Welcome to PHYS 480: Experimental Modern Physics

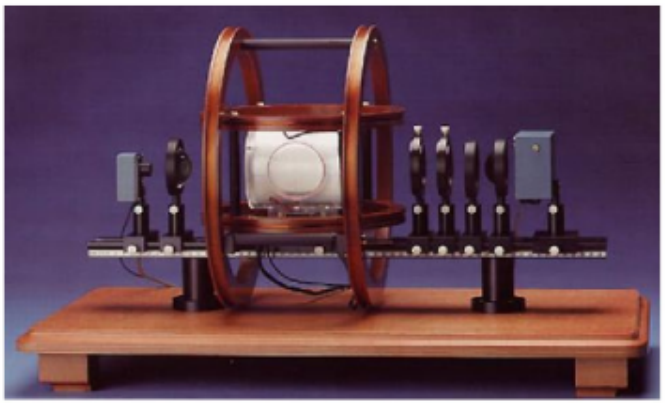
Greg Severn

University of San Diego®
COLLEGE OF ARTS AND SCIENCES
Department of Physics and Biophysics

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

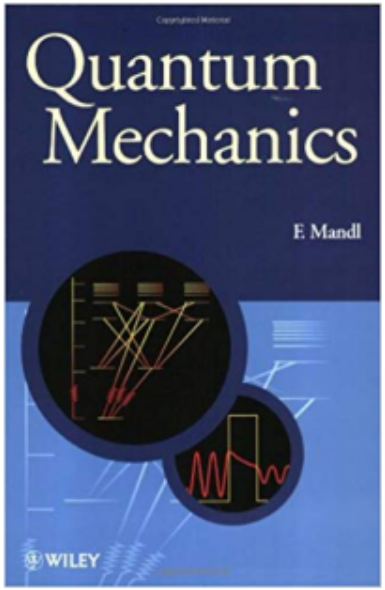
January 25, 2020

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

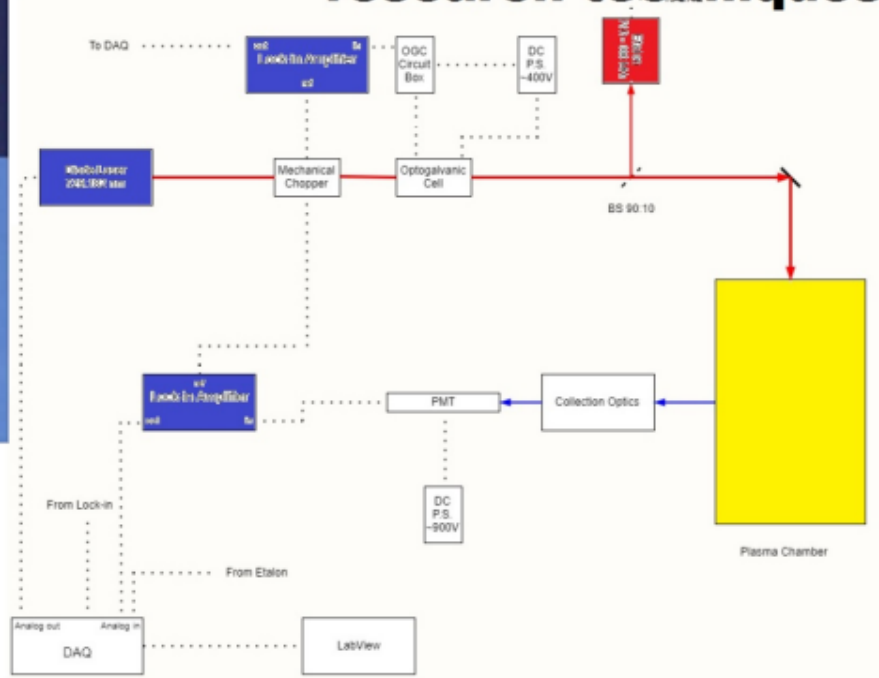


