# Technical Typesetting for Physics Teachers with TEX and LATEX

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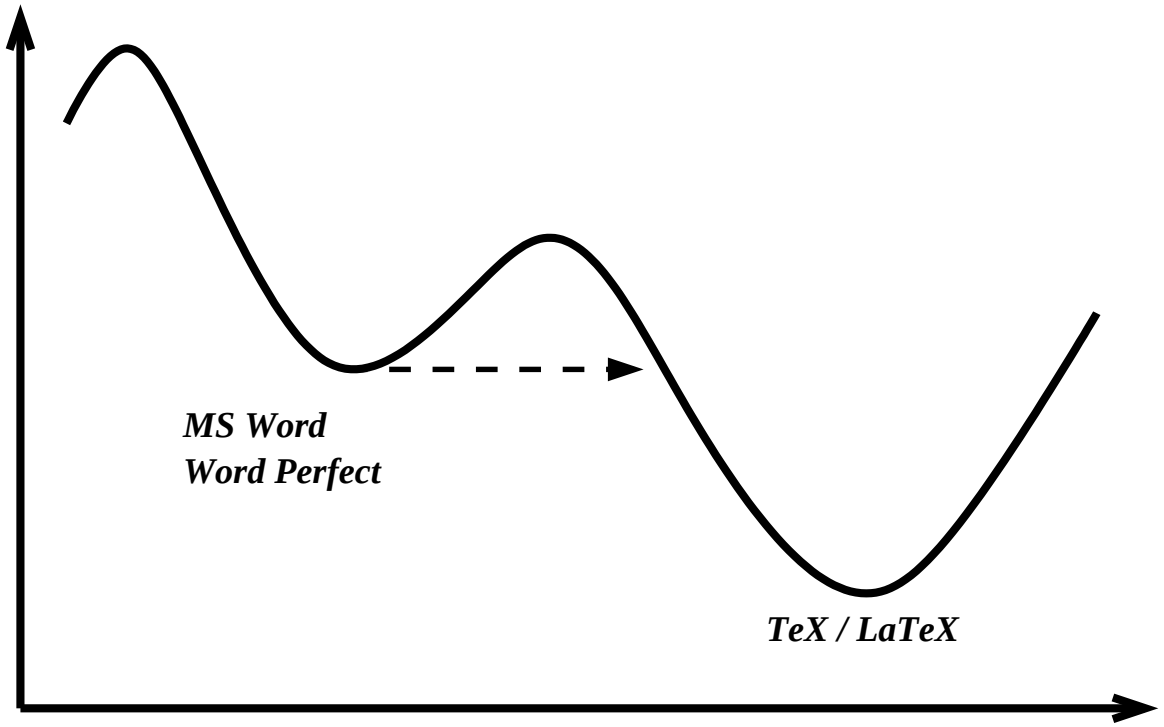
*"Beautiful equations made easy"*

# Why Use TEX?

TEX (pronounced "Tech") is a technical typesetting system created by Donald Knuth of Stanford University. It is used by most physicists, mathematicians, and computer scientists, and many astronomers.

MS Word works for $E = mc^2$ and $H_2O$, so why use TEX?



# Scientific typesetting made easy

TEX can correctly typeset complicated mathematical expresions, with proper alignment of all elements and automatic equation numbering:

$$\nabla \cdot \vec{D} = \frac{\rho}{\epsilon} \tag{1a}$$

$$\nabla \cdot \vec{B} = 0 \tag{1b}$$

$$\nabla \times \vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t} \tag{1c}$$

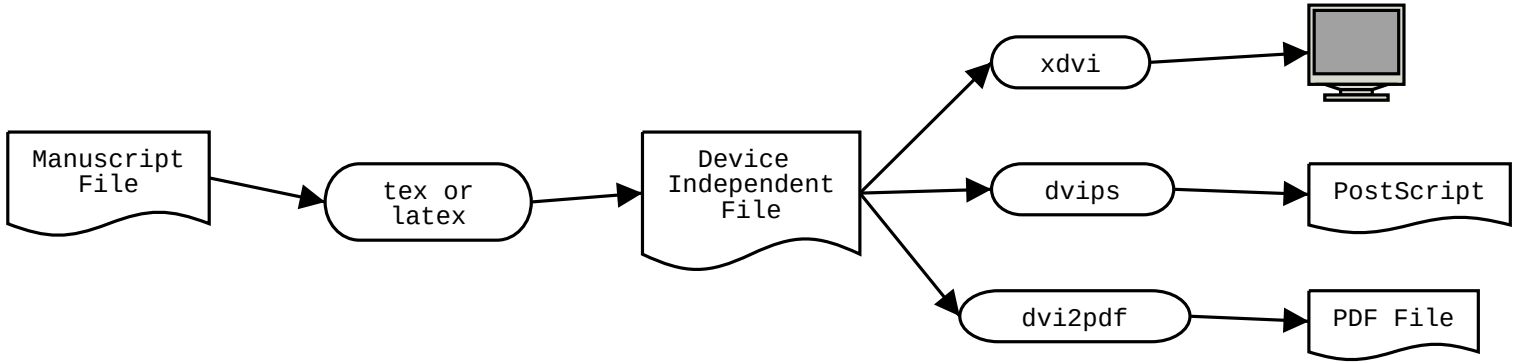
$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} + \vec{J} \tag{1d}$$

