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一场发生在脑海深处的自发极化

What is Light?
Try hard to Understand & Expand it
A General Description of Light

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September 12, 2020

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* A \LaTeX lover

ETP Company

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Colophon

This document was typeset with the help of KOMA-Script and L^AT_EX using the kao-book class.

The source code of this book is available at:

<https://github.com/fmarotta/kaobook>

(You are welcome to contribute!)

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世界的和谐体现在形式和数量上，自然哲学的心和灵魂以及一切诗歌都体现在数学美的概念上。

– D'Arcy Wentworth Thompson

前言

我的观点是，每个 \LaTeX 极客，至少在他的一生中有一次，都觉得有必要创建自己的类：这就是发生在我身上的事情，这就是结果，但是，这应该被看作是一个仍在进行中的工作。实际上，这个类并不完全是原创的，但它是我在许多指南、教程、博客和 text.stackexchange.com 文章中发现的所有最佳思想的混合体。特别是，主要的想法来自两个来源：

- ▶ [Ken Arroyo Ohori's Doctoral Thesis](#), which served, with the author's permission, as a backbone for the implementation of this class;
- ▶ The [Tufte-Latex Class](#), which was a model for the style.

本书第一章是导论，涵盖了本课程最基本的特点。接下来，有一堆章节专门讨论所有的命令和环境，你可以用来写一本书；特别地，它将解释如何添加注释、图形和表以及引用。第二部分讨论页面布局和设计，以及其他特性，如彩色框和定理环境。

我开始写这门课是作为一个实验，因此它应该被视为。由于它一直是我个人使用的缩进，它可能不是完美的，但我发现它很满意的用途，我想让它。我分享这篇文章，希望有人能从这里找到写作的灵感。

Federico Marotta

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1.1 主要思想

许多现代印刷教科书采用了突出的页边空白处的布局，在这里可以显示小的数字、表格、注释和几乎所有的东西。可以说，这种布局通过将主要文本与辅助材料分离来帮助组织讨论，而辅助材料同时又非常接近文本中引用它的地方。

这份文件的目的并不是要道歉，因为有许多更适合这项任务的作者；所有这些单词的目的只是填充空间，以便读者可以看到用 `kaobook` 类编写的书是什么样子的。同时，我还将尝试说明类的特性。

`kaobook` 背后的主要思想来自于这个 [blog post](#)，实际上这个类的名称是专门为这篇文章的作者 Ken Arroyo Ohori 命名的，他允许我根据他的论文创建一个类。因此，如果你想知道更多喜欢 1.5 栏布局的理由，一定要阅读他的博客文章。

您可能已经注意到，灵感的另一个来源是 `tuft-latex` 类。设计相似的原因是很难改进已经很好的东西。但是，我认为这个类比 `tuft-latex` 更灵活。例如，我尝试只使用标准包，并尽可能少地从头实现¹ 因此，只要您阅读了提供该特性的包的文档，定制任何东西都应该非常容易。

在本书中，我将阐述该类的主要特性，并提供有关如何使用和更改内容的信息。让我们开始吧。

1.2 本类的功能

`kaobook` 类更关注文档结构，而不是样式。实际上，众所周知的 \LaTeX 原则是结构和样式应该尽可能地分离 (参见第 1.2 节)。这意味着这个类将只提供命令、环境和一般情况下的机会来执行用户可能使用或不使用的操作。实际上，类中嵌入了一些样式问题，但是用户可以轻松地定制它们。

主要特点如下：

Page Layout 减少文本宽度是为了提高可读性，并为页边距留出空间，以便显示任何类型的元素。

Chapter Headings 相对于 `tuft-latex`，我们提供了多种章节标题可供选择；例子将在后面的章节中看到。

Page Headers 它们跨越整个页面，包括页边距，并在双侧模式下交替显示章节和节名。²

Matters The commands `\frontmatter`, `\mainmatter` and `\backmatter` have been redefined in order to have automatically wide margins in the main matter, and narrow margins in the front and back matters. However, the page style can be changed at any moment, even in the middle of the document.