Advanced Experiments

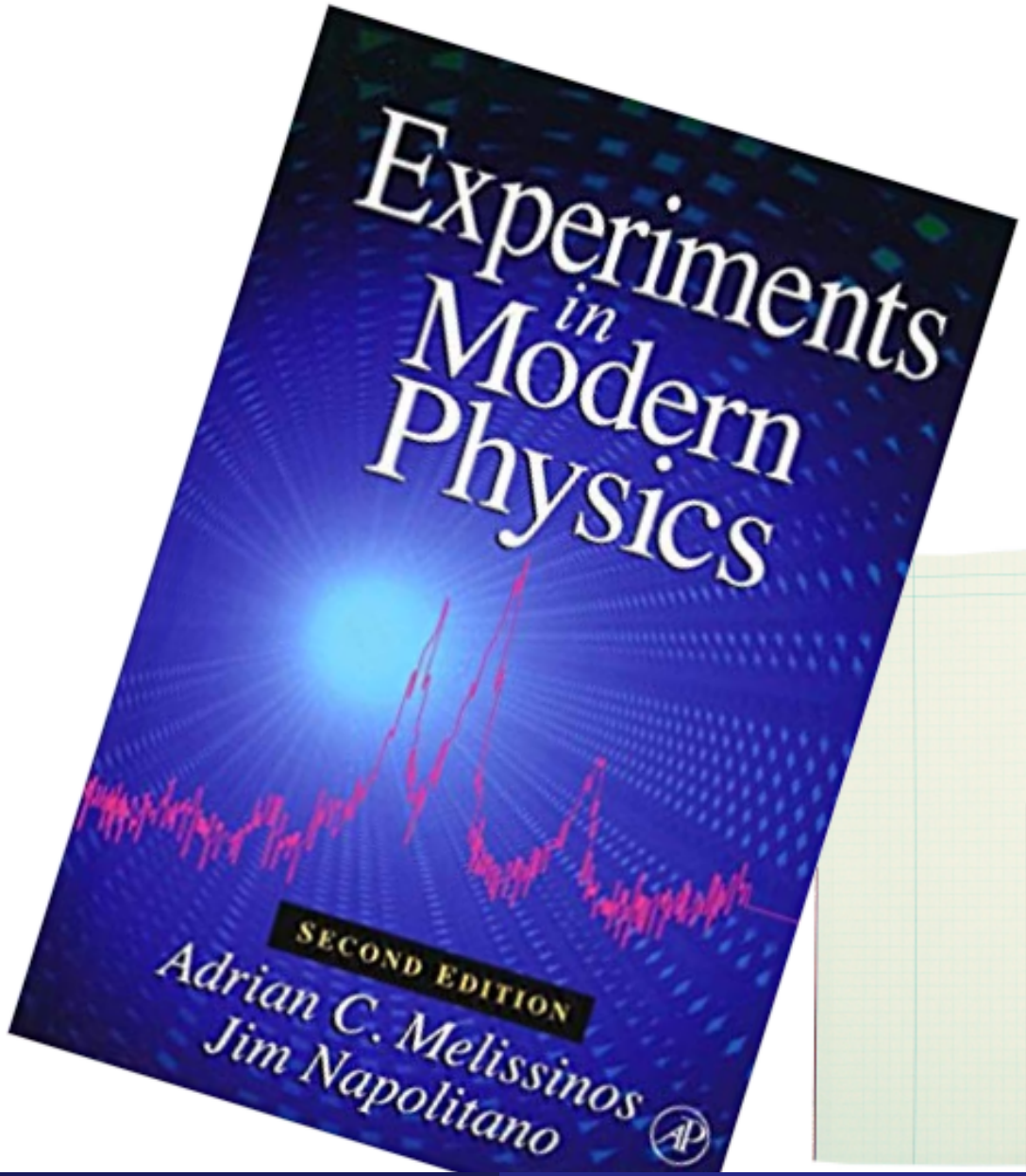
requiring advanced modern concepts



involving current research techniques



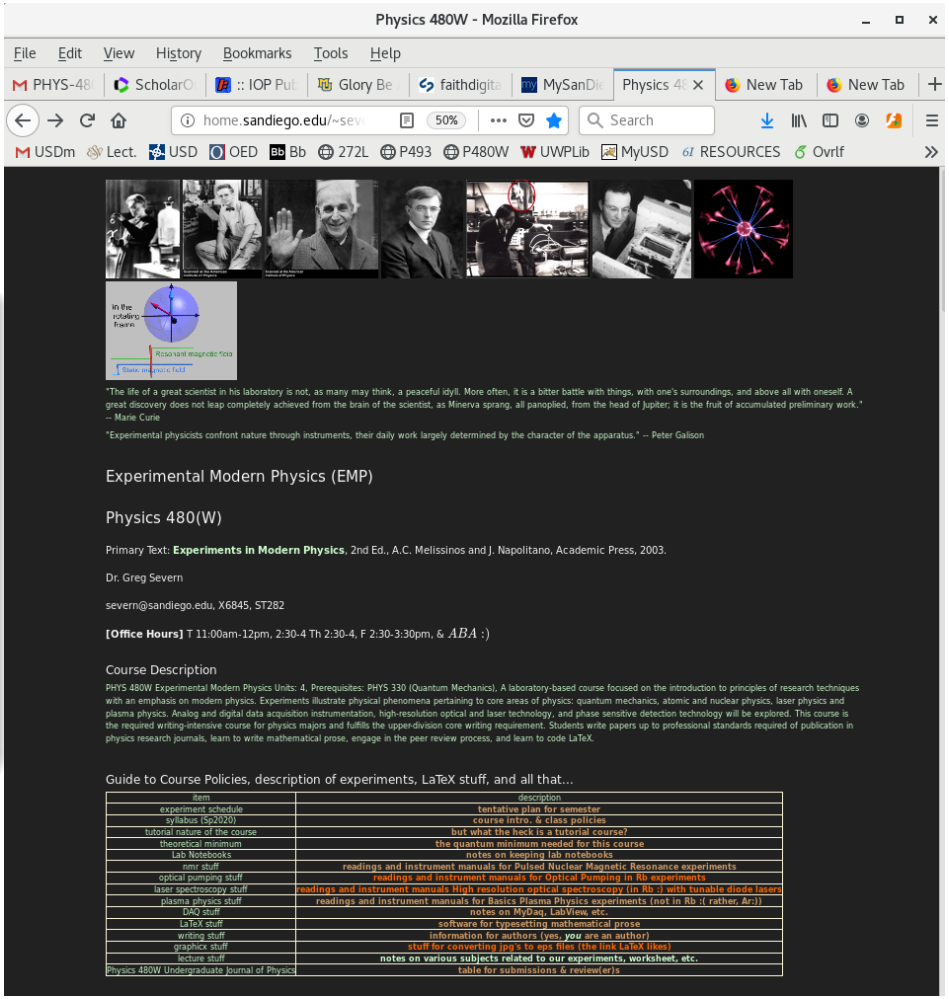
There is a required text and lab notebook



you have 3 reading assignments to be completed B4 Wednesday! see www.sandiego.edu/∼severn/p480w...

Reading Assignments

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



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 *Rb*
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 *Rb* hfs

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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)	

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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 NISTs 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 hierarchichal ones

