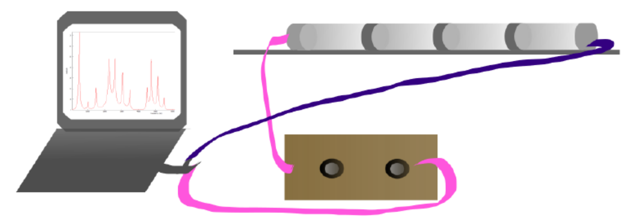
- Know the level of the audience you are addressing your paper to.
  PHYS 597 audience: your peers (not instructor!)
- Write your report in such a way that your reader is able to understand it without additional reading. This means, in particular:
  - defining all abbreviations;
  - making sure all terminology is defined;
  - clarifying all figure elements.
- If your reader stops understanding you, you will lose them.
- Good tip: while writing, imagine yourself four weeks ago as the reader.
- Another good tip: first ask questions, then answer them
  - Bad example: *I measured the acceleration of the apples falling from the tree.*
  - Good example: *In order to verify that the free fall acceleration is independent of the object's mass, I measured the acceleration of the apples falling from the tree.*

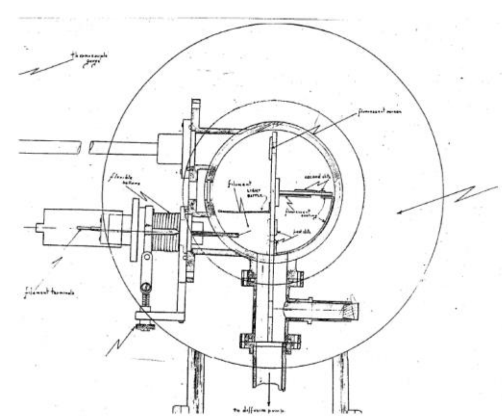
Do not be afraid to underestimate the intelligence of your audience.

Lab report requirements
Typical errors

- **Loose language**
  e.g. *We measure the electrons emitted by the sample*
  or *we multiply the signal by the frequency of the reference*
- **Scope too broad**
  Trying to cover the entire lab manual
- **Equations not fitting to the logic of the paper**
- **Figures not properly formatted**
- **Including textbook material**
- **Inappropriate details**
  e.g. The program labeled "HLMCOIL3.exe" was found in the students folder labeled "02Electron".







Lab reports: additional grading criteria

	Very Poor (F)	Poor (D)	Satisfactory (C)	Good (B)	Excellent (A)
	< 40 %	40 %	60 %	80 %	100 %
Title and Abstract					
Concise and precise description of investigation					
Conveys significance of paper and results					
Introduction and context					
Successfully establishes the context of the investigation					
Effectively conveys the goals and significance of the the study					
Theory and experiment					
Identifies and describes all key equations/equipment					
Clearly and concisely describes what has been done					
Provides sufficient detail to allow repeating the experiment					
Sufficient quality and quantity of data					

Lab reports: additional grading criteria

	Very Poor (F)	Poor (D)	Satisfactory (C)	Good (B)	Excellent (A)
	< 40 %	40 %	60 %	80 %	100 %
Discussion and conclusion					
Effectively compares results to hypotheses					
Provides reasoned and logical explanation for the comparison					
Summary provides closure and future perspectives (when applicable)					
Presentation					
The relevant data are properly processed and presented in an organized, compact, logical format					
Appropriate use of graphs and tables					
Report has appropriate length					
Report is written in scientific style					
Writing is logical					
All numbers with units and correct use of significant figures					
Uncertainty analysis appropriate and correct (when applicable)					
Report is free of grammatical and spelling mistakes					
Graphs are properly labeled; captions for figures and graphs are provided					
Relevant references have been included					
Appeal of the result conveyed					

Your report will be graded by the course instructor

How to proceed (suggestion)

- Start by writing section titles
- Write equations
- Sketch figures
- Only once you have a good idea how to create a coherent document, start writing sections. Do not “cut and paste” from the lab description!
- Stay brief (~1500 words will turn out to be short!)
- After every paragraph you wrote, ask yourself if it really conveys the desired message. Often, you will have mentioned so many details that the line of thought is obscured and reader confused
- Edit what you have written!

"In my writing, I average about ten pages a day. Unfortunately, they're all the same page." Michael Alley, The Craft of Scientific Writing

And: Start Early!

Research articles

A few language tips

A few language tips

“Which” or “that”?

“That” is the right choice for restrictive clauses:

- *The house that Jack built* (only one house)
- *An approach that is based on perturbation theory offers several advantages* (only an approach based on perturbation theory is under consideration).

