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Skill Pill: LaTeX Course

Lecture 3: Advanced Typesetting

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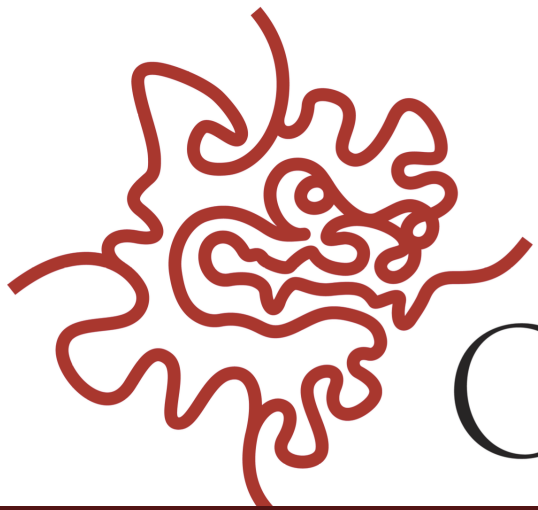

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Units of Length

Absolute Units:

- `cm`
- `mm`
- `pt` 1 pt = 0,351459804 mm
- `in` 1 inch = 2,54 cm

Relative Units:

- `em` width of the capital 'M' in the font in use
- `ex` heights of the lowercase 'x' in the font in use

Horizontal spacing:

`\hspace{length}` creates a horizontal space of the defined length except at the beginning or end of a line

`\hspace*{length}` similar to `\hspace{length}`, but it also works at the beginning or end of a line

`\hfill` creates a 'rubber length', which means that it will expand as much as needed to fill the line maximally.

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`\dotfill` similar to `\hfill`, but with dots

`\hrulefill` similar to `\hfill`, but with a line

Vertical spacing:

`\vspace{length}` creates a vertical space of the defined length in between two paragraphs except at the beginning or end of a page

`\vspace*{length}` similar to `\vspace{length}`, but it also works at the beginning or end of a page

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`\vspace{length}` creates a vertical space of the defined length in between two paragraphs except at the beginning or end of a page

`\vspace*{length}` similar to `\vspace{length}`, but it also works at the beginning or end of a page

`\vfill` creates a 'rubber length', which means that it will expand as much as needed to fill the page maximally.

`\\[length]` creates a vertical space of the defined length after the line break

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Counters

Counters are integers which are used for numbering various objects.
Important counters are:

`page`	counts the pages
`section`	counts the sections (c. f. `subsection`, `subsubsection`)
`equation`	counts the numbered equations
`enumi`	counts the numbered items of the `enumerate` environment (first layer, `enumii`, `enumiii`, `enumiv`, ... for the deeper layers)

LaTeX is organizing those counters automatically.

Manipulation of Counters

Counters can be manipulated using the following commands:

`\setcounter{counter}{value}` changes `counter` to `value`.

`\addtocounter{counter}{value}` adds `value` to `counter`.

`\stepcounter{counter}` increases the value of `counter` by 1 and resets all dependent counters to zero.

`\refstepcounter{counter}` similar to `\stepcounter{counter}`, but also adds a label for referencing.

Checking Counter values

In order to check the value of a set counter, you can call them in the document as follows

`\thepage` page count

`\thesection` section count (c. f. `subsection`, `subsubsection`)

`\theequation` equation count

`\theenumi` current count in the latest `enumerate` environment

LaTeXwill also call this command to print each counter, then increment the value by 1.

Creation and Access of Counters

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You can define your own counters using:

`\newcounter{myCounter}[higherrankcounter]` creates a new counter, with the name `myCounter` having the value 0. You can add an existing counter as optional argument (`higherrankcounter`) so that every time this counter is increased using `\stepcounter{higherrankcounter}` the new counter `myCounter` is set back to 0.

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With `\value{counter}` you can use the value of the counter in the source code. This command is not for printing the value in the document, but rather for handling.

Example:

```
\setcounter{Counter2}{\value{Counter1}}
```

`Counter2` is set to the value of `Counter1`

Example

If you want to start the document from page 5, you can use

```
\setcounter{page}{5}
```

at the beginning of the document.

Printing of Counters

In order to print the counters you can use different commands:

`\arabic{counter}` prints the value of `counter` as an arabic number (4).

`\roman{counter}` prints the value of `counter` as an lower case roman number (iv).

`\Roman{counter}` prints the value of `counter` as an upper case roman number (IV).

`\alph{counter}` prints the value of `counter` as an lower case letter (d).

`\Alph{counter}` prints the value of `counter` as an upper case letter (D).