This is no mere "processing" of words.

Some type of TEX or LaTEX is required to submit papers to the arXiv.

# The TEX Process – it's not WYSIWYG

Typesetting a paper with TEX is like compiling a computer program:




1. Instructions in "manuscript" file, `myfile.tex` (source code)
2. `tex` or `latex` (the TEX "engine" and macros (libraries)) produces device independent (DVI) file, `myfile.dvi` (object file)
3. DVI file viewed on screen, converted to PostScript file, or converted to a PDF file. (loader/linker)

On a Mac or PC this is all behind the scenes.

Note! pdfTEX goes straight from `.tex` to `.pdf`

# Typesetting: The Finer Points

Typesetting is more complex than word processing, but for regular text (no equations) typesetting is easy if you keep a few subtle points in mind:

- A new paragraph is signaled in TEX by a *blank line*. The entire paragraph is typeset at one time, with optimal line breaks chosen to make the entire paragraph look good.
- *Quotation marks* are more complicated: You should use left and right single quotes twice to get left and right quotation marks.
- Use a single dash for a short hyphen, "-", a double dash for a regular hyphen, "–", and a triple dash for a long hyphen "—".
- *Diacritical marks* are created with special control characters. For example, typeset the words "façade" and "coördinates" with `fa\c cade` and `co\"ordinates`.

*"I have seen — attack ships on fire off the shoulder of Orion.*
*I watched c-beams glitter in the dark near the Tannhäuser Gate."*

# Symbols, Subscripts, Superscripts

Mathematics text is typeset differently. Variables are typeset in italics, with different spacing. Mathematics in the body of a text must therefore be enclosed in "math quotes", which are dollar signs, `$`.

Math symbols are indicated by a "control word" name, which begins with a backslash, (eg. `$\alpha$` and `$\Omega$` produce $\alpha$ and $\Omega$).

Subscripts are indicated with an underscore `_`, while superscripts are indicated with a circumflex `^`. Grouping is indicated with curly brackets `{` and `}`.

- To get "$Y_l^m(\theta_1, \phi')$" you type:

```
$Y_l^m(\theta_1,\phi^\prime)$
```

- To get "$G_{\mu\nu} = g_{\mu\nu} R + \frac{1}{4} R_{\mu\nu}$" type:

```
$G_{\mu\nu} = g_{\mu\nu} R + {1 \over 4} R_{\mu\nu}$
```

# Displayed Equations

Long equations, or important equations, are set off from the text as "displayed" equations. To get a displayed equation you double the math quotes. To get this:

$$\langle \psi_1 | \psi_2 \rangle = \int_{-\infty}^{\infty} \frac{Y_l^m(\theta_1, \phi_1)\, Y_l^m(\theta_2, \phi_2)}{\sqrt{2\pi}}\, d\Omega$$

you would type this:

```
$$
\langle \psi_1\vert \psi_2 \rangle =
          \int_{-\infty}^\infty {
           Y_l^m(\theta_1,\phi_1) Y_l^m(\theta_2,\phi_2)
          \over \sqrt{2\pi} } \, d\Omega
$$
```

(In LaTeX you use `\[` and `\]` instead of `$$`)

# Maxwell's Equations

$$\nabla \cdot \vec{D} = \frac{\rho}{\epsilon}$$
$$\nabla \cdot \vec{B} = 0$$
$$\nabla \times \vec{E} = -\frac{1}{c}\frac{\partial \vec{B}}{\partial t}$$
$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} + \vec{J}$$

Maxwell's equations, nicely aligned, are produced by typing:

```
$$
\eqalign{
  \nabla \cdot \vec D     &=  {\rho \over \epsilon}      \cr
  \nabla \cdot \vec B     &=  0                          \cr
  \nabla \times \vec E    &=
           - {1 \over c} {\partial \vec B \over \partial t} \cr
  \nabla \times \vec H    &= \phantom{-}
   {\partial \vec D \over \partial t} + \vec J \cr}
$$
```