“Which” is the right choice for nonrestrictive clauses:

- *The umbra is surrounded by a penumbra, which is not as dark*
- *This approach, which is based on perturbation theory, has generated a good deal of controversy* (the nonrestrictive “which” clause simply gives additional information – the sentence would still make sense without it)

“Which” is usually preceded by a comma.

This section includes ideas from “WRITING A SCIENTIFIC RESEARCH ARTICLE”, www.columbia.edu/cu/biology/ug/research/paper.html
and “WRITING A BETTER SCIENTIFIC ARTICLE”, rmp.aps.org/files/rmpguapa.pdf

A few language tips

Where

"Where" refers to a place or a region. It should not be used for nonlocalized abstractions.

a case where	→	*a case in which* or *when*
a situation where	→	*a situation in which*
a form where	→	*a form in which*

Effect or affect?

Temperature has an *effect* on the reaction. Temperature *affects* the reaction.

Starting a sentence with "This."

- spare us from having to repeat cumbersome phrases
- provide a smooth link with what has gone before.
- can confuse the reader if the thing to which they refer – the antecedent – is not clear.

To banish any doubt, provide a reminder: "this approach," "this procedure," "this substitution," "these terms."

E.g. or i.e.?

e.g. Latin *exempli gratia*, meaning "for example".

i.e. Latin *id est*, meaning "that is"

A few language tips

Active or passive voice?

- Active sentences are more vigorous, put more muscle into your prose style
- The active voice encourages economy
- Compare:
    - *A review of the main problems in this field was given by Luo* et al.
    - *Science is done by people*

with

- *Luo* et al. *reviewed the main problems in this field.*
- *People do science*

- Sometimes passive voice is useful: puts emphasis on the thing being acted upon, by naming it at the beginning of a sentence: "This problem has been the subject of intensive study ever since 1934".
- Adds variety, can make text more elegant

Present or past tense?

Past tense:

- Makes the text more true to facts: "we measured", "the setup has been assembled" sound better than "we measure", "the setup is assembled".
- Difficult to keep consistency: "We collected the data that was/is in agreement with the theory".

Whatever you choose, stay consistent throughout the text.

Use short sentences!

Oral presentations

Oral presentation – the general context

- Several speakers per session, often on related topics
- Many people in the audience (you may have to use a microphone – generally portable)
- The session chair directs the session: he/she introduces the speaker and directs the question-and-answer period
- The chair will stand up when your time is up
- Generally, there are no questions during a talk (but there may be)

Oral presentation – general remarks

How much time do I have? (talk + questions/answers).

What previous knowledge can I expect?
- specialists or mixed public?
- have there been other speakers before me?

Do not be afraid to underestimate the intelligence of your audience

Oral presentation - structure

No surprise:
- Introduction (where am I from, who did I work with, motivation)*
- Outline
    - can also come before the motivation
    - not recommended for $\leq$ 20 minute talk
- Theoretical and experimental details, methodology
- Results
- Discussion of results
- Summary and outlook
- Acknowledgements

*See presentation by Krister Shalm/NIST at QCRYPT 2013
http://www.youtube.com/watch?v=Vt84rSJa7VI&list=PLBRgytHojT9ZyijSJeF6vdCxH5AIfzo61&index=22

UNIVERSITY OF CALGARY

Preparing your slides
Culture

- Avoid distractive background – use something sober and keep logos (e.g. your Institute, the UofC,…) to a minimum amount and small
- Type everything you say, but briefly. Audience tends to get distracted!
- Don't overcharge slides with words
- As few equations as possible. Can you understand an equation in 30 seconds?
- Avoid "busy" slides. No more than 1-2 plots per slide
- The time of extensive animations is gone. Do animate when clarity will benefit
- Count 1 minute per slide on average
- Use Times font of size 20 or Arial of size 18. Larger fonts for section titles. Smaller fonts for citations/emergencies only
- Typically, do not prepare figures in PowerPoint. Prepare them elsewhere, then paste into PowerPoint
- Make sure special symbols are displayed correctly. Insist on using your laptop whenever possible. Have a backup on a memory stick

UNIVERSITY OF CALGARY

Preparing your slides
Culture

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- Make sure special symbols are displayed correctly. Insist on using your own laptop whenever possible (but test before your session). Have a backup on a memory stick

Slide: example [A. Steinberg]

Bad title

Some density matrices...

Good general organization.

Not too busy. Message conveyed.