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1: 这也意味着更容易理解和贡献类开发。实际上，还有很多地方需要改进，所以如果您感兴趣，可以在 [github](#) 上查看存储库！

2: 这是 Tufte 设计的另一个不同之处。

3: Sidenotes (like this!) are numbered while marginnotes are not



Figure 1.1: The Mona Lisa.
https://commons.wikimedia.org/wiki/File:Mona_Lisa,_by_Leonardo_da_Vinci,_from_C2RMF_retouched.jpg

4: 参考 第 7 章来获取更多示例。

The audacious users might feel tempted to edit some of these packages. I'd be immensely happy if they sent me examples of what they have been able to do!

Margin text We provide commands `\sidenote` and `\marginnote` to put text in the margins.³

Margin figs/tabs A couple of useful environments is `marginfigure` and `marginable`, which, not surprisingly, allow you to put figures and tables in the margins (*cfr.* 图 1.1).

Margin toc Finally, since we have wide margins, why don't add a little table of contents in them? See `\margintoc` for that.

Hyperref `hyperref` is loaded and by default we try to add bookmarks in a sensible way; in particular, the bookmarks levels are automatically reset at `\appendix` and `\backmatter`. Moreover, we also provide a small package to ease the hyperreferencing of other parts of the text.

Bibliography We want the reader to be able to know what has been cited without having to go to the end of the document every time, so citations go in the margins as well as at the end, as in Tufte-Latex. Unlike that class, however, you are free to customise the citations as you wish.

The order of the title pages, table of contents and preface can be easily changed, as in any \LaTeX document. In addition, the class is based on KOMA-Script's `scrbook`, therefore it inherits all the goodies of that.

1.3 本类未实现的功能

As anticipated, further customisation of the book is left to the user. Indeed, every book may have sidenotes, margin figures and so on, but each book will have its own fonts, toc style, special environments and so on. For this reason, in addition to the class, we provide only sensible defaults, but if these features are not needed, they can be left out. These special packages are located in the `style` directory, which is organised as follows:

style.sty 这个包包含页面布局、页眉和页脚、章节标题和整个文档中使用的字体的规范。

packages.sty 加载额外的包，用特殊的内容来装饰写作 (例如，这里加载 `listing` 包，因为不是每本书都需要它)。还定义了一些有用的命令，用于以相同的方式打印相同的单词，例如斜体的拉丁单词或逐字的 `packages`。

references.sty 一些有用的命令来管理标签和引用，再次确保以一致的方式引用相同的元素。

environments.sty 提供特殊的环境，比如框。简单和复杂的环境都是可用的; 所谓复杂，我们的意思是它们被赋予一个计数器，浮动的，可以放在一个特殊的目录中。⁴

theorems.sty The style of mathematical environments. Actually, there are two such packages: one is for plain theorems, *i.e.* the theorems are printed in plain text; the other uses `mdframed` to draw a box around theorems. You can plug the most appropriate style into its document.

In the rest of the book, I shall assume that the reader is not a novice in the use of \LaTeX , and refer to the documentation of the packages used in this class for things that are already explained there. Moreover, I assume that the reader is willing to make minor edits to the provided packages for styles, environments and commands, if he or she does not like the default settings.

类选项、命令和环境

从十七世纪上半叶到十八世纪末，通过“实验现象 → ‘合理’揣测 → 建模解释”的方式，人们探究和争论着光的本质。

- ▶ 笛卡尔 (1596)、格里马第 (1618)、波义耳 (1627)、惠更斯 (1629)、胡克 (1635)、牛顿 (1643) ...
- ▶ 拉普拉斯 (1749)、托马斯·杨 (1773)、马吕斯 (1775)、布儒斯特 (1781)、泊松 (1781)、阿拉戈 (1786)、夫琅禾费 (1787)、菲涅尔 (1788)、柯西 (1789) ...

