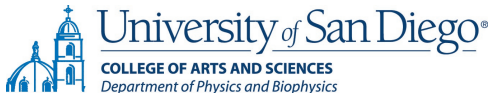


# Welcome to PHYS 480: Experimental Modern Physics

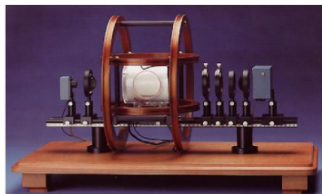
Greg Severn



the writing-intensive advanced *physics* lab course at  
USD

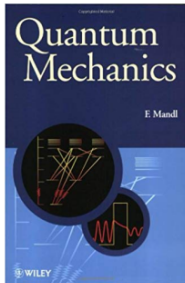
January 25, 2020

Let's introduce the course, interrelate its parts, and begin to unpack the pieces

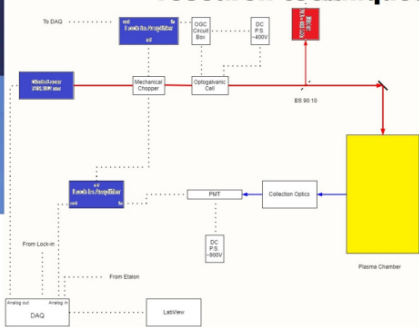


**Advanced Experiments**

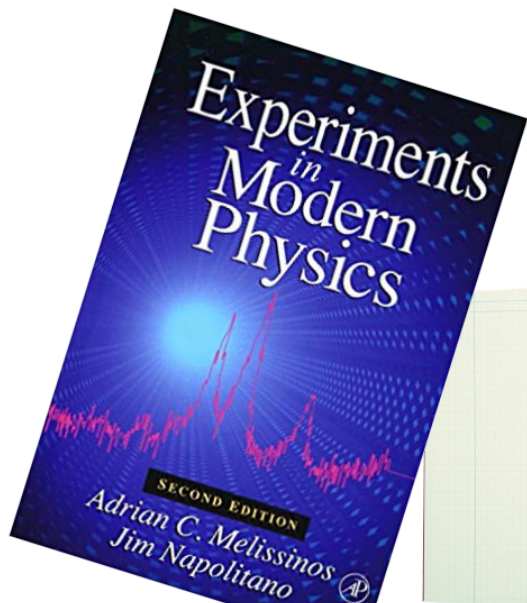
**requiring advanced  
modern concepts**



**involving current  
research techniques**



There is a required text and lab notebook



you have 3 reading assignments to be completed B4 Wednesday! see [www.sandiego.edu/~severn/p480w...](http://www.sandiego.edu/~severn/p480w...)

## Reading Assignments

- 1 lab handouts for PNMR, and Optical Pumping, **both by Wednesday.**
- 2 read 'math as prose' by Wednesday.

Physics 480W - Mozilla Firefox

home.sandiego.edu/~severn

Experimental Modern Physics (EMP)  
Physics 480(W)

Primary Text: *Experiments in Modern Physics*, 2nd Ed., A.C. Melissinos and J. Nappi/Roe, Academic Press, 2003.

Dr. Greg Severn  
severn@sandiego.edu, 9040, 57282

(Office Hours) T 11:00am-12pm, 2:30-4 Th 2:30-4 F 2:30-3:30pm, 6 ABA.)

Course Description

PHYS 480W Experimental Modern Physics (Units: 4, Prerequisite: PHYS 330 (Quantum Mechanics), A laboratory-based course focused on the introduction to principles of research techniques with an emphasis on modern physics. Experiments illustrate physical phenomena pertaining to core areas of physics: quantum mechanics, atomic and nuclear physics, laser physics and optical physics. Reading and digital data acquisition, instrumentation, high-resolution optical and laser techniques, and ground resolution detection technology and the experiment. This course is the required writing intensive course for physics majors and fulfills the upper-division core writing requirement. Students write papers to be published in students' research journals, learn to write mathematical proofs, engage in the peer review process, and learn to code LaTeX.

Guide to Course Policies, description of experiments, LaTeX stuff, and all that...