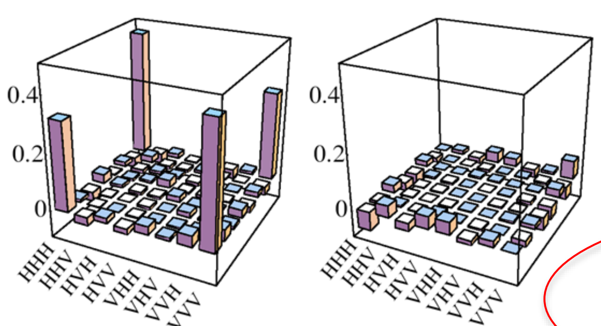
Much work on reconstruction of optical density matrices in the Kwiat group; theory advances due to Hradil & others, James & others, etc...; now a routine tool for characterizing new states, for testing gates or purification protocols, for testing *hypothetical* Bell Inequalities, etc...

Too much text

Misaligned

Polarisation state of 3 photons (GHZ state)

Resch, Walther, Zeilinger, PRL 94 (7) 070402 (05)



Spin state of Cs atoms (F=4), in two bases

Klose, Smith, Jessen, PRL 86 (21) 4721 (01)

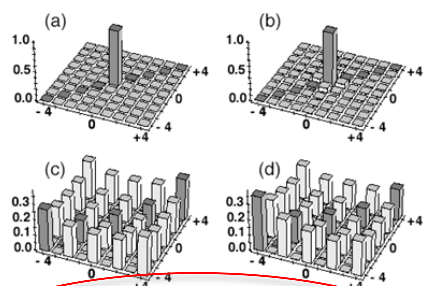


FIG. 4. (a) Input state $|m_y = 0\rangle$ prepared by optical pumping with linear $\hat{y}$-polarized light, and the reconstruction result (b) represented as density matrices in the $\{|m_y\rangle\}$ basis. The density matrices of input (c) and measured state (d) in the standard $\{|m_z\rangle\}$ basis. The fidelity is 0.96.

Caption invisible, irrelevant

How to structure a text

Original

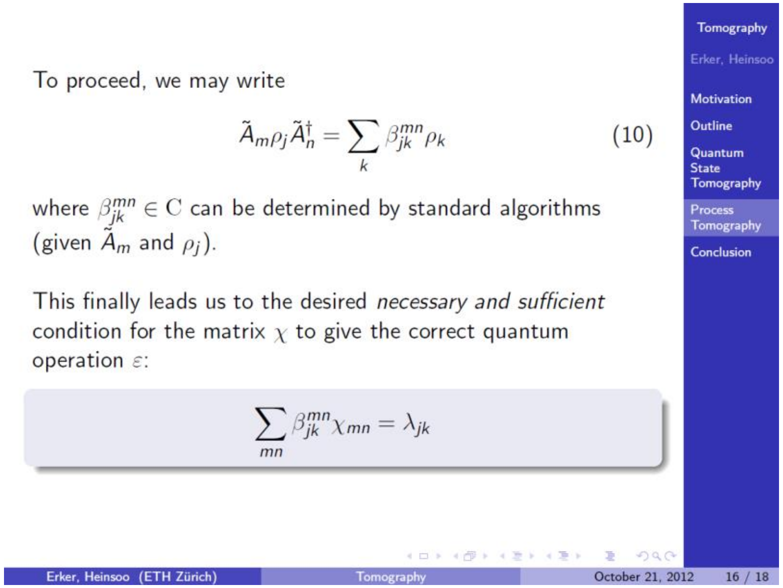
Much work on reconstruction of optical density matrices in the Kwiat group; theory advances due to Hradil & others, James & others, etc...; now a routine tool for characterizing new states, for testing gates or purification protocols, for testing *hypothetical* Bell Inequalities, etc...

Better formatting

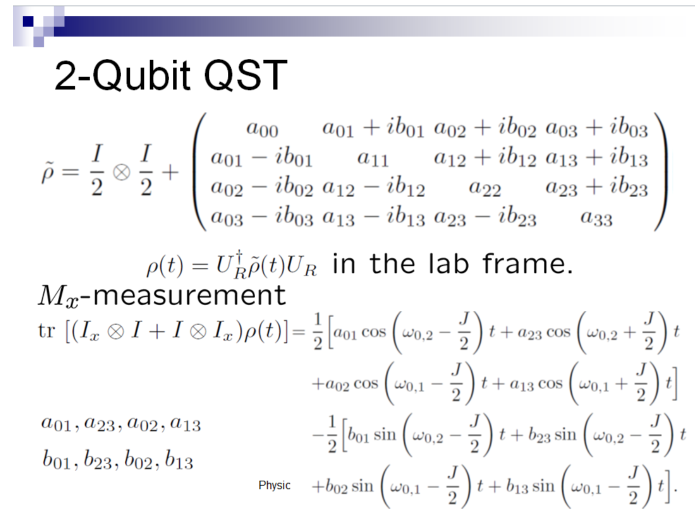
Reconstruction of optical density matrices

- Contributions
  - Kwiat group
  - theory advances due to Hradil, James & others
- Now a routine tool for
  - characterizing new states
  - testing gates or purification protocols
  - testing *hypothetical* Bell Inequalities
  - etc...