# Macro Definitions

TEX is extendable by defining new control words as "macros".
For example:

```
\def\Sph#1{Y_l^m(\theta_{#1},\phi_{#1})}
```

The argument `#1` is replaced with whatever argument you give to the macro. So you can produce

$$\langle\psi_1|\psi_2\rangle = \int_{-\infty}^{\infty} Y_l^m(\theta_1,\phi_1)Y_l^m(\theta_2,\phi_2)\,d\Omega$$

by typing:

```
$$
\langle \psi_1  \vert  \psi_2 \rangle =
          \int_{-\infty}^\infty \Sph{1} \Sph{2} \, d\Omega
$$
```

Large collections of pre-defined macros are called "formats".
REVTEX and TEXsis are special formats for physicists.

# Figures and Images

Drawings and figures can be included in the document if they are in an "Encapsulated" PostScript file (ie, an `.eps` file).

- In Plain TEX you need to use the macro file `epsf.tex`, like so:

```
\input epsf.tex
   ⋮
\line{\epsfxsize=\hsize\epsfbox{TeX-Process.eps}}
```

- In LaTEX you use the "`graphix`" style package, like so:

```
\usepackage{graphicx}
   ⋮
\includegraphics[width=\columnwidth]{LAT96Fig2}
```

JPEG and PNG images can be converted to EPS first. Example:

```
$  pngtopnm TeXShopScreen.png | pnmtops -noturn > TeXShopScreen.eps
```

# Citations and References

A utility program called BIBTEX makes it easy to manage citations and references:

1. You collect one or more bibliography files (eg. `mylist.bib`) containing a list of fields (title, author, journal, etc..) for each work that you might wish to cite. Each item is identified by a unique 'key'. For example:

```
@book{Bevington1969,
          title = {Data Reduction and Error Analysis
                    for the Physical Sciences},
          author = {Philip R. Bevington},
          edition = {First},
          publisher = {McGraw Hill},
          year = {1969}
}
```

2. In your text, when you wish to cite a work, you simply say `\cite{key}`. Each new work gets a new citation number.

3. At the end of the manuscript file you put

   ```
   \bibliography{mylist}
   ```

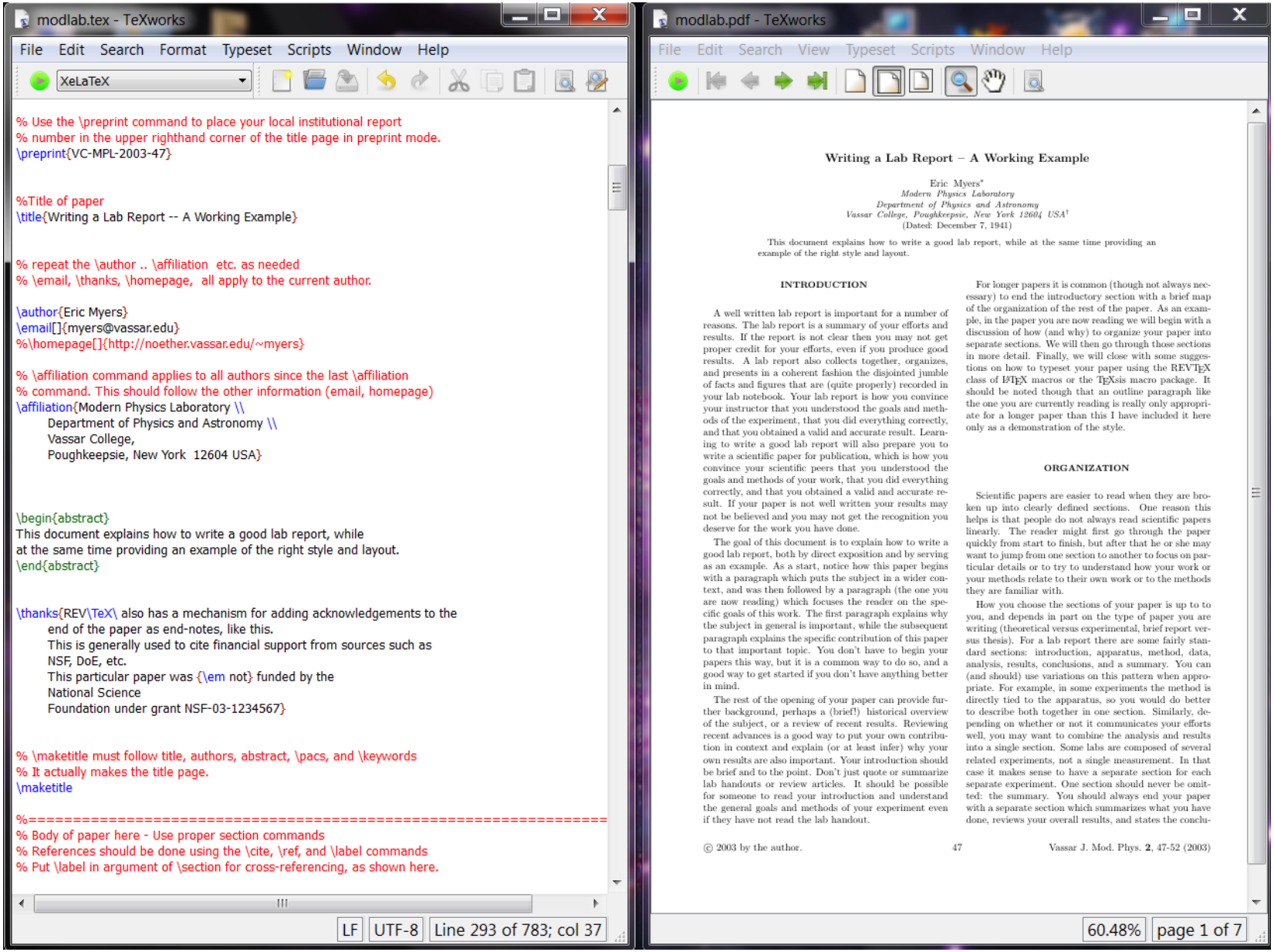
   This names the bibliography file (ie, `mylist.bib`) and it is also where the list of references will appear.