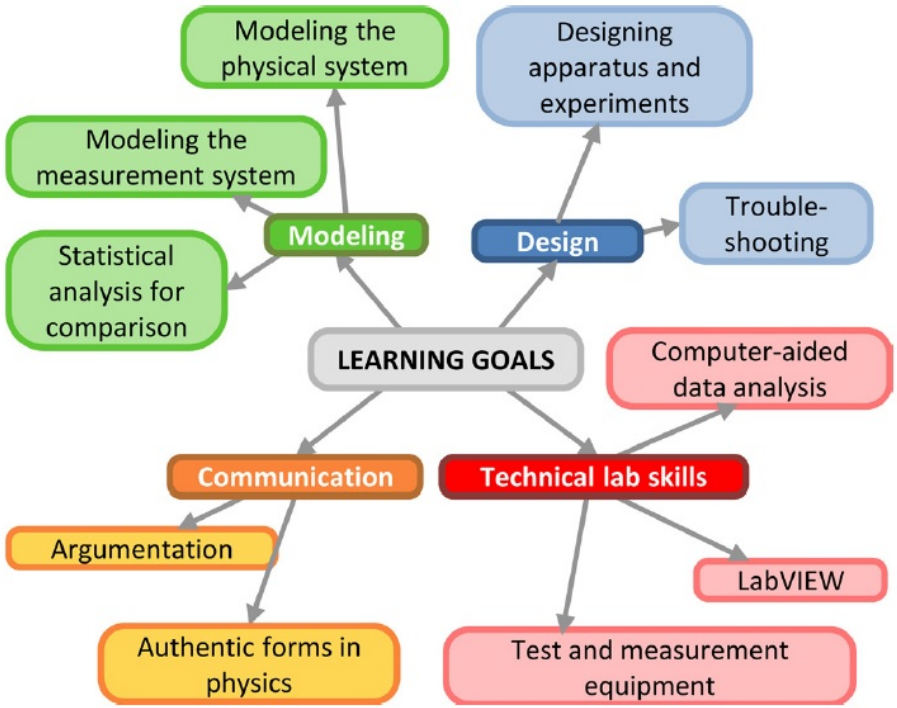

Fig. 2. Summary of the learning goals for the advanced physics lab course (in moderate detail).

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

Benjamin M. Zwickl,[a] Noah Finkelstein, and H. J. Lewandowski[b]
Department of Physics, University of Colorado Boulder, Boulder, Colorado 80309

(Received 14 July 2012; accepted 9 November 2012)

