

L^AT_EX FOR PHYSICS: A DEMO

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Purpose of this document. We demonstrate basic use of L^AT_EX, mostly for preparing physics texts. Our aim is to load this little demo with examples of common things you do when typesetting equations, as many as we can recall; and to show some very basic general text formatting. This is *very* incomplete – it is really a demo. But we hope that it can be your basic template and reference, for ‘getting your foot in the door’ with Latex. A few options for document layout, setting of various preferences etc, are used too. You can download this file and its source from <http://oregonstate.edu/~dimcoviz/reference/>. This demo may grow with time.

Please don’t mistake this for a good introduction to L^AT_EX! The first reference is by the developer of the latex macro, Leslie Lamport [1]. This little book will get you a long way; we have used it for years, rarely ever needing more. But it is concise, and it is *not* geared toward math. A very complete and excellent book is Grätzer’s “*More Math Into Latex*” [2]. Among many other qualities, it naturally and fully incorporates the important AMS math [5]. And if you turn into a die-hard Latex user, you may also want the “*Companion*” [3]. There is an abundance of Internet resources, for example the well known “*Not So Short Introduction to Latex*” [4]. A regular Latex user will certainly need a good book. For a physicist [2] may be the ultimate resource, backed by Internet.

1. WHAT IS L^AT_EX AND HOW DOES IT DO ITS THING?

L^AT_EX is a complete typesetting system. You type up a file, following certain rules, then have it processed by the program, and the created output is a document such as this one. Or a letter; or a thesis. Or a book. This is a full-fledged and flexible system. The interesting thing is that, while one can write a book with it, it is at the same time quite easy to produce basic documents that satisfy a lot of needs.

So, you type the input file with your text. (Look at the source from which this text was compiled.) Then you ‘run latex’ on it; there are various ways to invoke processing, with slight differences, and here we show a basic one. At a UNIX prompt (>) you enter the following commands:

```
> latex phys_demo.tex
> dvips -o phys_demo.ps phys_demo.dvi
> ps2pdf phys_demo.ps
```

The first line invokes the program “latex,” that processes your input file, creating the ‘.dvi’ file from it. The `dvips` command processes that file, creating as its output (-o) a postscript file. The last command would create a ‘pdf’ file, in case you need it. One of the chief alternatives to above commands is to use `pdflatex` command instead. Also, there are graphical environments, where you can type your input and then click on buttons that invoke appropriate programs. (For example, `WinEdt` is a very nice Windows GUI. Note that it is a *graphical interface*, and while it invokes latex programs to process the file, those programs need be installed separately. On Linux, try `Kile`.)

If you like to play with stuff, rather than have it ‘explained’ first, at this point you can drop this piece of paper, copy our input file – and go. Change the text and math we have prepared to your liking or needs. Try things out. Latex’s system starts making sense very quickly, and its commands are logical.

As the latex program processes your input file, it recognizes certain structures and commands, typesetting them into a nicely formatted output. Now we will briefly describe some of the most important rules that latex follows while processing this input file.

First off, there are two basic “modes” of processing: text and math. In the text mode, latex will simply take text as it flows, fitting it into lines (possibly hyphenating words if needed), until it reaches a completely blank line in your input file. This chunk of text is then formatted as a paragraph, such as this one. Text’s easy: you just type it up, and when you want to start a new paragraph leave a blank line.

Latex starts the math mode when it runs into one of a few particular commands. All that follows is treated as math, adjusted to look the way math should look, and honoring special syntax that allows you to produce math symbols. This mode is on until a closing symbol comes, after which latex is back in its text mode. The symbols within which it is in math mode are: \dots or $\backslash(\dots\backslash)$, for “inline” math, inserted in the text (what does $\Delta x \Delta p \geq \hbar/2$ mean?); or, $\backslashbegin{equation} \dots \backslashend{equation}$, which displays the math prominently, on separate lines. (There are other ways to invoke math mode.) This is just a general statement about modes, we’ll discuss math later.