Lengths

Similar to counters you can also create and manipulate lengths:

`\newlength{\name}` creates the length `\name` and sets it to `0pt`.

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`\settowidth{\name}{text}` sets the value of `\name` to the width of `text` in the current font.

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`\settoheight{\name}{text}` sets the value of `\name` to the heights of `text` above the baseline.

`\settodepth{\name}{text}` sets the value of `\name` to the heights of `text` below the baseline.

Example

Lengths can for example be used as arguments for \hspace{}:

```
\newlength{\length}
\settowidth{\length}{A few words}

⋮

\hspace{\length}
```

Lengths can be modified by multiplication:

```
\includegraphics[width=0.5\textwidth]{figure.jpg}
```

Important Lengths

Helpful lengths are e. g.

`\textwidth` width of the text

`\textheight` heights of the text

`\colwidth` width of a column when defined

`\baselineskip` line spacing

`\parindent` indent at the beginning of a paragraph

`\parskip` vertical distance between two paragraphs

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`\parskip` vertical distance between two paragraphs

With `\parindent` and `\parskip` you can for example customize the layout of your paragraphs.

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Setting the Line Spacing with setspace

In order to change the line spacing one can use the setspace package. Example:

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\usepackage[onehalfspacing]{setspace}
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creates a document with 1.5 line spacing.

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`onehalfspacing`

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creates a document with 1.5 line spacing.

Possible options:

`singlespacing` (standard)

`onehalfspacing`

`doublespacing`

Those options may be used as a declaration (switch), e. g. `\doublespacing` changes the format to double spacing. (from that point on).

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Page Style

The `\pagestyle{style}` command can be used to layout the content of the header and footer. `style` can be chosen from the following:

`empty`	empty header and footer
`plain`	page number in the footer (standard)
`headings`	chapter or section titles in the header (formatting depends on the document class)
`myheadings`	content of header and footer can be defined manually (the `scrlayer-scrpage` package offers an even greater variety)

If the `\pagestyle{style}` is placed within the preamble it affects the whole document, however if placed within the document it only has effect starting from the placement of the command. If you want to change the layout of a single page you can use `\thispagestyle{style}`.

Aufgrund der Relation

$$\hat{\boldsymbol{\varepsilon}}_{\sigma_f}(\theta,\varphi)\cdot\hat{\boldsymbol{\varepsilon}}_{\Lambda}(\theta_k,\varphi_k)=\hat{\boldsymbol{\varepsilon}}_{\sigma_f}(\theta,0)\cdot\hat{\boldsymbol{\varepsilon}}_{\Lambda}(\theta_k,\varphi_k-\varphi)\,, \tag{4.12}$$

die sich leicht überprüfen lässt, und der Integration über φ_k hängt der differentielle Wirkungsquerschnitt nicht vom Azimutalwinkel φ des gestreuten Photons ab. Daher kann der Einfachheit halber $\varphi = 0$ für die Berechnung angenommen werden. Dies ist zu erwarten, da auch bei der Streuung eines Bessel-Strahls zirkularer Polarisation keine Richtung ausgezeichnet ist. Nach Lösung des Integrals und Summation über die orthogonale Polarisationszustände σ_f erhält man für den differentiellen Wirkungsquerschnitt für die Thomson-Streuung eines Bessel-Strahls schließlich einen kompakten analytischen Ausdruck:

$$\frac{\mathrm{d}\sigma_{\mathrm{tw}}}{\mathrm{d}\Omega}=\frac{r_e^2}{4}\left[(1+\cos^2\theta_k)(1+\cos^2\theta)+2\sin^2\theta_k\sin^2\theta\right]. \tag{4.13}$$

Wie man leicht nachrechnet, erhält man im Fall $\theta_k = 0$ das Ergebnis für ebene Wellen, siehe Gl. (3.16). Man erkennt ebenfalls, das die topologische Ladung m in dem Ausdruck nicht vorkommt, sie hat also keinen Einfluss auf die Winkelverteilung.