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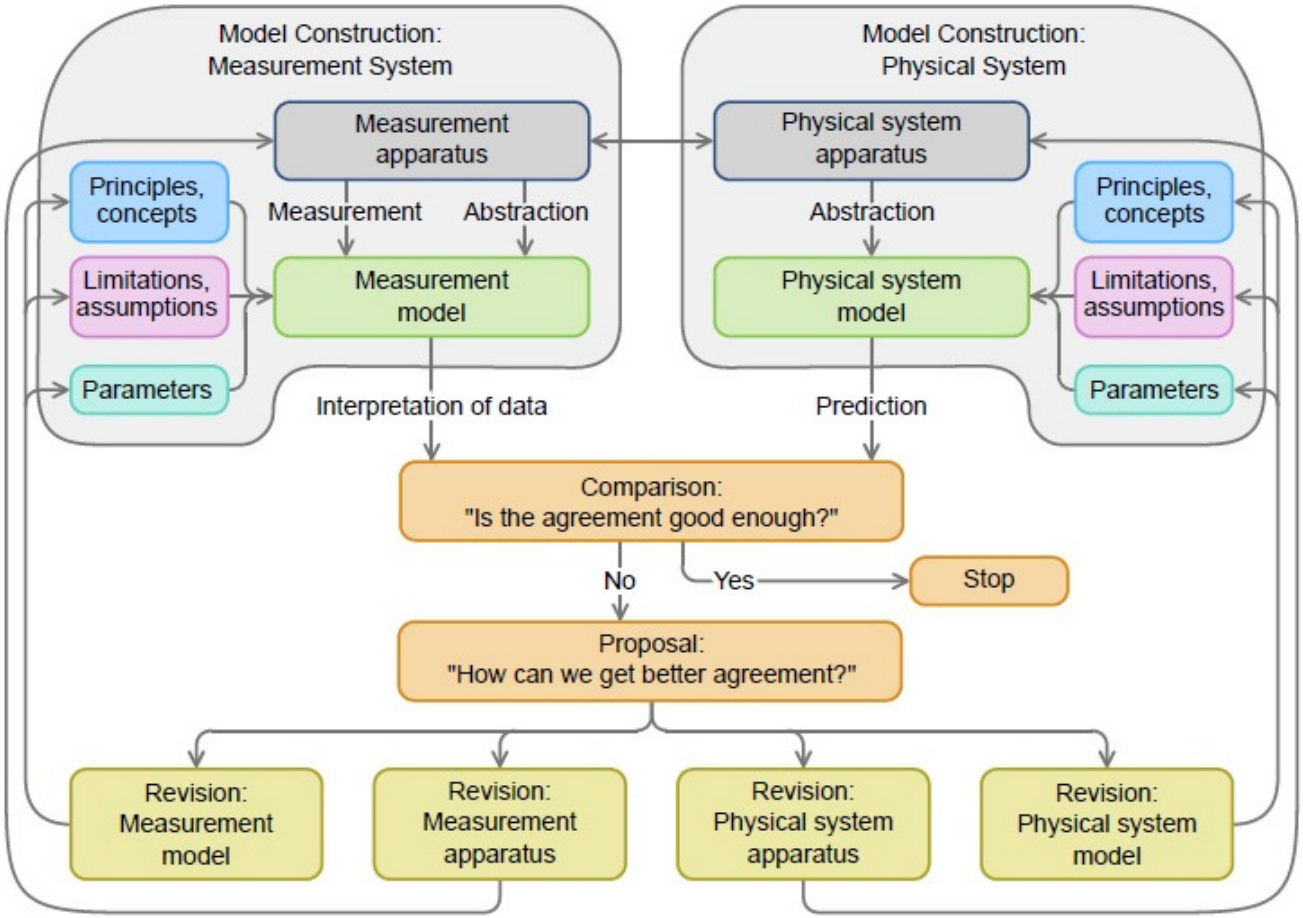
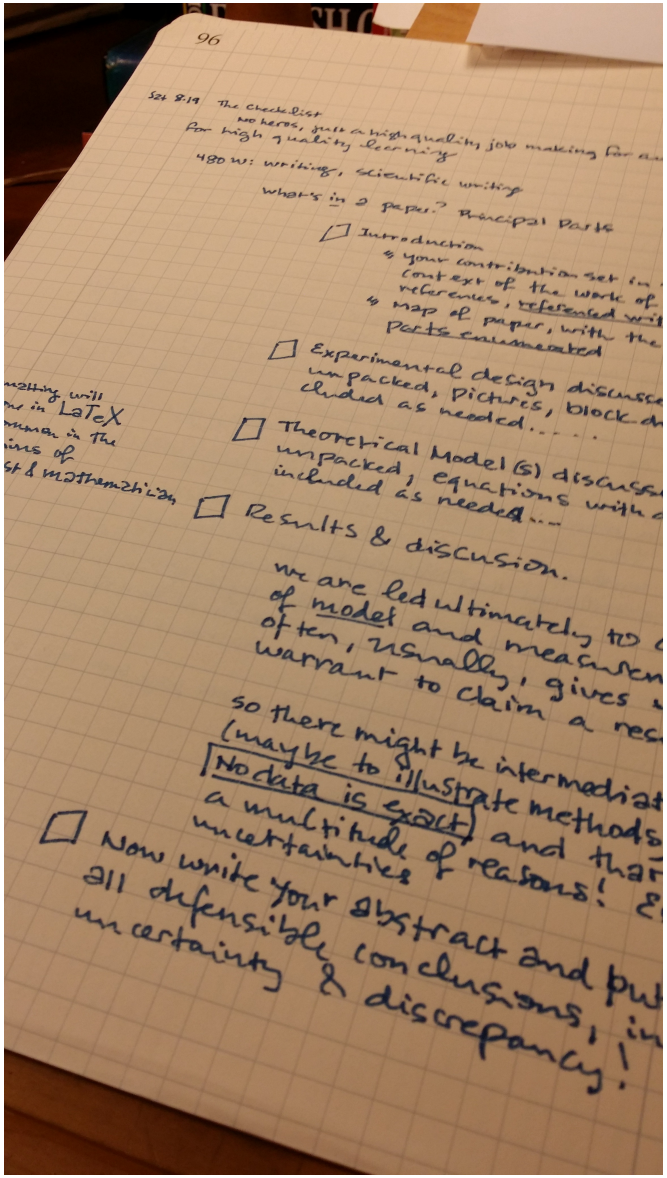