Policy	Description
Attendance	Attendance Policy for students
Late work	Late work Policy for students
Plagiarism	Plagiarism Policy for students
Writing	Writing Policy for students
Grading	Grading Policy for students
Experiments	Experiments Policy for students
Lab	Lab Policy for students
Office	Office Policy for students
Text	Text Policy for students
Software	Software Policy for students
Grading	Grading Policy for students
Experiments	Experiments Policy for students
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Office	Office Policy for students
Text	Text Policy for students
Software	Software Policy for students

There are 4 experiments, prosecuted on Monday (section 01) and Wednesday (section 02)! Tutorials, large group meetings, MWF

TABLE I. List of Experiments

Experiment Code	Topic & Laboratory
OP	High resolution optical spectroscopy, Zeeman effect and Hyperfine structure (hfs) in <i>Rb</i>
NMR	Pulsed nuclear magnetic resonance techniques, Nuclear Spin Echoes and estimating spin-spin relaxation times.
PW	Plasma physics, the Langmuir Probe, and Ion Acoustic Waves in laboratory plasmas
LS	High resolution laser spectroscopy and <i>Rb</i> hfs

There are 4 experiments, prosecuted on Monday (section 01) and Wednesday (section 02)! Tutorials, large group meetings, MWF

Course and Time	Room	M	W	F
Experimental Modern Physics (EMP) 480-01 (1:25-2:20)	ST292(lg), ST282(t)	Tutorial Group I	Tutorial Group I	Large group meeting (Groups I&II)
EMP Laboratory (2:30-5:20pm)	ST290, ST 287		Lab (Groups I & II)	

# There are 4 experiments, prosecuted on Monday (section 01) and Wednesday (section 02)! Tutorials, large group meetings, MWF

## Tutorial Questions

Dr. Greg Severn

Dept. of Physics, University of San Diego, San Diego CA 92110

(Dated: Fall 2017)

The process of experimental research involves integrating a great deal of different sorts of understandings. The researcher tries to put together an understanding of physical theory, concepts and ideas, along with a grasp of the capabilities of instruments and techniques in order to arrive at an *experimental design suitable for testing a theoretical model*. You have to understand how oscilloscopes, coax cables, DMM's, LabView vi's, Matlab .m files, photocells, quarter wave-plates, and so on, *work*, as surely as you have to understand how perturbation theory in quantum mechanics works. You must perturb Hamiltonians using linear algebra as confidently as you perturb atoms with RF electromagnetic radiation. To help the student weld together a comprehensive understanding of each experiment, we will have tutorial sessions each week of each experiment. Each experiment will come with a set of readings and questions (below!) the answers to which will be prepared in advance before the weekly tutorial meeting. Each experiment will give rise to different specific questions in addition to the common ones. The questions beyond the first 4 are listed in no particular order. Rather it is in the convergence and mutual coherence of (finding) their answers that (a) a clearer picture of the experiment arises, (b) an understanding of how research such as this can be done, and (c) how scientific questions can be posed and answers sought.

### I. OPTICAL PUMPING

1. What is the experiment designed to measure? What are the principal results (giving figures of merit, with units, where possible)?
2. How is the experiment designed to measure those quantities?
3. Sketch a block diagram of the apparatus and label all the principal parts. What does each part do?
4. What difficulties are encountered typically (physical, technological, and so on), and how does the

(look this up on NIST's database of atomic energy levels!), what are the units and magnitude of  $A$ ?

- (c) Further, what does it mean to say that  $J$ ,  $L$ , and  $S$  are good quantum numbers, but  $m_L$  and  $m_S$  are not? Note, the basis to take to achieve the result above of course is the  $|LSJM_J\rangle$  basis, with  $J = 3/2$  and  $J = 1/2$ . Note that the perturbation does not involve the  $\hat{J}_z$  operator (or measurement). How degenerate, or what is the statistical weight, each  $|LSJM_J\rangle$  state, say, where  $L = 1$ ,  $S = 1/2$ , and  $J = 3/2$ . How about where  $J = 1/2$ ?

# PHYS 480 possesses a motley of interconnected goals, not hierarchical ones

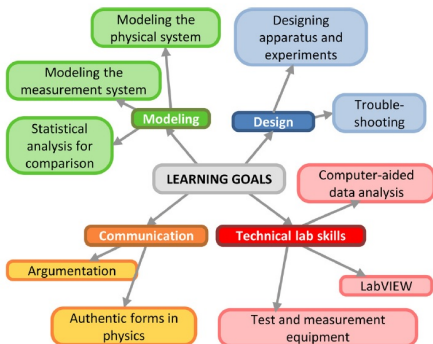


Fig. 2. Summary of the learning goals for the advanced physics lab course (in moderate detail).