可惜大江东去，浪淘尽千古风流人物，将近两个世纪的螺旋上升的历史，埋葬了无数观察棋局落子规则的先辈们，连同他们模型中深深浅浅的揣测和尝试，如相对于粒子学说占优的波动学说，将光波比作声波，认为光波是纵波；认为光波是机械波，需要介质传递，而介质被称为以太...然而光波既不是纵波，也不需要媒介承载，以太也不存在...因此细节再丰富的经验公式，也无法掩盖这个时期的人们对光规律的认识，仍只停留在启蒙阶段。

从十八世纪下半叶到十九世纪末，并行的第二条线程上，反倒是另一支研究电磁现象的队伍，异军突起、弯道超车，精确地将光波纳入电磁波的集合，给出了波动学派梦寐以求的，光波的数学形式。——光波的本质，就是电磁场波动方程的解析解。

- ▶ 库伦 (1736)、J.B. 毕奥 (1774)、安培 (1775)、奥斯特 (1777)、F. 萨伐尔 (1791)、法拉第 (1791) ...
- ▶ 斯托克斯 (1819)、麦克斯韦 (1831)、莫雷 (1838)、迈克尔逊 (1852)、J.J. 汤姆森 (1856)、赫兹 (1857) ...

二十世纪初，黑体辐射 (ε)、光电效应 (ν)、康普顿 X 射线散射 (p)、光压 (p) 的存在，光波有最小能量单元，该单元也有相应的动量，于是光的粒子性呈现出来。

同一时期，二次电子发射机制，光电倍增管，单光子探测器，如约而至。

- ▶ 普朗克 (1858)、爱因斯坦 (1879)、康普顿 (1892) ...

二十世纪下半叶，电子的双缝衍射，证实德布罗意关系在实物体系也成立，稳固了非实物体系——光的波粒二象性的认识。

同一时期，激光的发明，诞生了与黑体内最杂乱无章的热辐射相对应的，最井然有序的辐射，自此人类终于追梦到了两个几乎像南极北极一样绝对纯净但又绝对对立的理想之国⁶。

- ▶ 乔治·汤姆森 (1892)、梅曼 (1927) ...

二十一世纪初，单光子源出现，人类在可以探测单光子的同时，也可以制造和发射单光子了⁷。

波粒二象性、实物与辐射，两对四个概念，正因其最现实，所以也最魔幻；正因其既现实又魔幻，因此也最吸引人。

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6: 《统计物理》邂逅了《激光原理》。

7: 一般而言，在历史上的同一时间截面，检测精度总是高于加工精度、同一精度下检测难度低于制造难度。

而最物质和最不物质的东西，都需要用最严密的数学来描述，因为只有第三种极致，配得上这两种极致。

2.1 Electromagnetic wave

这条世界线的宇宙也诞生于一场大爆炸，不过这次 Big Bang 确定是人为引发的。

这条世界线的盘古名为“麦克斯韦”，他所创生的天地，被后世称为《电动力学》。

《经典电动力学》又发祥于“麦氏方程组的微分形式”。由之导出定态波动方程这样一个不含时的泛定方程，即亥姆霍兹方程，再结合边界条件，便可解出泛定方程系数待定的解，如行波，驻波，但更多情况下的解既不是在三个维度上的行波，也不是三个维度上的驻波，而是在开放和半开放的维度和方向上是行波⁸，而在两端封闭的维度上为驻波，并且在两端封闭的方向上，振幅随空间的起伏的空间周期、波长、波矢、本征值的取值均是分立的，取值不同的本征值对应不同本征模式的本征函数（子波），而这些子波的线性叠加，便构筑出了相应边界条件下的可能存在的解。若再给定初始条件，还可以解出解中的各项待定系数，确定初始时间断面之后的波的时空演化轨迹。于是便可通过《数学物理方法》上经典的波动形式，描绘光⁹。

落实到《电动力学》中的具体场景，在一个维度半封闭、两个维度自由的导体内表面下，可解出导体内电场为一沿着几乎平行于界面内法线向导体内部传播，并随着深入距离的增加而振幅指数衰减的行波、折射波（无论入射波方向如何）；而在一个维度全封闭、两个维度自由的谐振腔内...；两个维度封闭、单维度自由的波导内...；或三个维度上均有边界的封闭空间中...。

激光是电动力学所解出的平面电磁波集全有序时的极端情形，另一个情形是热辐射，此时的电磁波、电磁场用统计物理、量子电动力学来解释则更为漂亮。因此麦克斯韦所开辟的经典电动力学是万物之母，所解出的行波、驻波们，往下平行地分化了两个分支，一是井然有序的激光场及其横模纵模，二是极度无序的统计物理中的光子气体。这便找到了我们在宗谱上的绝对位置，以及追溯到了我们的兄弟和父母。

