# Tips For Organizing/Writing Your Prelim/Thesis

# Key Components of a Prelim Paper

1. Abstract - Concise (100 – 150 words) summary of procedure, preliminary results, and research plans (see abstract 'recipe' in addendum)

2. Introduction - Motivation for research, necessary background information for reader, important previous results, preview of findings. Include figures/diagrams to clearly convey key issues. ***Should be suitable for a non-expert!***

3. Methods and Procedures - Description of experimental or theoretical methods used or planned, methods for data acquisition and analysis. Include figures/diagrams to convey apparatus or procedures.

4. Preliminary Results and Discussion – Description/discussion of preliminary results obtained; discussion of models/hypotheses to be tested. Include figures showing any preliminary data.

5. Proposed Research- Description of plans for future work, with clear discussion of why this work is important to achieve research goals. Include figures that help explain research goals or planned activities.

6. References – Include references to the relevant scientific literature.

# The Prelim Title Page

"The title page must contain the title of the proposed thesis, an abstract, the name of the student and the advisor, and the approximate date of the exam."

Sources and Detectors for Optical Quantum Information Processing

Kevin Zielnicki

Advisor: Professor Paul G. Kwiat

March 16, 2011

**Abstract**

Over the last sixty years, classical information theory has revolutionized the understanding of the nature of information, and how it can be quantified and manipulated. Quantum information processing extends these lessons to quantum systems, where the properties of uncertainty and entanglement fundamentally defy classical explanation. This growing field has many potential applications, including computing, cryptography, communication, and metrology. As inherently mobile quantum particles, photons are likely to play an important role in any mature quantum information processing system. However, the available methods for producing and detecting complex multi-photon states place practical limits on the feasibility of sophisticated optical quantum information processing experiments. In this paper, I will motivate the need for improved sources and detectors, describe our progress towards these goals, and detail the directions of my continuing work in these areas. Section 1 discusses our efforts to produce a bright source of photon pairs via an optimized spontaneous parametric downconversion (SPDC) scheme. Section 2 deals with high efficiency detectors, specifically the visible light photon counter (VLPC).

# Key Components of a Thesis

1. Abstract - ~1 page summary of procedures, results, and conclusions (see 'recipe' for creating an abstract in the addendum)

2. Introduction - Motivation for research, necessary background information for reader, important previous results, preview of findings. Include figures/diagrams to clearly convey key issues. ***Should be suitable for a non-expert!***

3. Theoretical/Experimental Background – Survey of the relevant theoretical and/or experimental results relevant to your thesis work. Include figures/diagrams to help convey key ideas.

4. Methods and Procedures - Description of experimental or theoretical methods used or planned, methods for data acquisition and analysis. Include figures/diagrams to convey apparatus or procedures.

5. Results and Discussion – Description/discussion of results obtained; discussion of models/hypotheses to be tested or comparison to experiments. Use different chapters for different topics.

# Key Components of a Thesis (cont.)

6. Acknowledgments – Provide acknowledgments to advisor, collaborators, funding agencies, etc..

7. References – Include references to the relevant scientific literature.

8. Appendices – Provide additional information on experimental details, theoretical calculations, code you've written, etc.

For detailed descriptions of how to write these different sections, see: https://my.physics.illinois.edu/info/index.asp?id=20

More detail about each of these sections is also included as an addendum to this presentation.

# How Do You Start?

First, draft an outline for your prelim or thesis!!