There is more to it than the basic modes, of course. All kinds of “environments” can be used, within which latex will format text in a different manner. For example: within $\backslashbegin{itemize}$ and $\backslashend{itemize}$, you enter \backslashitem ’s, and bulleted ‘items’ are produced. So this input:

```
 $\backslashbegin{itemize}$ 
 $\backslashitem$  Different “environments,” such as  $\backslashtexttt{enumerate}$ , can be very useful
 $\backslashitem$  There are many, like:  $\backslashtexttt{quote}$ ,  $\backslashtexttt{equation}$  (turns on math mode),
 $\backslashtexttt{theorem}$ ,  $\backslashtexttt{center}$  ...
 $\backslashitem[]$  (Btw, the symbol for  $\backslashverb|\backslashitem|$  in  $\backslashtexttt{itemize}$ , bullet by default,
can be changed too.)
 $\backslashend{itemize}$ 
```

will, upon processing, produce this output:

- Different “environments,” such as `enumerate`, can be very useful
 - There are many, like: `quote`, `equation` (turns on math mode), `theorem`, `center` ...
 - The enumeration method in `enumerate` (roman literals) can be changed.
- (Btw, the symbol for `\item` in `itemize`, bullet by default, can be changed too.)

An important example is handling graphics: this is done within an “environment,” and there are various ones that you can choose from. Or, you can create a whole ‘mini page’ layout, right within a normal page, using the `minipage` environment. (One good use of this is for placing a figure and equations side by side; there is an example in Section 4.) Another example: the above input that is shown is typed within `verbatim` environment, so that it is not processed but shown as typed, `verbatim`. (Then this is typed again without `verbatim`, and so is processed into our itemized list.) This environment can be used to show computer code, for example.

You can do simple text manipulation without resorting to an environment: there are *many* text-formatting “commands.” They are normally made up of a backslash (\backslash), followed by command’s name, and then a pair of braces within which is its “argument,” the text to format: $\backslashtextsl{\textsl this}$ gives *slant this*. Some environments have command-versions too, for short, in-line uses. For example, the latex commands that we show in the text are typed within the `\verb` command, which operates much like the mentioned `verbatim` environment. Note that there are all *kinds* of commands, which do things other than slant a word or two. Some commands can take options too: $\backslashcommand[options]{argument}$. We are only talking about basic text formatting.

That’s about it. You type your text, where blank lines start new paragraphs. When you want a particular layout or format, you can use an “environment” that produces it (math included). When you need math inserted in your text, you type it between two \$ signs (for example). And

then there are various commands, which can format a short piece of text without breaking the paragraph. Before we show some examples of basic text formatting, we wish to finish this overview by mentioning the top-level layout of a valid Latex input file.

All your text to be processed goes between `\begin{document}` and `\end{document}` commands. Everything before the ‘beginning’ is called the “preamble,” where many general options can be set. Only one line is required, to specify the overall document style (“class”) to be used, possibly with options. Bibliography goes at the end, see Section 5. Here’s a rather minimal, yet fully capable input file. It should compile.

```
\documentclass{article}
\usepackage{amsmath,amssymb,latexsym}
\usepackage{graphicx}
\begin{document}
\section{Introduction}
Your text, \emph{nically} organized into sections.
\section{Stuff}
Do your  $x^2$  inline, or displayed: \[ f(x) = x^2 \quad \text{is easy!} \]
Don't forget to properly quote your sources: see \cite{best_book}.
\end{document}
\thebibliography{99}
\bibitem{best_book}
... actual reference
```

Our choice: `\documentclass[11pt,fleqn,reqno,oneside]{amsart}`. This sets the style to be of an ‘article’ kind: `{amsart}`. The options are: font-size of 11pt (default: 10pt); equations to be aligned on the left (`fleqn`) and numbered on the right (`reqno`); and it is meant to be printed one-sided, what only affects a few minor things.¹

There are many other styles, such as `article` (legacy), `letter`, etc. Or, the name of a separate “style file” can be used, instead of a built-in class, where the style file defines how to process the document. Many journals require you to use their specific style, often determining most typesetting options. If the purpose of your document does not demand a set format (like a thesis or a submitted paper may), there are also many options you can choose from: have it layed out in two columns, if you wish or must; as a “draft;” for different paper sizes; etc. A number of options for how math is handled can be set too.