2.1.1 无源介质中电磁场波动方程

可以证明¹⁰，普遍形式的微分形式的麦氏方程组，其四个方程均仍适用于非均匀、各向异性，甚至非线性的电磁介质，并且适用于非稳恒电磁场。以 SI 单位制写为：

8: 对导体上下表面单向封闭的是如此；但对无侧面的开腔间的稳态场分布问题，在开放方向上却不是行波而是稳态横模，这是因为该方向的行波都出射或衍射掉了，剩下的稳态场不再分布于腔镜外缘，不再被衍射。

9: 《电动力学》全反射波导内两端封闭的两个维度上的 TEW 和 TMW、《激光原理》一维封闭腔镜中稳定光场分布的纵模，连同《量子力学》中的“一维无限深势阱势下的定态薛定谔方程的解”、封闭空间导致粒子与波的动量波矢均分立取值等等，其源头理应均可追溯到《数学物理方法》中“边界条件、泛定方程均齐次的分离变数法/傅里叶级数法”中的“两端固定的一维弦的横振动”这个“第一类边界问题”，这也是一切“驻波条件”的来源。

10: 其来源可查看一份由 Docear 绘制的思维导图。

定理 2.1.1 注释

- ★ 各物理量头上腭化符代表时变
- ★ 花体代表相应物理量的数学表达式是实的，虚部为零
- ★ 这里不考虑将 $\tilde{\mathcal{J}}_f$ 和 \mathbf{v} 扩展为满足洛伦兹协变的四维矢量；因为暂不需将 Maxwell 方程组拓展为描绘相对性的高速带电粒子所激发的统一电磁场的协变形式。

定理 2.1.1 (Maxwell 方程组 - 微分形式)

$$\left\{ \begin{array}{l} \nabla \cdot \tilde{\mathcal{D}} = \tilde{\rho}_f \\ \nabla \cdot \tilde{\mathcal{B}} = 0 \\ \nabla \times \tilde{\mathcal{E}} = -\frac{\partial \tilde{\mathcal{B}}}{\partial t} \\ \nabla \times \tilde{\mathcal{H}} = \tilde{\mathcal{J}}_f + \frac{\partial \tilde{\mathcal{D}}}{\partial t} \end{array} \right. \quad (2.1)$$

其中, $\tilde{\mathcal{D}}, \tilde{\mathcal{B}}, \tilde{\mathcal{E}}, \tilde{\mathcal{H}}$ 都是实的、具有物理意义的, 复色场、时变场。这体现了 Maxwell 方程组包罗万象、无一例外的普适性。

考虑如下理想电介质, 其自由电荷体密度 $\tilde{\rho}_f = 0$, 传导电流面密度 $\tilde{\mathcal{J}}_f = \tilde{\rho}_f \cdot \mathbf{v} = \mathbf{0}$ ¹¹, 则四号方程右侧只剩极化电流与位移电流之和 $\partial\tilde{\mathcal{D}}/\partial t$; 将考虑上述条件下的四号方程, 代入经 $\nabla \times$ 作用后的三号方程中, 得:

$$\begin{aligned}\nabla \times (\nabla \times \tilde{\mathcal{E}}) &= \nabla \times \left(-\frac{\partial \tilde{\mathcal{B}}}{\partial t} \right) = -\frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{B}}) \\ &\xrightarrow[\tilde{\mathcal{B}}=\mu_0(\tilde{\mathcal{H}}+\tilde{\mathcal{M}})]{\text{四号方程}} -\mu_0 \frac{\partial}{\partial t} \left(\frac{\partial \tilde{\mathcal{D}}}{\partial t} + \nabla \times \tilde{\mathcal{M}} \right) \\ &= -\mu_0 \left[\frac{\partial^2 \tilde{\mathcal{D}}}{\partial t^2} + \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{M}}) \right] \\ &\xrightarrow[c=\frac{1}{\sqrt{\mu_0 \epsilon_0}}]{\tilde{\mathcal{D}}=\epsilon_0 \tilde{\mathcal{E}}+\tilde{\mathcal{P}}} -\frac{1}{c^2 \cdot \mu_0 \epsilon_0} \cdot \mu_0 \left[\frac{\partial^2 (\epsilon_0 \tilde{\mathcal{E}} + \tilde{\mathcal{P}})}{\partial t^2} + \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{M}}) \right] \\ &= -\frac{1}{c^2} \frac{\partial^2 \tilde{\mathcal{E}}}{\partial t^2} - \frac{1}{c^2 \cdot \epsilon_0} \left[\frac{\partial^2 \tilde{\mathcal{P}}}{\partial t^2} + \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{M}}) \right] \quad (2.3)\end{aligned}$$