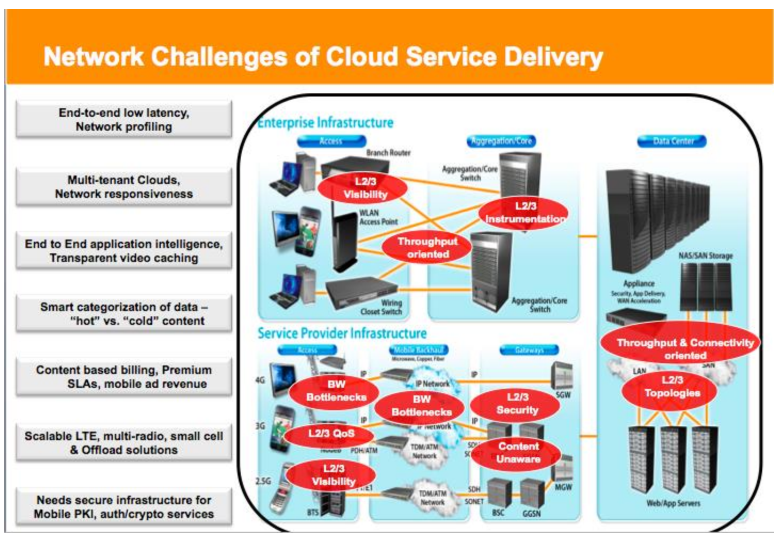
More not-so-good examples



Copy-paste from article



Too many equations. Poor formatting



Busy slide

Preparing your slides
Remarks on contents

- Always imagine yourself in the audience listening to your talk. Will you be able to comprehend this information during the time the slide is displayed?
- Title slide: your name, names of co-authors, institution
- No need for outline in a short talk
- Show the significance of your result and its place in the "big picture". It is more important to demonstrate that, than to convey technical details
- Last slide: conclusion and outlook
- Very last slide (optional): "Thank you", group photo, funding sources

Remarks on speaking

- Rehearse your talk by speaking aloud
- Start by thanking the chair for the introduction and the organizers for inviting/allowing you to speak at this wonderful conference
- Keep eye contact with the audience
  - You can see when people get bored
  - You can see when people misunderstood you. Some people nod.
  - Repeat/skip when necessary
- Emphasize the main message by pronouncing it several times and stressing with voice.
- Last sentence: “Thank you for listening”, never “Any questions?”
- Never speak longer than your full slot. Extending just into the question period is ok, but not to your benefit
- Do not be afraid to underestimate the intelligence of your audience

A few more remarks

- Don’t run around (too much)
- Don’t stand in front of the screen
- Use a laser pointer or a pencil. Do not point with your finger.
- Don’t blind anybody with your laser pointer
- Don’t pretend you know the answer to a question if you don’t. It is ok to say “I don’t know” or, if you have only a vague idea “Let’s discuss this offline”. You can even say “I’ll pass this question”.

How to address the APS

Karl K. Darrow

October 1961, page 20

Choose an article in *The Physical Review*; let it be in your own field if you will, lest the result of the experiment be too frightful. Sit down in an uncomfortable chair, and read the article—but read it according to the following prescriptions. Read straight through from beginning to end at the rate of 160 to 180 words per minute. Never stop to think over anything, not even for five seconds. Never turn back, not even to refresh your memory as to the meaning of a symbol or the form of an equation. Never look at an illustration until you get to the place where it is mentioned in the context; and when you get to that place, look at the illustration for ten or fifteen seconds and never look at it again. If this is not the way that your listeners will apprehend you when when you give a paper, you are an outstanding speaker.

Your presentation in this class

- The oral presentation counts towards your final mark
- It covers your first lab
- Done during lecture hours
- The total time is 12 minutes, followed by 3 minutes of questions and answers (subject to change)
- The marking is based on
  - satisfying the standard structure of a presentation
  - layout of slides
  - clarity of presentation
- Date: November 28; December 1, 6, 8 (?)