FIG. 1. Diagram for the experimental modeling framework.

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

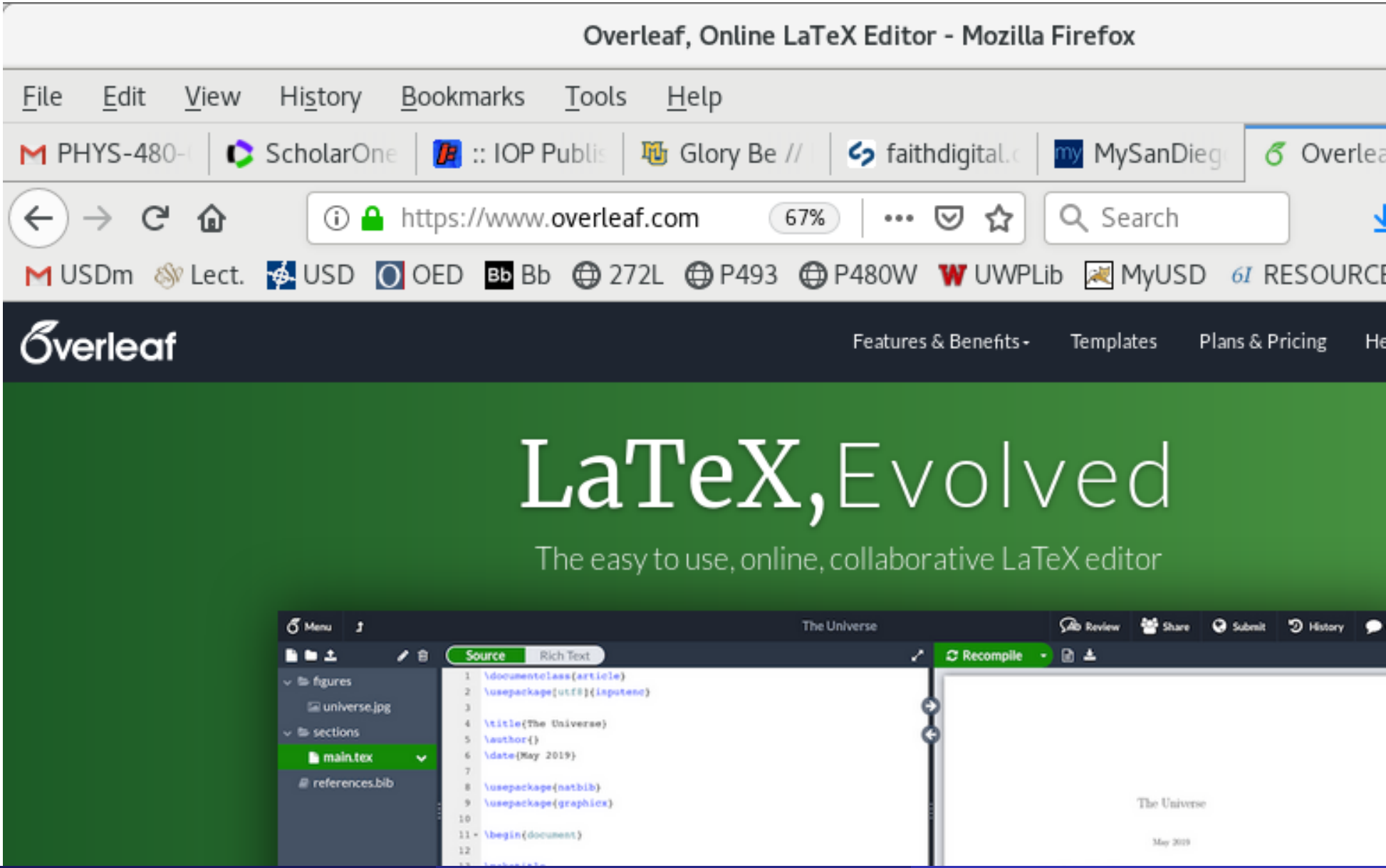


Writing for Physics Journals (AIP, APS)

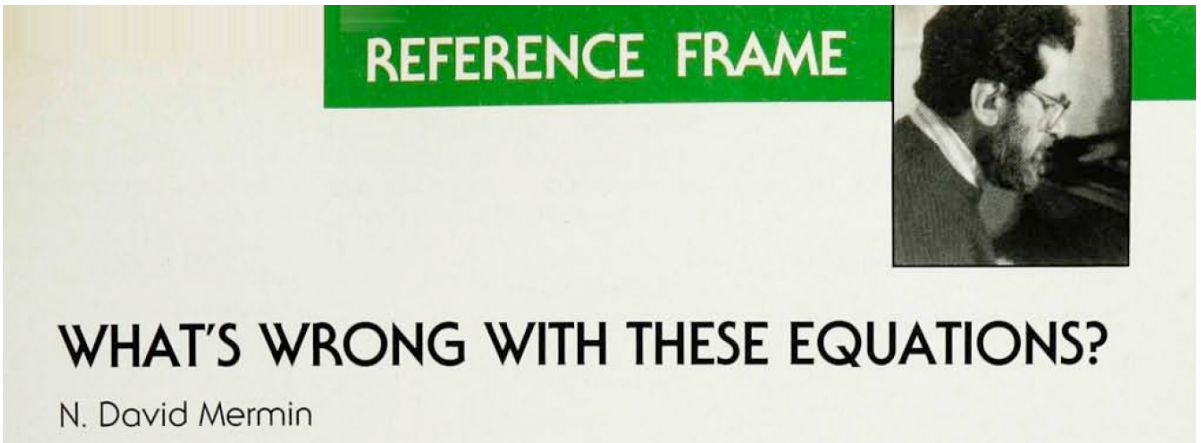
1. LaTeX
2. Writing mathematical prose
3. Writing a paper
4. Reviewing (& revising) a paper