In the preamble you can define your own convenient commands, like we have in our file. All kinds of things can be set up.² Importantly, you can insert packages, via `\usepackage{...}`. There are many, offering great additions to the default functionality. Most of them come with the Latex distribution, and you only need to instruct latex to actually load them. Some worth metioning right here are:

math: Since we use `amsart` document class, which loads 4 great AMS math packages, we only add `\usepackage{amssymb,latexsym}`, for symbols. If `article` class is used instead (legacy but OK), for nice math one would want to add: `{amsmath,amsfonts,amsthm}` and `{amssymb,latexsym}`, typically as two separate `\usepackage{}` lines.

graphics: There are a few packages for dealing with graphics: we use `graphicx`.

slides: Presentations are prepared (a little) differently; look up `beamer`. We like it.

Even the shortest list of basic things in Latex goes on and on, but this already runs longer than we thought it would. So we’ll now go to specific examples of how to actually do the thing.

¹Our reason: we didn’t want our names printed on every second page, what you get by default with `amsart` style.

²See our choice for margins, reducing the white space around the text. (Remove those lines to see the default.)

2. BASIC TEXT FORMATTING

Sometimes you need to *visually emphasize*³ things. Note that the `\emph{...}` just used has a slight cursive. *When there is more than a word or two to be made visually distinct, I find ‘slanted text’ to be more readable.* **Bold** is quite **striking**; I rarely use it.

Occasionally, there is need for different font sizes as well. The footnote size also goes by command `{\Small ...}`. And there may be a need for a different font family, like `sans serif`, or `type writer`; or maybe for an even more EYE-CATCHING FONT. *For longer passages of texts that need be distinguished visually, a reasonable choice may be some combination of a different font and a smaller size.*

Extra spaces in the input file are ignored; there is always exactly `one\llspace` \rightarrow one space, between words. Still, sometimes we may need to adjust the width of the spacing a little. You rarely need this in the text, but it can be helpful for equations, so we will show some examples below. (Note that Latex adjusts spaces anyway, when deciding how to lay out the paragraph in lines.)

Note In some kinds of documents, you may need to put a note in the margin using `\marginpar{...}`.

but easy
with this!

Please note that this cannot accomodate much text, and even what shows on screen can get cut off on the printer. Remember that these should be used sparingly, and only very rarely. We have shortcuts to customized commands for margin notes, defined in the preamble, that are used here.

- You can use symbols, too.

One last comment on the use of margins, footnotes, various fonts, and such: most of the time, you don’t want your report to look like a Christmas tree. I’d suggest: focus on the content. Latex is designed to make it easy to do so.

3. EQUATIONS, OF COURSE

Often you’ll need to place math right in the sentence, to avoid breaking the flow of the statement (what displayed equations can do). Let’s push it: `$$\sum_{i=1}^{3N} e^{-\beta \epsilon_i}$$` is shown as $\sum_i e^{-\beta \epsilon_i}$ – btw, what quantity is this? This may be too clumsy looking to be right in the text, but it is handled well! Now let’s look at a displayed equation. The following input

```
\begin{equation} \label{eq_dispEx}
f(\vec{x}) = \sum_{i=1}^3 x_i^2 \quad \text{(What is this function?)}
\end{equation}
```

produces the equation below. The `\label{...}` command is not necessary for typesetting this equation. It is there only so that we can refer to it elsewhere, without having to know its number.

$$f(\vec{x}) = \sum_{i=1}^3 x_i^2 \quad (\text{What is this function?}) \quad (1)$$

Now we can talk about Eq. (1), even when its number changes as we add or remove others. This is the business of “cross-referencing.” It is a huge convenience, so we’ll say a few words about it.

When something may need to be referred to elsewhere in the text, we put a `\label{...}` next to it. Like in the above equation, or like we did in our very first `\subsection*{...}`. Then all we need is to say `\ref{...}`, with our name for the label in the curlyes (`eq_dispEx` above), and we get a numeric reference to it. This is used to refer to anything that Latex can enumerate: section, equation, figure, etc. We usually want to add parenthesis and/or a descriptive word, to be clear what we refer to, as `\ref{...}` only produces the number itself. And we want to use the `~`, like so: `Eq.~(\ref{...})`; then `Eq.` and the rest will never be separated across lines. Finally, for citing references say `\cite{...}` and in the curlyes give the name of that reference as specified in your bibliography entry. This is either at the end of the input file (look it up in this one), or in a separate file (see Section 5). To get references updated when you change them, you need to run Latex twice. Now we’ll throw at you some more statements on math mode. First a couple of biggies.

³Well written text should not need this much. Oh, and don’t overdo it with footnotes; they can be distracting.