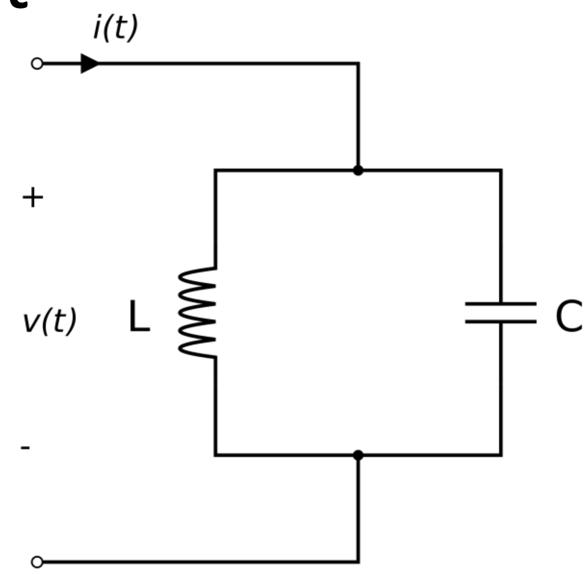
Oral interview

What to expect

Oral interview

- Goal: test your understanding of the material
- Format: discussion of two professionals. You will be asked to explain what you did to a non-expert.
- Additional questions: everything related to the experiment
- Administered after 1^{st} and 2^{nd} report have been submitted
- The interview will be conducted by your course instructor

Questions: example
L-C circuit experiment



- Give the definition of capacitance
- Write the expression for the capacitance of a capacitor
- Give the definition of inductance
- Write the expression for the inductance of a solenoid
- Write the expression for the eigen frequency of the LC circuit
- Give the definition of the quality factor
- Write the expression for the quality factor
- Draw a typical frequency spectrum and mark the salient parameters (e.g. width of the resonance).
- What is the shape of the resonance curve called?

Writing a strong fellowship/grant application

Grant applications

~~What should I write?~~

What are the questions I should answer to find out what to write?

1) What is the reason why somebody would give money?
2) Who reads the proposal?
3) What would convince this person to accept my proposal?

Grant applications

1) What is the reason why somebody would give money?

* Education of high-quality students for research teams working in selected, multi-disciplinary areas

2) Who reads the proposal?

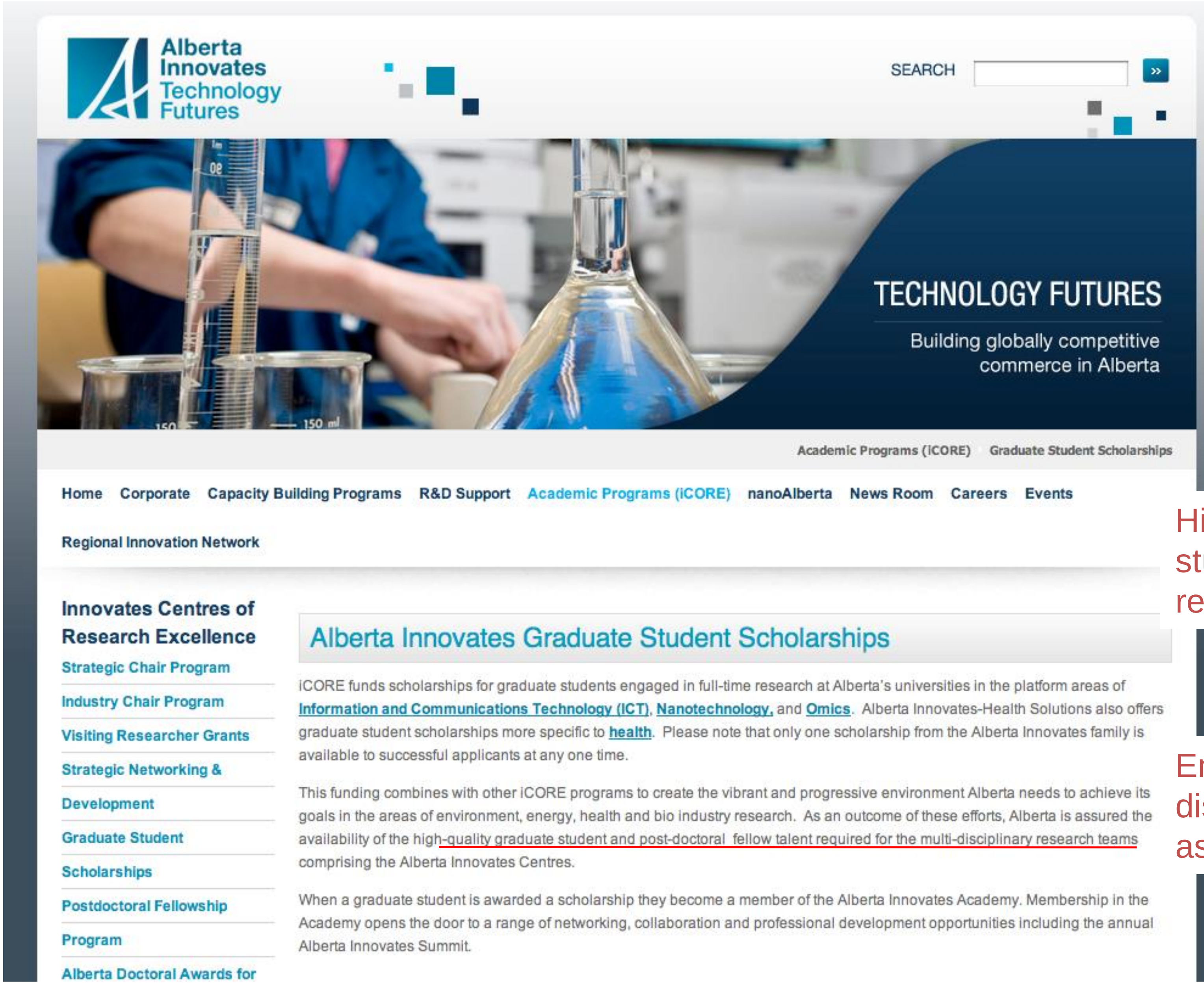
* People at the UofC – probably not all specialists in your field