# How To Write an Outline

Example of basic (Level 1) structure of scientific outline:

**I. Introduction** (Get the reader's/viewers attention; states key idea(s) or thesis; provides essential background)

**II. Procedures** (Provides background on key experimental/theoretical methods)

**III. Results** (Presents key results that support ideas discussed in Introduction)

**IV. Discussion** (Interprets results; Discusses results in the context of prevailing models)

**V. Summary and Conclusions** (Reemphasizes key results and how they support thesis; Discusses new directions)

# How To Write an Outline

Example of a more detailed (Level 2) structure of scientific outline:

## I. Introduction

- A. Attention-grabbing, “big picture” statement of issue
- B. Key previous results leading to state of the field
- C. Unaddressed problems
- D. Preview of key points of talk/paper

## II. Procedures

- A. Experimental methods
- B. Theoretical methods
- C. Data processing
- D. Error analysis

## III. Results

- A. Key results 1
- B. Key results 2
- C. Key results 3

Provides more details of internal organization of each section

# How To Write an Outline

Example of an even more detailed (Level 3) structure of scientific outline:

- **I. Introduction**
  - **A. Attention-grabbing, "big picture" statement of issue**
    - **i. Interesting diagram to show**
    - **ii. Interesting quote to give or reference to include**
  - **B. Key previous results leading to state of the field**
    - **i. Specific papers that will be referenced**
    - **ii. Previous ideas that will be emphasized**
  - **C. Unaddressed problems**
  - **D. Preview of key points of talk/paper**
- **II. Procedures**
  - **A. Experimental methods**
    - **i. Experimental diagram to show**
    - **ii. Procedural flow chart #1**
  - **B. Theoretical methods**
  - **C. Data processing**
    - **i. Flow chart describing data analysis**
  - **D. Error analysis**

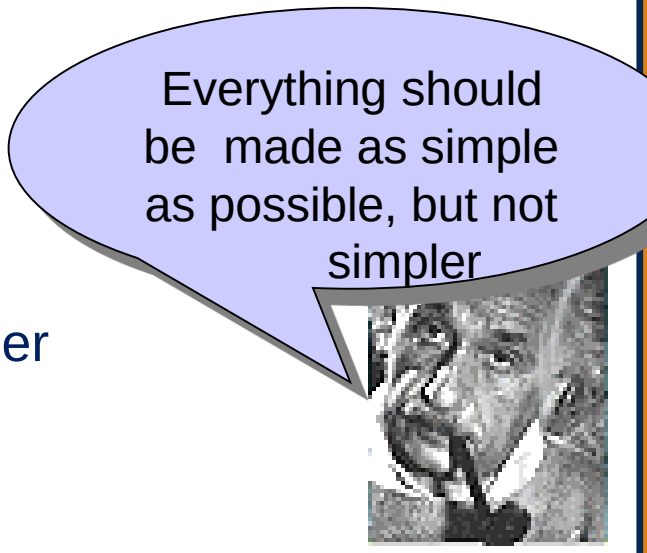
Provides specific details figures, quotes, references, sentences, etc. to support section

# Benefits of an Outline

(1). Your paper will be logically organized from the beginning

(2). It is less likely that there will be unnecessary information in your prelim/thesis

(3). Outlines allow you to break up your prelim paper or thesis into more manageable sections that you can tackle individually




(4). You can use the same outline for your prelim/final talk!

# Other Sections

Your paper will also include some or all of the following additional sections:

## References

You must reference outside sources of information and results

Be generous in your offering of appropriate credit for relevant ideas that contributed to your work

## Acknowledgments

Acknowledge individuals with whom you've had useful discussions relevant to your research, and individuals involved in some aspect of the experiment who were not co-authors

Acknowledge funding sources for the research reported

# Tips for Writing Your Prelim/Thesis

(1). Start with the Preliminary Results or Procedure sections: To "get into the flow" of writing you might start with the Preliminary Results and Procedure sections. Save the abstract and introduction sections for later.

(2). Write in plain English: avoid colloquialisms, technical jargon, slang words and phrases, and complex words. Remember that the prelim should be written so that the non-expert members of your committee can understand it

(3). Keep sentences short: Avoid lengthy and complex sentences (>25 words with long strings of modifiers)…edit, edit, edit!