4.3 Berechnung der Stokes-Parameter

Die Untersuchung der Polarisation der gestreuten Strahlung geschieht mittels der Stokes-Parameter, die man gemäß Unterabschnitt 2.3.3 aus der Dichtematrix erhält. Die Elemente der Dichtematrix sind

$$\rho_{\sigma\sigma'}=\int\frac{\mathrm{d}\varphi_k}{2\pi}\frac{(\hat{\boldsymbol{\varepsilon}}^*_{\sigma}(\theta,0)\cdot\hat{\boldsymbol{\varepsilon}}_{\Lambda}(\theta_k,\varphi_k))\,(\hat{\boldsymbol{\varepsilon}}^*_{\sigma'}(\theta,0)\cdot\hat{\boldsymbol{\varepsilon}}_{\Lambda}(\theta_k,\varphi_k))^*}{\frac{1}{4}\left[(1+\cos^2\theta_k)(1+\cos^2\theta)+2\sin^2\theta_k\sin^2\theta\right]}. \tag{4.14}$$

Die Integration ergibt

$$\boldsymbol{\rho}=\frac{1}{(1+\cos^2\theta_k)(1+\cos^2\theta)+2\sin^2\theta_k\sin^2\theta}\times\begin{pmatrix}(1+\cos^2\theta_k)\cos^2\theta+2\sin^2\theta_k\sin^2\theta & -2\mathrm{i}\Lambda\cos\theta_k\cos\theta\\ 2\mathrm{i}\Lambda\cos\theta_k\cos\theta & 1+\cos^2\theta_k\end{pmatrix} \tag{4.15}$$

und daraus erhält man die Stokes-Parameter als kompakte analytische Ausdrücke

$$\tilde{P}_1=\frac{(1-3\cos^2\theta_k)\sin^2\theta}{(1+\cos^2\theta_k)(1+\cos^2\theta)+2\sin^2\theta_k\sin^2\theta}, \tag{4.16}$$

$$\tilde{P}_2=0\,, \tag{4.17}$$

$$\tilde{P}_3=\frac{4\Lambda\cos\theta_k\cos\theta}{(1+\cos^2\theta_k)(1+\cos^2\theta)+2\sin^2\theta_k\sin^2\theta}. \tag{4.18}$$

Im Gegensatz zum differentiellen Wirkungsquerschnitt sind die Stokes-Parameter von der Helizität des Bessel-Strahls abhängig, diese bestimmt das Vorzeichen von $\tilde{P}_3$. Aus den Stokes-Parametern ergibt sich der Polarisationsgrad zu

$$\Pi=\frac{\sqrt{(1-3\cos^2\theta_k)^2\sin^4\theta+16\cos^2\theta_k\cos^2\theta}}{(1+\cos^2\theta_k)(1+\cos^2\theta)+2\sin^2\theta_k\sin^2\theta}. \tag{4.19}$$

Auch hier erkennt man, dass sich im Fall $\theta_k = 0$ die Stokes-Parameter und der Polarisationsgrad für ebene Wellen (siehe Gln. (3.19) und (3.20)) ergeben.

4.4 Einfluss der Parameter des Bessel-Strahls auf Winkelverteilung und Polarisation

Die topologische Ladung m hat keinen Einfluss auf Winkelverteilung und Polarisation der gestreuten Strahlung, da sie in der Entwicklung (2.49) lediglich in Form eines Phasenterms innerhalb der Amplituden $a_{\varkappa m}$ in die Berechnung eingeht, der durch die Bildung des Betragsquadrates verschwindet.

4.4.1 Einfluss der Helizität Λ

Die Helizität Λ des Bessel-Strahls bestimmt lediglich das Vorzeichen von $\tilde{P}_3$, die Winkelverteilung und die restlichen Stokes-Parameter hängen nicht von ihr ab. Dies ist zu erwarten, da $\tilde{P}_3$ den Anteil der zirkularen Polarisation angibt und das Vorzeichen die entsprechende Helizität beschreibt. In dieser Hinsicht verhalten sich Bessel-Strahlen und ebene Photonenwellen gleich.

4.4.2 Einfluss des Öffnungswinkels θ_k

In Abbildung 4.1 ist die Winkelverteilung der gestreuten Photonen für verschiedene Öffnungswinkel θ_k zwischen 0 und 90° dargestellt. Der Fall $\theta_k = 90°$ ist dabei ein rein theoretischer Grenzfall: In diesem Fall ist $k_z = 0$, die Welle propagiert also nicht mehr entlang der z-Achse, sondern nur noch in radialer Richtung. Er wird hier dennoch angeführt, um die theoretischen Grenzen aufzuzeigen.

Für $\theta_k = 0$ entsprechen der differentielle Wirkungsquerschnitt und die Stokes-Parameter exakt denen für den Streuung einer ebenen Welle. Je größer der Öffnungswinkel ist, desto deutlicher werden die Unterschiede.

The scrlayer-scrpage Package

With the scrlayer-scrpage package you can customize the header and the footer of the document. For further information visit:

http://sunsite.informatik.rwth-aachen.de/ftp/pub/mirror/ctan/macros/latex/contrib/koma-script/doc/scrguien.pdf

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Title Pages with `\maketitle`

If `titlepage` is set as an optional argument for the document class, a separated title page will be created. This is standard for some document classes.