3) What would convince this person to accept my proposal?

* the “job” is important in view of (1), it is done in the correct environment, and you are the right person to do it

You will be judged on the clarity of the proposal, academic history (grades, work in research labs, previous grants, papers,…), and reference letters *http://www.albertatechfutures.ca/gss.aspx*

Example 1: AITF



High-quality students for research teams

Emphasize multi-disciplinary aspects (if any)

GRADUATE STUDENT SCHOLARSHIPS
PROGRAM GUIDELINES AND HANDBOOK

The information below outlines the 2013 Graduate Student Scholarships program. This program is administered and adjudicated by the Alberta universities involved.

Please contact your Alberta university of choice for information regarding university-specific application processes and procedures. University contact information is located on page 10 of this document.

The information contained in this document pertains to recipients of the 2013 Graduate Student Scholarships. It is not applicable to students awarded funding in previous competitions from Alberta Innovates – Technology Futures and heritage organizations: Alberta Ingenuity and iCORE.

GENERAL CONDITIONS

This document describes the terms and conditions for recipients of an Alberta Innovates Graduate Student Scholarship.

The Alberta Innovates Graduate Student Scholarships are open to Canadian, Permanent Resident and International Students.

You are eligible!

SPONSORING SUPERVISOR

Each candidate must be sponsored by a faculty supervisor, possessing both a record of productive research within a research area described below and sufficient resources to ensure the satisfactory conduct of the research.