便有无源非线性电磁介质中, 电场波动方程的最普遍形式:

推论 2.1.2 (无源非线性电磁介质 - 电场波动方程的最普遍形式)

$$\nabla \times (\nabla \times \tilde{\mathcal{E}}) + \frac{1}{c^2} \frac{\partial^2 \tilde{\mathcal{E}}}{\partial t^2} = -\frac{1}{\epsilon_0 c^2} \left[\frac{\partial^2 \tilde{\mathcal{P}}}{\partial t^2} + \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{M}}) \right] \quad (2.4)$$

同理, 通过类似的步骤, 可得无源非线性电磁介质中, 磁场波动方程的最普遍形式:

推论 2.1.3 (无源非线性电磁介质 - 磁场波动方程的最普遍形式)

$$\nabla \times (\nabla \times \tilde{\mathcal{H}}) + \frac{1}{c^2} \frac{\partial^2 \tilde{\mathcal{H}}}{\partial t^2} = -\frac{1}{c^2} \frac{\partial^2 \tilde{\mathcal{M}}}{\partial t^2} + \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{P}}) \quad (2.5)$$

上述一组方程¹², 还可分别写作另两种形式:

$$\begin{cases} \nabla \times (\nabla \times \tilde{\mathcal{E}}) + \frac{1}{\epsilon_0 c^2} \frac{\partial^2 \tilde{\mathcal{D}}}{\partial t^2} = -\frac{1}{\epsilon_0 c^2} \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{M}}) \\ \nabla \times (\nabla \times \tilde{\mathcal{H}}) + \frac{1}{\mu_0 c^2} \frac{\partial^2 \tilde{\mathcal{B}}}{\partial t^2} = \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{P}}) \end{cases} \quad (2.6)$$

$$\begin{cases} \nabla \times (\nabla \times \tilde{\mathcal{D}}) + \frac{1}{c^2} \frac{\partial^2 \tilde{\mathcal{D}}}{\partial t^2} = \nabla \times (\nabla \times \tilde{\mathcal{P}}) - \frac{1}{c^2} \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{M}}) \\ \nabla \times (\nabla \times \tilde{\mathcal{B}}) + \frac{1}{c^2} \frac{\partial^2 \tilde{\mathcal{B}}}{\partial t^2} = \mu_0 \left[\nabla \times (\nabla \times \tilde{\mathcal{M}}) + \frac{\partial}{\partial t} (\nabla \times \tilde{\mathcal{P}}) \right] \end{cases} \quad (2.7)$$

但一般不采用这两种形式, 因为二者含有过多的、关于电磁场的非线性函数的物理量们, 不便于求解。

2.1.2 复色场的单色化

特殊函数的齐次常微分方程, 如拉普拉斯方程、亥姆霍兹方程、波动方程、输运方程, 在具有不同对称性的坐标系下的通解, 将引出不同的基本函数族。复色场可以由具有与之相同对称性的基本函数族, 在具有相应对称性的坐标系下展开。

11: 在导体中, 当电磁波周期大于材料固有的特征时间 τ , 即电磁波频率不太高 (偏红), 且导体电导率较大的良导体条件下, 良导体内部自由电荷分布以指数衰减, 自由电荷只能分布于导体表面。但导体内部的传导电流却可能不为零, 这相当于导体内部 $\tilde{\rho}_f \rightarrow 0$ 虽趋近于零, 但 $|\mathbf{v}|$ 仍较大, 以至于 $\tilde{\mathcal{J}}_f = \tilde{\rho}_f \cdot \mathbf{v} \neq \mathbf{0}$ 。