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Example:

```
\documentclass[titlepage]{scrartcl}
```

Title Pages with the `titlepage` Environment

In order to customize your title page you can use the `titlepage` environment.

The title page is defined within `\begin{titlepage}...\end{titlepage}`.

Many examples may be found in the linked document.
`http://ftp.jaist.ac.jp/pub/CTAN/info/latex-samples/TitlePages/titlepages.pdf`

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Multiple LaTeX Files

In order to structure the document you can use different files (e. g. for different chapters). You include those files into your main document using

```
\include{file/path}
```

or

```
\input{file/path}
```

The command `\input` includes the content without any page breaks, whereas `\include` causes a page break before and after the content of the loaded file. Furthermore one can not nest `\include`.

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Defining New Commands

To define a new command you can use

```
\newcommand{\commandname}{definition of command}
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Example:

```
\newcommand{\degcelsius}{\,^\circ\mathrm{C}}
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Example:

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```

From now on you can use `\degcelsius` throughout your whole document: `$T=23\degcelsius$` creates $T = 23\,^\circ\mathrm{C}$.

Defining New Commands

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You can also define commands with arguments:

```
\newcommand{\commandname}[number of arguments]{definition
    of command}
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Example:

```
\newcommand{\e}[1]{\ensuremath{\times 10^{#1}}}
```

Defining New Commands

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```
\newcommand{\commandname}[number of arguments]{definition
    of command}
```

Example:

```
\newcommand{\e}[1]{\ensuremath{\times 10^{#1}}}
```

Now `\e{}` can be used as command: `$N_A=6.022\e{23}$` creates $N_A = 6.022 \times 10^{23}$.

Redefinition of Commands

In order to redefine an existing command you have to use `\renewcommand{}[]{}` instead of `\newcommand{}[]{}` with the same syntax.

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Bibliography with thebibliography

In order to create a bibliography you can use the thebibliography environment.

Example:

```
\begin{thebibliography}{2}
\bibitem{jackson} J.D. Jackson:
\emph{Classical Electrodynamics.}
$3^{\mathrm{rd}}$\ Ed., New York: Wiley, 1999.
\bibitem{sakurai} J.J. Sakurai:
\emph{Advanced Quantum Mechanics.}
Reading, Mass.: Addison-Wesley, 1967.
\end{thebibliography}
```

The second argument {2} denotes the longest label in the bibliography.

References

[1] J.D. Jackson: *Classical Electrodynamics*. 3rd Ed., New York: Wiley, 1999.

[2] J.J. Sakurai: *Advanced Quantum Mechanics*. Reading, Mass.: Addison-Wesley, 1967.

Bibliography with thebibliography

The bibliography items can be referenced in the text using \cite{key}, which creates a label based in the definition in the bibliography.

Example:

```
Further calculations may be found in the textbook
    of J.D. Jackson \cite{jackson}.
```

creates

Further calculations may be found in the textbook of J.D. Jackson [1].

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Bibliographies with the Biblatex package

The Biblatex packages offers the possibility to create a bibliography based on a .bib file.

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The entries of a .bib file look for example like this:

```
@article{rechtsman2013PhoFlotopins,
author = {Rechtsman, Mikael C and Zeuner, Julia M and
    Plotnik, Yonatan and Lumer, Yaakov and Podolsky, Daniel
    and Dreisow, Felix and Nolte, Stefan and Segev,
    Mordechai and Szameit, Alexander},
journal = {Nature},
number = {7444},
pages = {196--200},
publisher = {Nature Publishing Group},
title = {{Photonic Floquet topological insulators}},
url = {http://www.nature.com/nature/journal/v496/n7444/
    abs/nature12066.html},
volume = {496},
year = {2013}
}
```

How to use Biblatex

```
\usepackage{hyperref}

\usepackage[sorting=none, hyperref, maxbibnames=6]{biblatex}

\addbibresource{literature.bib}

\begin{document}

As it was shown by Rechtsman et al.
    \cite{rechtsman2013PhoFlotopins} \dots

\printbibliography

\end{document}
```

As it was shown by Rechtsman et al. [1] ...

References

[1] Mikael C Rechtsman et al. "Photonic Floquet topological insulators". In: *Nature* 496.7444 (2013), pp. 196–200. URL: http://www.nature.com/nature/journal/v496/n7444/abs/nature12066.html.

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One of the advantages of the `biblatex` package are the numerous options.

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Documentation: `http://ftp.jaist.ac.jp/pub/CTAN/macros/latex/contrib/biblatex/doc/biblatex.pdf`