(4). Have a friend read your prelim/thesis: This will help you catch typos, grammatical errors, and confusing writing in your prelim/thesis

# Tips for Writing Your Prelim/Thesis (cont.)

(5). Make good use of figures and diagrams: "A picture paints a thousand words." Good figures and diagrams will help the reader visualize what you are writing…remember, you might have a good picture in your mind of what you are describing, but keep your more inexperienced audience in mind when you write.

(6). Make sure the introduction section of your prelim/thesis, *at least*, is understandable by a non-expert (i.e., the "outside" member of your committee): As a scientist, it is important that you be able to convey your results and ideas to general audiences, and an important place to start is the prelim and thesis.

# Addendum: Key Components of a Prelim/Thesis

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# The Abstract

The abstract gives the reader an overview of the key motivations, methods, and results of the proposed research

## Descriptive Abstract

Briefly describes what the prelim/thesis contains

Prelim:  short, generally 100-200 words; Thesis: ~ 1 page

Includes purpose, methods, results, conclusions, recommendations

Highlights essential points

## Tips and Guidelines

Should involve well-developed and concise paragraphs

Should be understandable by a non-expert audience

Summarizes study, i.e., has no information NOT in paper

Generally uses introduction-results-conclusions structure

Shouldn’t include complex equations, references, figures, etc.

# Content of Scientific Abstracts

The abstract should contain (in this order):

1. A brief statement of the motivations and/or issues associated with the research
2. A short description of the methods used
3. A summary of the key results obtained
4. A statement of the implications of the key results

# Content of Scientific Abstracts

Control the length of your abstract by controlling the length of your answers to the four questions, NOT by omitting any of the answers:

Short abstract (~100 word, e.g., *Phys. Rev. Lett.* abstract):

one-sentence answers

Longer abstract (~200 word, e.g., *Phys. Review* abstract):

2-3 sentence answers

One-page abstract (e.g., proposal project summary):

one paragraph answers

# Example Abstract

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

## Optical Response of Relativistic Electrons in the Polar BiTeI Semiconductor

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

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

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Motivation

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

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Methods used

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

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Brief summary of key results

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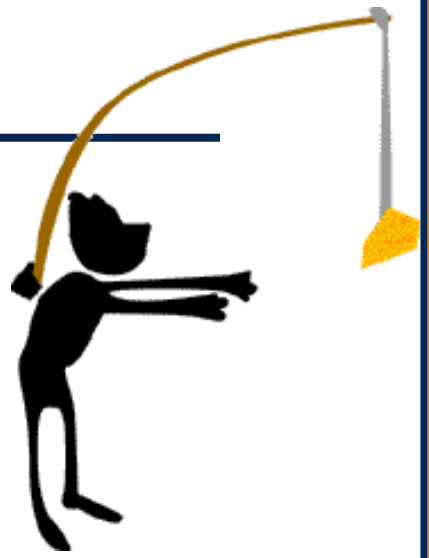
Brief statement of implications of results

# The Introduction



In the introduction, you provide the basic motivations for the proposed work, give necessary background so the non-expert reader can understand the research, and preview the essential results of the proposed work

## Elements of an Effective Introduction

Key information: State the problem being investigated, and briefly describe the experimental or theoretical method used

Motivations: Describe the goals and significance of the research, i.e., why is the research worth doing?