4. When you run TEX, the citations are added to an auxiliary file, `myfile.aux`. You then run the BIBTEX program, which collects the citations, selects the references from the bibliography file, and outputs the list of references as `myfile.bbl`.

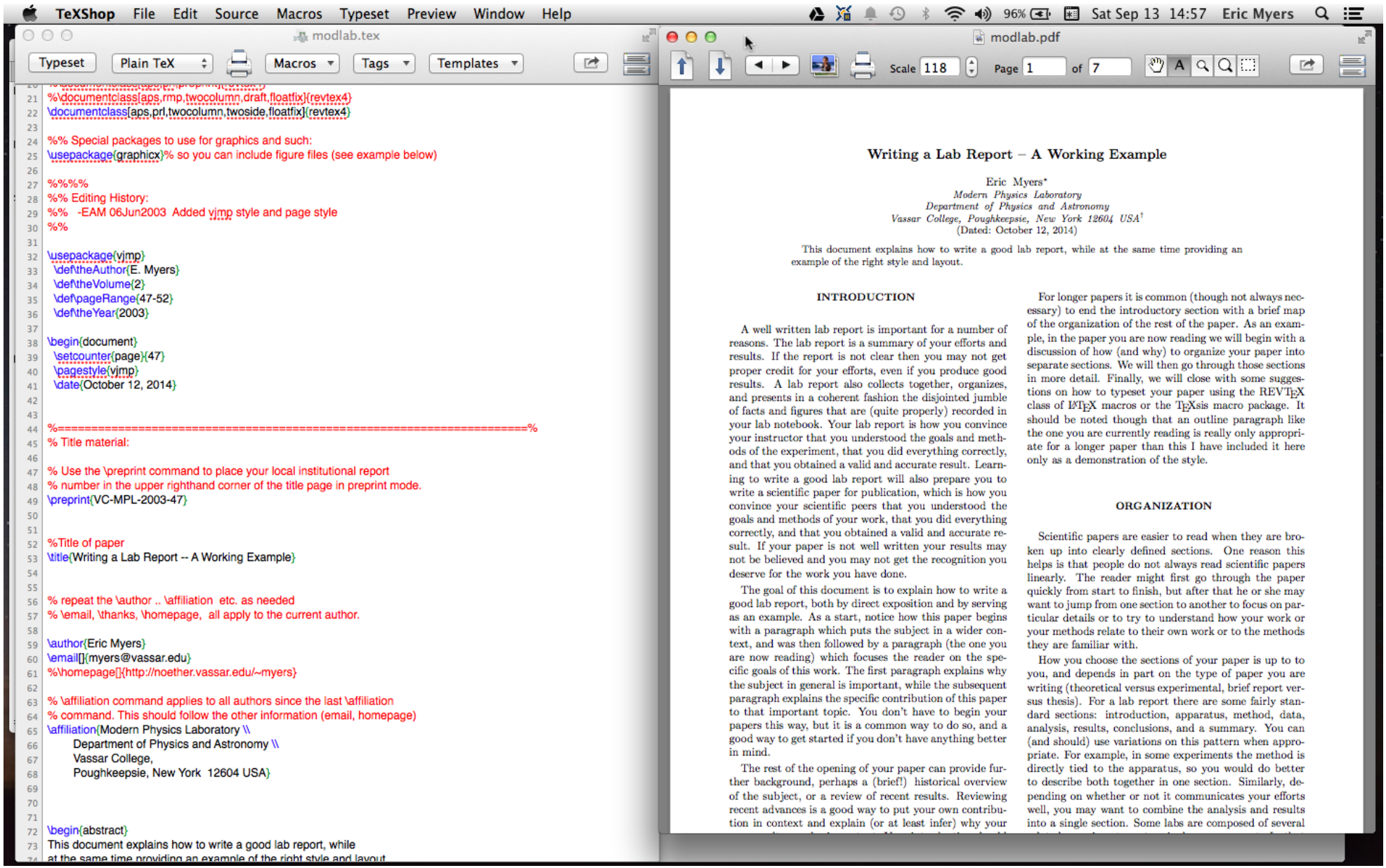
5. When you run TEX again the list of references (in `myfile.bbl`) is inserted at the end of your document (where you put the `\bibliography`).