(PS: 以上结论可通过解下述方程组查看:

$$\begin{cases} \nabla \cdot \tilde{\mathcal{D}} = \tilde{\rho}_f \\ \nabla \cdot \tilde{\mathcal{J}}_f + \frac{\partial \tilde{\rho}_f}{\partial t} = 0 \\ \tilde{\mathcal{J}}_f = \sigma \tilde{\mathcal{E}} \end{cases} \quad (2.2)$$

这种良导体自身体内电荷衰减快, 只有表面可分布电荷、很容易达到静电平衡的内禀属性, 配合高电导率所导致的大传导电流, 将导致良导体内折射单色电磁波几乎均沿界面法线传播 (全反射的折射波却平行于界面传播), 且良导体表面下几个穿透深度处的电磁场趋近于零 (全反射时也是), 则良导体/金属面或涂银、镀金的腔镜可认为是将复色场振幅在边界处骤降至零的边界条件, 以至于两端为零则可以使用驻波条件。

对良导体而言, 其表面的反射波的电场的平行、垂直分量的反射系数均接近于 1, 意味着两个正交方向的入-反射波的电场振幅接近, 反射波的偏振态与入射波几乎相同; 而电磁场边值关系约束反射波的相位、频率在边界上与入射波相同, 且波矢满足 snell 定律。则良导体表面的反射波近乎理想 (无损耗、无偏振态改变、无相位跃变或附加相移) 的镜面反射。但理想反射不应理解为光粒撞上后弹回。两电介质界面、全反射、良导体, 三种情形下的反射波、折射波, 均应理解为由交界面上位移电流作为次波波源, 同时产生并发出的一对交变电磁场。

12: 注意到上述六大物理量 $\tilde{\mathcal{E}}, \tilde{\mathcal{P}}, \tilde{\mathcal{D}}, \tilde{\mathcal{H}}, \tilde{\mathcal{M}}, \tilde{\mathcal{B}}$ 都是叠加场。这些叠加场所构成的波动方程多无法直接求解。一个办法是只考虑具有相同频率的场们所构成的方程, 即将方程单色化。为此首先需将六大物理量单色化, 这样它们才可在频率上统一, 并与方程同频。

此后便可使用分量变量法, 将波动方程定态化, 并给出解的空间部分。可见, 场的单色化, 是求解波动方程的充分条件之一、是一个可求出解的有效途径; 同时, 场的单色化, 也是引入电磁非线性效应的必要条件。而引入电磁非线性效应, 将与场的单色化一起, 共同构成波动方程单色化、定态化、给出解的充分条件。

13: 在统计物理中, 对单体系统的自由粒子的波函数、多体系统中无相互作用的理想气体的波函数, 如有限空间中的热辐射系统 (相对论性理想玻色气体), 均喜欢采用箱归一化边界条件——一方面这是在八卦限量空间中解释体系态密度的由来的要求 (尽管这可用相格解释说法来代替); 另一方面, 在热统中, 甚至可以说在理论物理学家眼中, 人们并不关心体系的边界条件; 当然, 由于热力学极限下所有边界条件都收敛到同一个结果, 则对大量粒子体系, 加有平移对称性的周期性边界条件, 将最大程度简化计算过程。在固体物理中, 对有限长一维原子链的集体振动 (格波), 也采取箱归一化即 B-K 周期性边界条件。

14: 在数学物理方法中, 将定义在有有限区间上的非周期函数 $f(x)$, 延拓为另一周期函数 $g(x)$, 对新周期函数 $g(x)$ 做傅里叶展开后, 用级数和在在有限区间上的值, 代表原非周期函数 $f(x)$ 。——这便允许物理学家将非周期的复色场, 改造为周期复色场, 然后傅里叶展开为单色平面 (行) 波场。

推论 2.1.5 注释

为方便表示, 认为 $\mathcal{A}_i \parallel \mathcal{B}_i \parallel \mathcal{C}_i$, 此时叠加场 $\tilde{\mathcal{G}}(\mathbf{r}, t)$ 是单向的; 但由于任何一个实际的复色多向场, 仍可看做多个单向叠加场构成, 所以此处的假设是合理的。