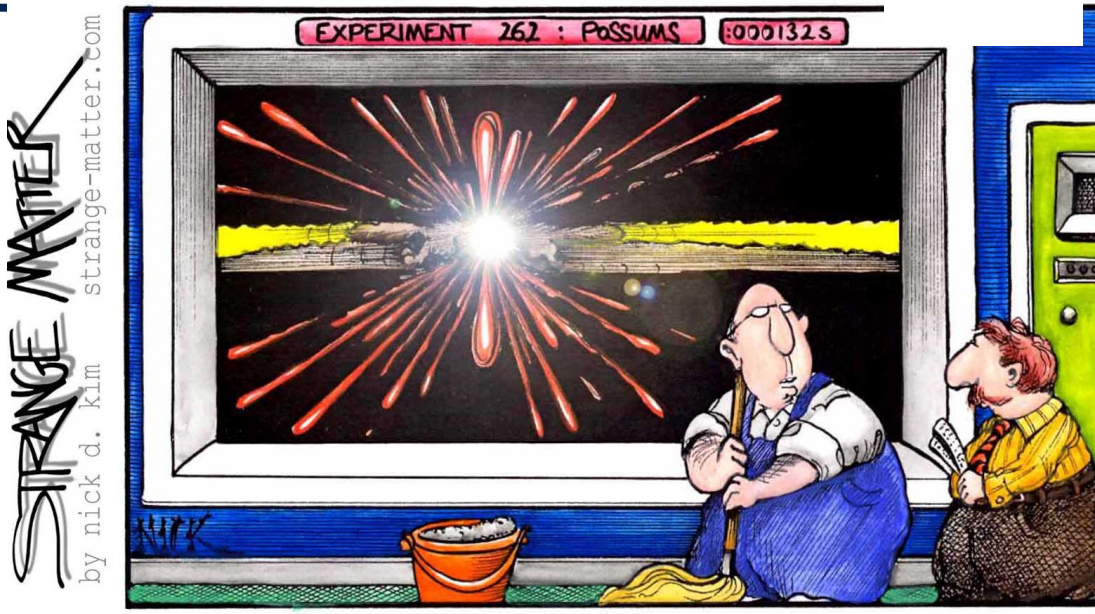
Background: Provide (concisely) relevant background material, so that non-expert readers can appreciate the research problem and its motivation. This would include previous related research, relevant theories, and unanswered questions

## Tips/Guidelines

Remember your audience!!: Use the introduction to orient your non-expert committee to the details of your project and research!

# The Experimental/Theoretical Procedure

The purpose of this section is to describe the experimental or theoretical techniques and methods with enough detail to allow the committee to evaluate your methods




**"Sure been a heap more work for ME around here since those Biologists got granted research time on the ol' Supercollider..."**

## Important Elements

Techniques used: Provide enough detail so that the committee can have some idea of the experimental or theoretical methods used

Methods used: Describe general procedures used in obtaining your results (e.g., data analysis, data processing) with sufficient detail for the committee to evaluate those methods

# Experimental/Theoretical Procedure (cont.)

## Tips and Guidelines

In the prelim, avoid unnecessary detail…this is not an instruction manual. In the thesis, more detail is warranted and will be appreciated by your advisor and students following your project, but put non-essential details in the appendices

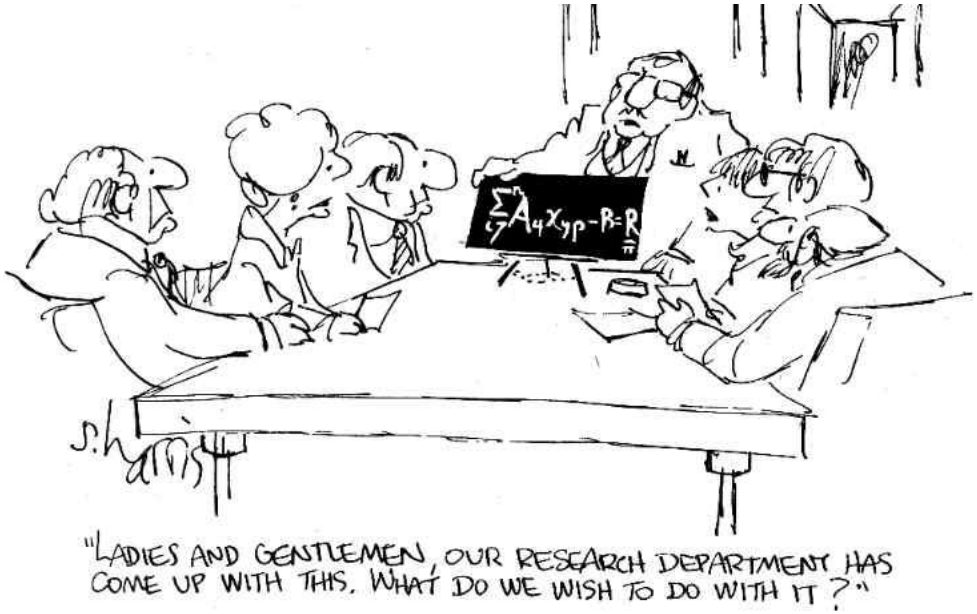
Diagrams or figures of the experimental set-up or key parts of the apparatus are often useful—they show scale and point out important features