- (1) No blank lines in math mode are allowed. These can be sneaky bugs.
- (2) Spaces don't matter in math mode either: $\$ _x^2 _ + 1 \$$ typesets as: $x^2 + 1$.

There are many environments for math mode. For math that will run over more than one line, here we use `align` and `gather` (remember, need to `\begin{}` and `\end{}` them). The AMS-math packages have many fine-grained facilities. When you have a specific need, check out your options. (Don't use the original Latex's `eqnarray`. Often required, and better, is `align`.) One little thing: command `\\` ends the current line (without indentation characteristic of a new paragraph). It is a normal text command, the shortcut for `\newline`. But it is essential in multi-line math environments, a part of syntax, generally indicating the end of the line.

If you want an un-numbered equation, you can use asterisk: `\begin{equation*}`. (This is a way to suppress enumeration of many other things; our very first `\subsection*{}` is an example.) Or use `\[...]`, which displays math, but doesn't enumerate it. Another way to turn off numbering, useful for multi-line math environments, is: on the equation's line add `\notag`. Using `\tag{name}`, on the equation's line, allows reference to that equation by the actual `name`. (No number is generated; the equation is typeset with `(name)` in the margin.)

Probably a better way to do inline math is: `\(...\)`. The 'shortcut' `\(...\)` can make it harder for Latex to spot certain errors, as the same symbol is used to start and end a mode.

If math turns heavy, having a *good* resource helps. The book [2] is extremely strong on math typesetting, using AMS-math all along. The following examples should help with a lot of basics.

3.1. Examples. They are not random, contrary to appearance. We try to include most little things that one uses regularly. The examples are mostly drawn from what we needed to write. Note that these are by no means complete, nor meant to be 'the best' ways to do this.

Sometimes, integrals can replace sums. (When can this be done? And come up with examples.)

$$\begin{aligned}
 P_1 &= \sum_{i=1}^N (l_i - 1) \rightarrow \frac{L^3}{\pi^3 c^3} \frac{4\pi}{8} \int_0^{w_p} dw w^2 \left(\frac{B}{\tau_p \omega} - 1 \right) = \frac{4\pi}{8} \frac{L^3}{\pi^3 c^3} \int_0^{\frac{2\pi c \mu}{l_p}} dw w^2 \left(\frac{B}{(l_p/c)\omega} - 1 \right) \\
 &= \frac{4\pi}{8} \frac{L^3}{\pi^3 c^3} \frac{cB}{l_p} \frac{1}{2} \left(\frac{2\pi \mu c}{l_p} \right)^2 - \underbrace{\frac{4\pi}{8} \frac{L^3}{\pi^3 c^3} \int_0^{w_p} dw w^2}_{= N = \frac{4\pi \mu^3}{3} \left(\frac{L}{l_p} \right)^3} = \mu^2 \left(\frac{L}{l_p} \right)^3 B \left(1 - \frac{4\pi \mu}{3B} \right) \quad (2)
 \end{aligned}$$

Too much of an equation runs over margins; and numbering may suffer too, see Eqs. (3-5).

Hyper-volume of a tetrahedron (\mathcal{P}^N) in N -dimensional space, recursively adding boundaries (\mathcal{B}).

$$\widetilde{W} = V(\mathcal{P}^N) + \mathcal{B}_w[\mathcal{P}^N] = V(\mathcal{P}^N) + \left\{ V(\mathcal{P}_1^{N-1}) + V(\mathcal{P}_2^{N-1}) + \dots + V(\mathcal{P}_N^{N-1}) \right\} \quad (3)$$

$$= \frac{1}{N!} l_1 \dots l_N + \left\{ \underbrace{\frac{1}{(N-1)!} l_2 \dots l_N^{(1)}}_{V \text{ of subspace } \perp \text{ to } x_1} + \underbrace{\mathcal{B}_w[\mathcal{P}_1^{N-1}]}_{\text{its boundary}} \right\} + \dots + \left\{ \underbrace{\frac{1}{(N-1)!} l_1 \dots l_{N-1}^{(N)}}_{\dots \text{ complement to } x_N} + \underbrace{\mathcal{B}_w[\mathcal{P}_N^{N-1}]}_{\text{its boundary}} \right\}$$

$$\dots \text{ (long) } \dots = \sum_{n=1}^N \frac{1}{n!} \left(\sum_{c_p} \prod_{k=1}^n l_{i_k}^{(c_p)} \right) = \sum_{n=1}^N \frac{1}{n!} \left(\sum_{i_1 < \dots < i_n} l_{i_1} l_{i_2} \dots l_{i_n} \right) \equiv \sum_i \frac{1}{n!} \widehat{S}_n \quad (4)$$