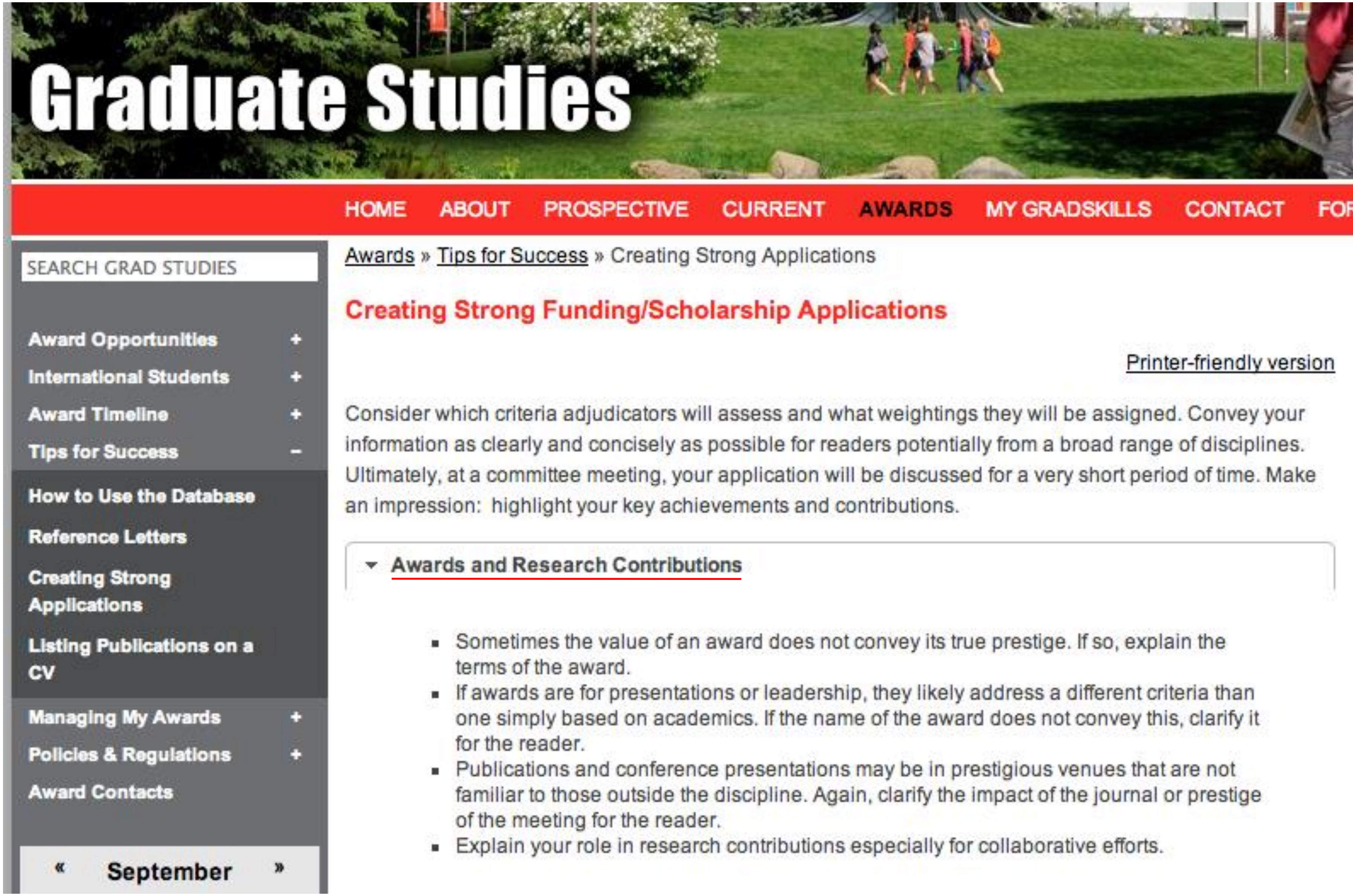
Emphasize correct environment (if possible)

REVIEW PROCEDURE AND SELECTION CRITERIA

Each Alberta university will review all applications and evaluate them based on excellence and strategic alignment in areas of scientific research important to Alberta. These areas are: Information and Communications Technology (ICT), Nanotechnology, and Omics; (Omics consists of: Genomics, Proteomics, Metabolomics, Transcriptomics and Regulomics.) in and of themselves or additionally which support the areas of Health, Bio-industries, Energy and Environment.

Right topic?

Example 2: UofC



Graduate Studies

HOME ABOUT PROSPECTIVE CURRENT AWARDS MY GRADSKILLS CONTACT FOR

SEARCH GRAD STUDIES

- Award Opportunities +
- International Students +
- Award Timeline +
- Tips for Success −
  - How to Use the Database
  - Reference Letters
  - Creating Strong Applications
  - Listing Publications on a CV
- Managing My Awards +
- Policies & Regulations +
- Award Contacts

« September »

Awards » Tips for Success » Creating Strong Applications

Creating Strong Funding/Scholarship Applications

Printer-friendly version

Consider which criteria adjudicators will assess and what weightings they will be assigned. Convey your information as clearly and concisely as possible for readers potentially from a broad range of disciplines. Ultimately, at a committee meeting, your application will be discussed for a very short period of time. Make an impression: highlight your key achievements and contributions.