Schematics or flow charts are also useful to show processes

Describe any methods used to extract or analyze data

# Results and Discussion Section

The purpose of this section is to present, analyze and discuss your main results. This can be done in multiple chapters associated with distinct projects. In the prelim, this section will include any preliminary results.




## Important Elements

Summary of results: Describe the any results obtained, with accompanying figures, graphs, and associated figure captions

Relevant details: Highlight for the reader any noteworthy observations

Discuss relevant experiments or models: Theoretical prelim papers should discuss any relevant experimental results, experimental prelim papers should describe any relevant theoretical proposals

# Results and Discussion Section (cont.)

## Important Elements (cont.)

Sources of errors: Discuss any experimental errors or experimental design problems that might have influenced your ability to draw conclusions

Alternative models: Be sure to offer alternative explanations for your data, if they exist (and they always do!)

The future: Discuss where the research might go next, and what questions remain after your study

# The Proposed Work Section (Prelim)

The goal of this section is to outline the work that you propose to do as part of your thesis work

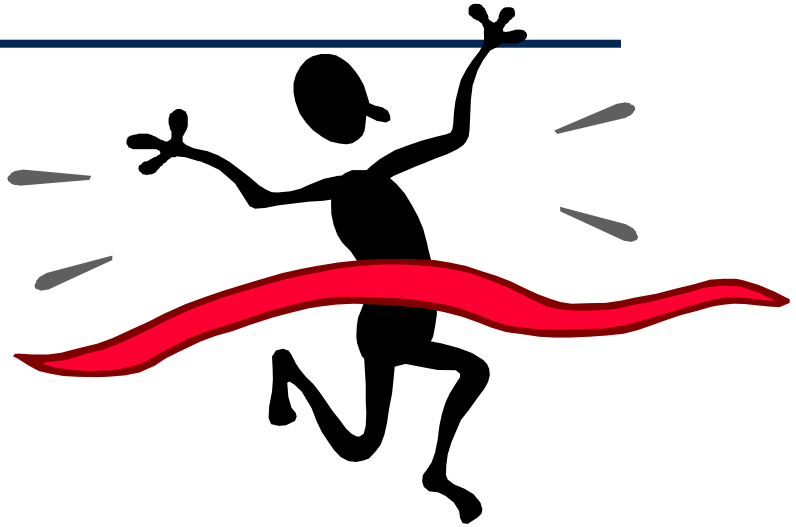
## Important Elements

Sources of errors/problems: Discuss any experimental errors, experimental design problems, theoretical problems that need to be addressed to perform the work proposed

Future work: Clearly discuss the future work planned, outline any obvious impediments to accomplishing the goals and how you plan to circumvent these impediments, and describe how the planned work – if successful – will help you achieve the goals laid out in your “motivations” section

# Summary and Conclusions

The goal of this section is to reemphasize the most significant results and conclusions associated with your research



## Important Elements

Summarize: Reiterate the key points of your proposed research (in prelim) or finished research (thesis), but don't introduce new interpretations or analysis of data in this section

Provide closure: Discuss whether the goals put forward in the introduction were met (thesis)

Make recommendations: Describe how a future study could be improved—suggest what the next course of action of your work should be (thesis)

Be clear and concise