## The process of transforming an advanced lab course: Goals, curriculum, and assessments

Benjamin M. Zwickl,<sup>a)</sup> Noah Finkelstein, and H. J. Lewandowski<sup>b)</sup>  
*Department of Physics, University of Colorado Boulder, Boulder, Colorado 80309*

(Received 14 July 2012; accepted 9 November 2012)



# PHYS 480 possesses a motley of interconnected goals, not hierarchical ones

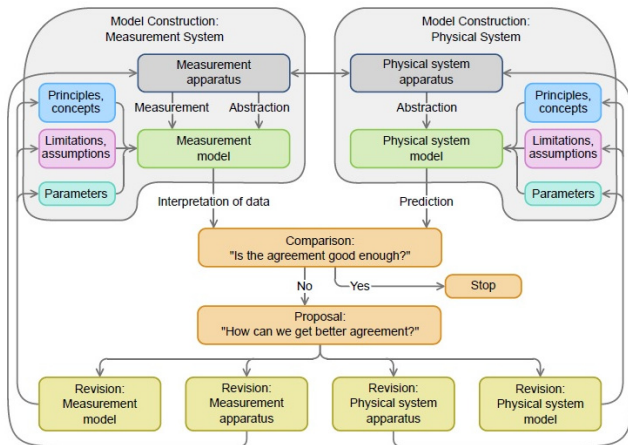
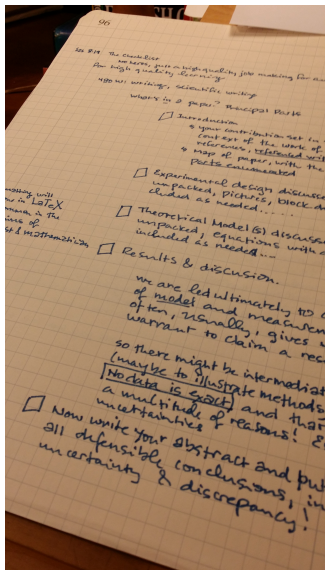


FIG. 1. Diagram for the experimental modeling framework.

# There are 2 great goals in 480: #1 Do good experimental work, & #2 Write mathematical and physical prose well



## Writing for Physics Journals (AIP, APS)

- 1 L<sup>A</sup>T<sub>E</sub>X
- 2 Writing mathematical prose
- 3 Writing a paper
- 4 Reviewing (& revising) a paper

We will use Overleaf to be our LaTeX cloud server  
it's all online now

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# LaTeX, Evolved

The easy to use, online, collaborative LaTeX editor

Menu The Universe Review Share Submit History

Source Rich Text Recompile

```
1 \documentclass{article}
2 \usepackage{utfl}{inputenc}
3
4 \title{The Universe}
5 \author{}
6 \date{May 2019}
7
8 \usepackage{natbib}
9 \usepackage{graphics}
10
11 \begin{document}
```

figures  
  - universe.jpg

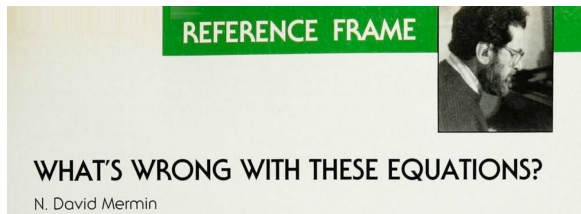
sections  
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The Universe

May 2019

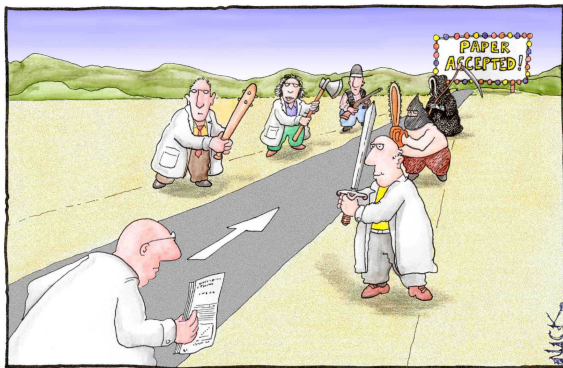
There are rools to help us with mathematical prose, the lot of a physicist's life!



## Writing Mathematical Prose: the 3 Rools

- 1 Fisher's rule: *number all displayed equations*
- 2 Good Samaritan rule: *when citing Eq. 2.47, identify it by a phrase too*
- 3 Math is prose (too) rule: *this one is self explanatory(?)*

The review process is a cycle of writing, revising ( $2\pi$  times?  $\pi^2$ ?), submission, revision, and **resubmission**



Most scientists regarded the new streamlined peer-review process as 'quite an improvement.'