The terms are: all different products $\{l_{i_1} \dots l_{i_n}\}$, out of $\{l_{i_1}, \dots, l_{i_N}\}$. (The index $c_p \dots$)

Spreading angle of the radiation passing through the solar corona, due to refraction

$$\alpha = 2 \left(1 - \underbrace{\frac{\beta}{2} \sum_i \frac{A_i}{r_0^{p_i}}}_{\text{generates } o(\beta)} \right) r_0 \int_{r_0}^{\infty} \left[\frac{\beta}{2} \sum_i \frac{A_i p_i}{r^{p_i+1}} \cdot \frac{1}{r} \left(1 + \underbrace{\frac{\beta}{2} \sum_i \frac{A_i}{r^{p_i}}}_{\text{generates } o(\beta)} \right) \frac{1}{\sqrt{1 - (r_0/r)^2}} \right] dr$$

The integral is calculated readily, using substitution $\cos \theta = r_0/r$, and its more convenient form

$$I = r_0 \int_{r_0}^{\infty} \frac{1}{r^{p+1}} \frac{dr}{\sqrt{r^2 - r_0^2}}, \quad \text{with: } \tan \theta = \frac{\sqrt{r^2 - r_0^2}}{r_0}, \quad -\frac{r_0}{r^2} r = -\sin \theta d\theta \quad \text{and } r = \frac{r_0}{\cos \theta} \quad (5)$$

$$= r_0 \int_0^{\pi/2} \frac{\frac{(r_0/\cos \theta)^2}{r_0} \sin \theta d\theta}{\left(\frac{r_0}{\cos \theta}\right)^{p+1} r_0 \tan \theta} = \boxed{\frac{1}{r_0^p} \int_0^{\pi/2} \cos^p \theta d\theta} \quad (6)$$

The remaining integral is evaluated using the beta function, in case you're curious. (EXERCISE)

With no restriction on occupation numbers ($\sum_i n_i \neq \text{const.}$), and with the simple expression for the energy ($E_{\{n_i\}} = \sum_i \hbar \omega_i n_i$, with $\omega = c|\mathbf{k}|$), the partition function for equilibrated photon gas

$$Z = \sum_{n_{\mathbf{k},\epsilon}} e^{-\beta \sum_{n_{\mathbf{k},\epsilon}} \hbar \omega_{\mathbf{k}} n_{\mathbf{k},\epsilon}} = \prod_{\mathbf{k},\epsilon} \sum_{n=0}^{\infty} e^{-\beta \hbar \omega n} = \prod_{\mathbf{k},\epsilon} \frac{1}{1 - e^{-\beta \hbar \omega}} \quad (\text{Prove equalities.}) \quad (7)$$

Can you explain what the quantity below is? (Hint: $[J_x, J_y] = iJ_z$, and cyclic permutations.)

$$J_z = \frac{1}{i} \left. \frac{dR_z(\theta)}{d\theta} \right|_{\theta=0} = \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}, \quad R_z(\theta) = \begin{pmatrix} \cos \theta & \sin \theta & 0 \\ -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad [J_x, J_y] = iJ_z \quad (8)$$

Matricies (of various kinds) need be embedded in another math environment. See [2, 9.7.1].

What can you say about these? (In a nutshell, I mean.) Can you answer the questions?

$$\frac{\partial H}{\partial p_i} = \dot{q}_i \quad \text{and} \quad \frac{\partial H}{\partial q_i} = -\dot{p}_i. \quad \text{How does this relate to: } \frac{d}{dt} \left(\frac{\partial L}{\partial \dot{q}_i} \right) - \frac{\partial L}{\partial q_i} = 0 \quad (9)$$

$$\hat{\mathcal{H}}|\psi_{\{n_i\}}\rangle = E_{\{n_i\}}|\psi_{\{n_i\}}\rangle \quad \text{What do we mean by subscripts } \{n_i\} ? \quad (10)$$

$$i\hbar \frac{\partial |\psi\rangle}{\partial t} = \hat{\mathcal{H}}|\psi\rangle \quad \text{Find the stationary solution for SHO in energy representation.} \quad (11)$$

$$\partial_\mu F^{\mu\nu} = j^\nu, \quad \partial_\mu \tilde{F}^{\mu\nu} = 0. \quad \text{Get the 'usual' Maxwell's equations from this.} \quad (12)$$

$$\text{Above we use: } F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu, \quad \text{its dual } \tilde{F}^{\mu\nu} = \frac{1}{2} \epsilon^{\mu\nu\rho\sigma} F_{\rho\sigma}. \quad \text{Also, } \partial^\mu \equiv \frac{\partial}{\partial x^\mu}$$