We will use Overleaf to be our LaTeX cloud server

it's all online now



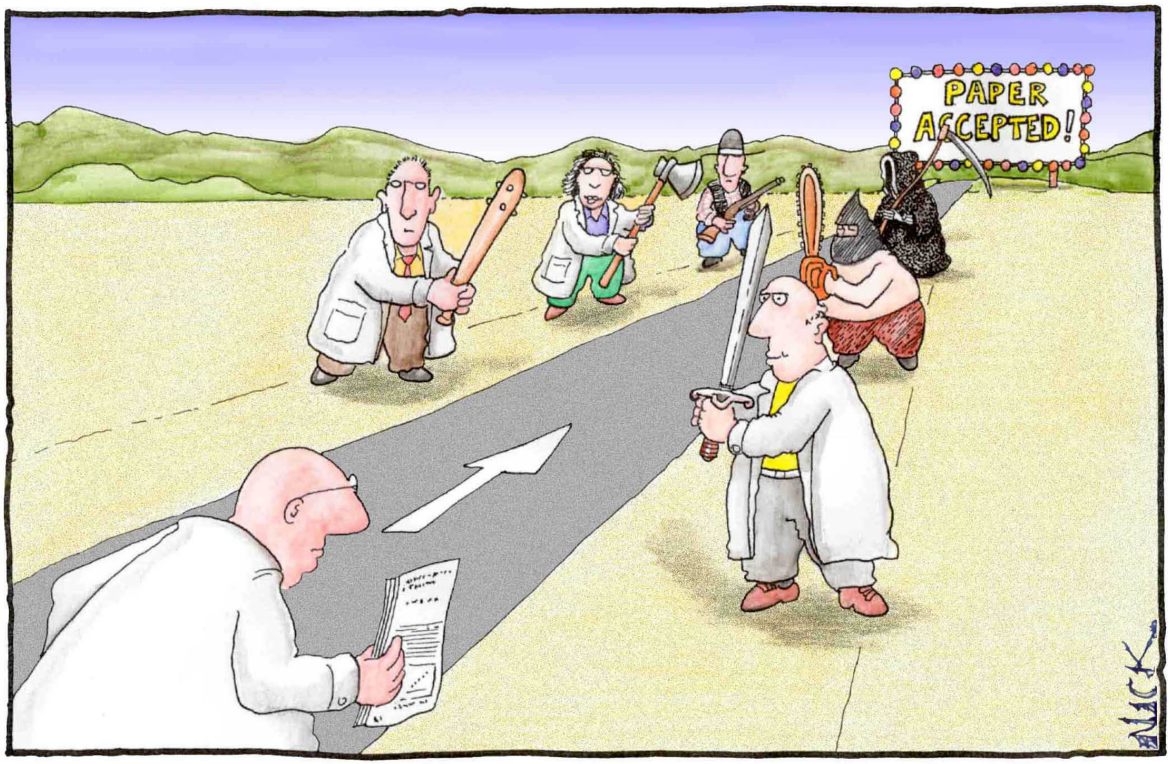
There are rools to help us with mathematical prose, the lot of a physicist's life!



Writing Mathematical Prose: the 3 Rools

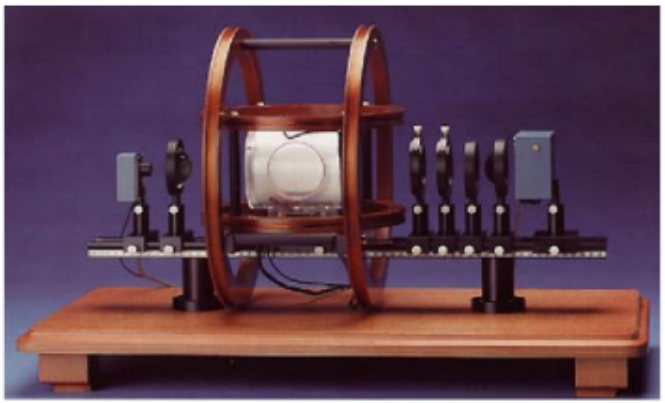
1. Fisher's rule: *number all displayed equations*
2. Good Samaritan rule: *when citing Eq. 2.47, identify it by a phrase too*
3. Math is prose (too) rule: *this one is self explanatory(?)*

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



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

We introduced the course, what happens on FRIDAY's, and began with writing!



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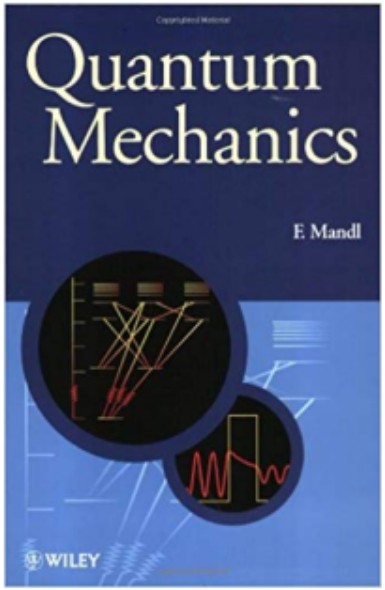

involving current research techniques