Awards and Research Contributions

- Sometimes the value of an award does not convey its true prestige. If so, explain the terms of the award.
- If awards are for presentations or leadership, they likely address a different criteria than one simply based on academics. If the name of the award does not convey this, clarify it for the reader.
- Publications and conference presentations may be in prestigious venues that are not familiar to those outside the discipline. Again, clarify the impact of the journal or prestige of the meeting for the reader.
- Explain your role in research contributions especially for collaborative efforts.

http://grad.ucalgary.ca/awards/creating_strong_applications_cfp

Research Proposals

Be concise and precise

- **Capture the committee's imagination**
- Try the 30-second rule: can you explain to someone not in your field what your proposed research is about? If yes, proceed to the next step; if not, keep trying. Peers in unrelated fields are perfect audiences.
- Write clearly (be friendly and open) and avoid jargon. Remember that most grant assessment committees come from disciplines other than your own. Request non-academic readers to review your proposal to ensure it is clear. Aim for prose that can be understood by the non-specialist but, at the same time, show a familiarity with the specialist field.
- Become your own ambassador: believe in what you propose, and write enthusiastically (but not uncritically) about it.
- What is the key question or questions that the research will address? How will the question(s) be answered? Why is this the most appropriate way to explore the question? Justify the methodology.
- What's new and why it's important. Highlight any way that your research project promises a notable advancement or innovation in the discipline.
- Ensure the proposal is not too vague a project, conveying no specific plan.
- The project must also be achievable within the time-frame allowed. For example, don't propose to "examine the critical history of performances of Hamlet". Offer milestones if possible.
- The first paragraph is most important as this is what the committee will remember about the project.
- Engage the relevant scholarship. Prepare a bibliography, cite key names in field.
- Convey your research goals without resorting to disparaging others. For example, "except for me, everybody else has shown themselves incapable of approaching this topic, particularly Scholars X and Y".

Use simple terms

One key question!

Sounds familiar!

Attract immediate attention

http://grad.ucalgary.ca/awards/creating_strong_applications_cfp

Reference letters

UNIVERSITY OF CALGARY
GRADUATE STUDIES

Faculty of Graduate Studies
Scholarship Office
MLT 213, 2500 University Drive NW
Telephone: (403) 220-4938
gsaward@ucalgary.ca
www.grad.ucalgary.ca

APPENDIX C - SCHOLARSHIP REFERENCE FORM

To be completed by Referee

Student Name: | Program: Select One

I have known the applicant in my capacity as ☐ teacher ☐ supervisor ☐ advisor ☐ employer
☐ other: *please explain*

I have known the applicant for years and months.

The applicant ranks in the top % of approximately students at the
☐ Undergraduate ☐ Master's ☐ Doctoral level I have encountered in years.

☐ I have read the applicant's research proposal. ☐ I have **not** read the applicant's research proposal.

	Outstanding			Above Average		Average	Below Average	Unable to Judge
	upper 2%	upper 5%	upper 10%	upper 20%	upper 30%	upper 50%	lower 50%	
Background preparation	☐	☐	☐	☐	☐	☐	☐	☐
Originality	☐	☐	☐	☐	☐	☐	☐	☐
Potential research ability	☐	☐	☐	☐	☐	☐	☐	☐
Industry/perseverance	☐	☐	☐	☐	☐	☐	☐	☐
Judgement/critical sense	☐	☐	☐	☐	☐	☐	☐	☐
Intellectual ability	☐	☐	☐	☐	☐	☐	☐	☐
Teaching ability	☐	☐	☐	☐	☐	☐	☐	☐
Oral communication	☐	☐	☐	☐	☐	☐	☐	☐
Written communication	☐	☐	☐	☐	☐	☐	☐	☐
Overall evaluation	☐	☐	☐	☐	☐	☐	☐	☐

Please rank the applicant as a scholarship candidate:
☐ Highly Recommended ☐ Recommended ☐ Not Recommended ☐ Unable to judge

Name of Referee (Please Print/Type)	E-mail Address (Institutional or Business)
Position and Department	Institution
Mailing Address (Institutional or Business)	(Institutional or Business) Telephone ( ) Fax Number ( )
Signature of Referee	Date

The recommender fills out this form AND writes a letter

Numerical values are typically exaggerated. Nobody is ever below 30%!

More about reference letters

Who to ask for a reference letter

- somebody who knows you well and can judge you on the given criteria
- somebody at the professorial level, if possible known in his field/to the people who read the application
- somebody who writes well

When and how to ask for a reference letter

- Approach potential referees in time and ask if they would agree to write a reference letter.
- Provide a clear description of what you want to have addressed.
- Don't insist if the answer is vague or negative.
- Don't forget to say thank you, and don't hesitate to let your referee know if you were successful.

What a reference letter contains

- History of the recommender's interactions with you
- List of your accomplishments (specific!)
- Anecdotes illustrating your excellence
- Subjective evaluation and recommendation

→ It is not enough that the recommender likes you!

Conclusion and outlook

We have discussed how to inform yourself about, and communicate science

- lab proposals
- lab books
- lab reports and scientific papers
- grant applications
- oral presentations

Next: get familiar with these skills, and show that you master them

- lab tour
- presentation about first lab in November