A comment on delimiters in equations. Parenthesis and brackets are typed in, braces need be 'escaped' as they are normally parts of commands ($\backslash{}$ gives you the left brace, etc). Often these

are needed large, to nicely surround fractions, matrices and such. Latex does adjust the size, but not always well. Then we can use `\left(... \right)`, to get suitably large `()`. (The same goes for brackets and braces: `\left[` and `\left\{` will produce left symbols of necessary size.)

And a comment on another thing you'll often find in these equations: the spacing adjustments. You can add the whole inter-word space (`\quad`), or add a little space (`\,`), or you can take small negative space (`\!`), and these were three. For more spacing, `\quad` is great. Latex messes with these in a paragraph anyway, what you can actually see above (`\quad` isn't really bigger than `\,`). But in equations they are useful. Please remember that this is a matter of the *final* tune-up; and that it only affects how equations *look* – it won't make the contents any better.

4. GRAPHICS

One can do a lot with graphics in Latex; there are in fact whole books on this. But much of graphics is done simply. The figure below, from the file `exocytCartoon.eps`, is included here by typing:

```
\begin{figure}[ht]
  \includegraphics[width=3.6in]{exocytCartoon}
  \caption{ {\small This cartoon ...} } \label{fig_exocyt}
\end{figure}
```

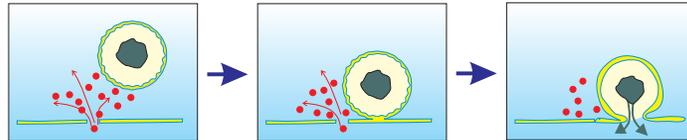
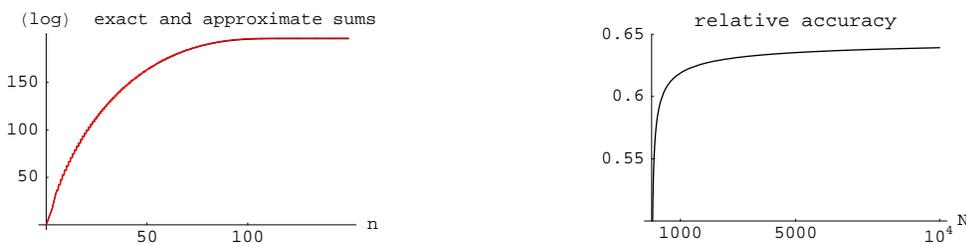


FIGURE 1. This cartoon represents a surge of Ca^{2+} ions from the synaptic cleft into the neural cell (through a calcium channel which opens briefly), leading to exocytosis.

When you want multiple figs (or anything) in a row, the simplest way to go is with `\hbox{}`, like so: `\hbox{ \includegraphics{...} \hspace{2cm} \includegraphics{...} }`. Here are two *Mathematica* plots, checking an approximation for a sum



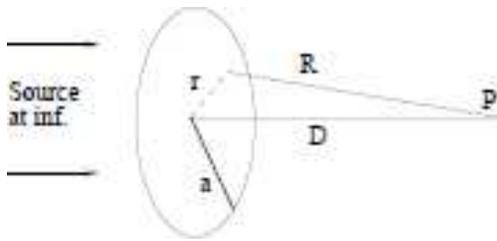
Note that with `\hbox{}` you need to set up all spacing and centering on your own. It is raw.