You only need to run BIBTEX again if you add, delete, or re-arrange references.

# TEX on Windows – MiKTeX and TeXWorks



# TEX on Mac – TeXShop



# TEX on Linux – TEX Live

- TEX is available in all major Linux distributions as "TeX Live" (just the TEX engine, no front end, but lots of other tools):

  **Fedora/Red Hat:**

  ```
  $ sudo yum install texlive
  ```

  **Ubuntu/Debian:**

  ```
  $ sudo apt-get install texlive
  ```

- Use your favorite editor (`emacs`, `vi`, `nedit`) as the "front-end".
- Use `xdvi` to view the DVI file, or any PDF viewer for PDF output.
- Or, `texworks` packages also available on Ubuntu, Debian, and Fedora Linux.

# TEX for Physicists

- For LaTEX there is a "class" of macros called REVTEX which is used by the American Physical Society to typeset their journals (eg. *Physical Review*, *Physical Review Letters*, and *Reviews of Modern Physics*). Authors are encouraged to submit computer manuscripts using REVTEX.
- For Plain TEX the equivalent is TEXsis (`http://www.texsis.org`)
- For the Vassar Journal of Modern Physics there is a style file called `vjmp.sty` for use with REVTEX (see below...)

# Modern Physics Laboratory – Physics 201 at Vassar

How I transitioned college students from MS Word to REVTEX:

- Pairs of students performed 5 experiments, each 2 weeks long (2×3 hours per week, lab always open)
- Each team turned in a written report for the first 4 labs, alternating role of "first" and "second" author, using Word, TEX, or whatever they wanted
- Final experiment performed as a team, but each student report written as sole author. Use of REVTeX required.
- REVTeX examples and documentation provided from the start, so each student could transition at their own pace.

See `http://www.spy-hill.net/~myers/vassar/201/notes`

# Resources – TEX Software

- MiKTeX – TeX Engine for Windows (`http://www.miktex.org/`)
- TeXWorks – simple TeX front end for Mac and Windows (`http://www.tug.org/texworks/`)
- WinEdt – text editor for Windows and MiKTeX (`http://www.winedt.com/`)
- TeXShop – TeX front-end for Mac (`http://pages.uoregon.edu/koch/texshop/`)
- MacTeX.pkg – TeX Live for Mac (required by TeXShop) (`http://pages.uoregon.edu/koch/texshop/obtaining.html`)
- TeX Live – comprehensive TeX system for Linux (and Windows) (`https://www.tug.org/texlive/`)

# General TEX Resources

- `modlab.zip` – example REVTEX paper for Vassar Modern Physics Laboratory (`http://www.spy-hill.net/myers/vassar/201/notes`)
- REVTeX 4.1 – LaTeX macros used by American Physical Society (`https://journals.aps.org/revtex`)
- TUG – TEX User's Group (`http://www.tug.org/`)

- *"The TEXbook"* by Donald Knuth
- *"LaTEX: A Document Preparation System"* by Leslie Lamport
- *"A Gentle Introduction to TEX"* by Michael Doob