Here's a more involved set up, using the powerful `minipage`. A wave from a point source propagating through an opening (aperture) results in the light disturbance at a point (P) behind it. In Kirchof's scalar theory, this is obtained as the integral over the secondary waves propagated from the aperture

$$E(P) = -\frac{Ai}{2\lambda} \iint_{\mathcal{A}} \frac{e^{ik(r+s)}}{rs} [\cos(n, r) - \cos(n, s)] dS \quad \rightarrow \quad A \iint_{\mathcal{A}} \tilde{E}(\tilde{P}) Q(\tilde{P}) \frac{e^{-ikR}}{R} dS$$

Some simplifications have been employed above. Now we want it simpler yet. See Fig. (2). At this point we refer to the figure, since Latex may have to place it on another page, if there is no room right below or above this text.⁴ This is an example of issues with placement of “floating” objects, such as figures.

⁴Note that `\label{name}`, needed for `Fig. (\ref{name})`, in the figure environment *must* be by the `\caption{}`.



$$\begin{aligned}
 R &= D \sqrt{1 + (r/D)^2} \\
 &= D \left(1 + \frac{1}{2} \left(\frac{r}{D} \right)^2 + \frac{1}{8} \left(\frac{r}{D} \right)^4 + \dots \right) \\
 kR &= \frac{D}{\lambda} + \frac{1}{2} \left(\frac{r^2}{\lambda D} \right) + \frac{1}{8} \left(\frac{r^2}{\lambda D} \right) \left(\frac{r}{D} \right)^2 + \dots
 \end{aligned}$$

FIGURE 2. With the point of observation (P) very far, the smallness of r/D allows this expansion. (With source not at infinity everything in the aperture has to be considered on the spherical wave front.)

5. QUOTE YOUR SOURCES: BIBLIOGRAPHY

The badest and meanest tool for this is BIB_TE_X. You need a separate file(s) with bibliographical entries, formatted in a particular way. This is used from your latex input file, via two simple commands. There are *excellent* Internet resources, see for example [6].

If you don't need to have a database with many references, Latex's great bibliography system will do nicely: references are typed in at the end of your input file. Each starts with `\bibitem{name}`, and then the actual reference information follows. You use with `\cite{name}`.

6. ERRORS

Well, right, *the errors*. You will get things wrong. (Anyway, we do.) Forgetting a backslash or a closing curly comes easily, and the subsequent processing will break down, with a message. And we better tell you right now: Latex's error reporting is not very friendly. The best way to deal with this is to see, from its message, where in the file Latex thinks the error is, and look carefully *around*⁵ that line in your input, spotting the error. For this it is crucial to process the input often. (I 'latex' my source file every minute or few. It only takes seconds. For me this is a part of typing.) Then it is easy to spot the mistake – it's just been typed in! This goes just like for programming: compile often, otherwise finding errors may be a nightmare. With this habit you don't really notice occasional errors, and using Latex is very pleasurable, with the output that is certainly rewarding.

REFERENCES

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- [2] George Grätzer, “*More Math Into LaTeX*,” 4th Edition, Springer 2007.
- [3] F. Mittelbach, M. Goossens, J. Braams, D. Carlisle, and Chris Rowley, “*The LaTeX Companion*,” 2nd Ed. Addison-Wesley 2004.
- [4] Most current version: <http://www.ctan.org/tex-archive/info/lshort/english/> (“CTAN,” the standard tex archive, is the source for many latex goodies.) Get the file “`lshort_letter.pdf`,” formatted for the ‘letter’ size paper (US). The original location is: <http://tobi.oetiker.ch/lshort/lshort.pdf>
- [5] <http://www.ams.org/tex/amsmath-faq.html>
- [6] Our favorite ones: <http://www.bibtex.org/>, http://en.wikibooks.org/wiki/LaTeX/Bibliography_Management, <http://www.andy-roberts.net/misc/latex/latextutorial3.html>, <http://newton.ex.ac.uk/tex/pack/bibtex/btxdoc/btxdoc.html>, http://artis.imag.fr/~Xavier.Decoret/resources/xdkbibtex/bibtex_summary.html.

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⁵Often Latex notices that there is a problem a little *after* the actual error in the file.

latex2dnd. Demo Course. git2edx. latex2edx. MIT announces the release of version 1.1 of the open-source latex2edx compiler for generating interactive MITx / edX courses from LaTeX. <https://github.com/mitocw/latex2edx>. This system is particularly useful for producing interactive course content where the expressive power of LaTeX is helpful, e.g. with math, physics, CS content. latex2edx provides interactivity via the introduction of a basic new macro, the "answer box" `\edXabox`, which defines a mechanism for student input, as well as how that input is to be graded. Also introduced are