推论 2.1.5 另一种不推荐的写法

$$\begin{aligned}\tilde{\mathcal{G}}(\mathbf{r}, t) &= \sum_{i=-\infty}^{\infty} \mathcal{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)} \\ &= \sum_i' \mathcal{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)} + \text{c.c.} \\ &= \sum_i' [\mathcal{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)} + \text{c.c.}] \\ &= \sum_{i=1}^{\infty} [\mathcal{C}_i \cos(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t - \varphi_i) + \text{c.c.}] \\ &= \sum_i' [\mathcal{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t - \varphi_i)} + \text{c.c.}] \quad (2.9)\end{aligned}$$

在数学物理方法中, 波动方程和输运方程在分离变量之后, 空间部分方程均为亥姆霍兹方程,

那么在物理¹³上, 所有可空间周期性延拓的复色场, 其单色光波场便可用三角函数族表示; 同时也可用三角函数族的复数形式表示, 这是因为数学物理方法上, 实数形式的傅里叶级数可推导出复数形式的傅里叶级数。

在数学物理方法中, 周期函数 $g(x)$ ¹⁴ 的实数和复数形式的傅里叶级数分别为:

定理 2.1.4 (Mathematics - 实数 & 复数形式的傅里叶级数)

$$\begin{aligned}g(x) &= a_0 + \sum_{i=1}^{\infty} \left[a_i \cos\left(\frac{2\pi}{\Lambda} i \cdot x\right) + b_i \sin\left(\frac{2\pi}{\Lambda} i \cdot x\right) \right] \quad (a, b \in \mathbb{R}) \\ &= \sum_{i=0}^{\infty} c_i \cos\left(\frac{2\pi}{\Lambda} i \cdot x - \varphi_i\right) \quad (c \in \mathbb{R}; \varphi_0 = 0, a_i = c_i \cos \varphi_i, b_i = c_i \sin \varphi_i) \\ &= \sum_{i=-\infty}^{\infty} c_i e^{i\frac{2\pi}{\Lambda} i \cdot x} \quad \left(c \in \mathbb{C}; c_0 = a_0, c_+ = \frac{a_i - ib_i}{2}, c_- = \frac{a_i + ib_i}{2}\right) \\ &= \sum_{i=-\infty}^{\infty} g_i e^{i\left(\frac{2\pi}{\Lambda} i \cdot x - \varphi_i\right)} \quad \left[g_0 = c_0, g_i = \frac{c_{|i|}}{2} \quad (i \neq 0)\right]\end{aligned} \quad (2.8)$$

在物理上, 对周期性延拓后的矢量场的傅里叶展开, 同样也有实数和复数形式:

推论 2.1.5 (Physics - 实数 & 复数形式的傅里叶级数)

$$\begin{aligned}\tilde{\mathcal{G}}(\mathbf{r}, t) &= \mathcal{A}_0 + \sum_{i=1}^{\infty} \left[\mathcal{A}_i \cos\left(\frac{2\pi}{\lambda} i \hat{\mathbf{k}}_i \cdot \mathbf{r} - \frac{2\pi}{T} i \cdot t\right) + \mathcal{B}_i \sin\left(\frac{2\pi}{\lambda} i \hat{\mathbf{k}}_i \cdot \mathbf{r} - \frac{2\pi}{T} i \cdot t\right) \right]^I \\ &= \mathcal{A}_0 + \sum_{i=1}^{\infty} [\mathcal{A}_i \cos(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t) + \mathcal{B}_i \sin(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)]^{II} \\ &= \sum_{i=0}^{\infty} \mathcal{C}_i \cos(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t - \varphi_i)^{III} \\ &\quad (|\mathcal{A}|, |\mathcal{B}|, |\mathcal{C}| \in \mathbb{R}; \varphi_0 = 0, \mathcal{A}_i = \mathcal{C}_i \cos \varphi_i, \mathcal{B}_i = \mathcal{C}_i \sin \varphi_i) \\ &= \sum_{i=-\infty}^{\infty} \mathcal{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)} \\ &\quad (|\mathcal{C}| \in \mathbb{C}; \mathcal{C}_0 = \mathcal{A}_0, \mathcal{C}_+ = \frac{\mathcal{A}_i - i\mathcal{B}_i}{2}, \mathcal{C}_- = \frac{\mathcal{A}_i + i\mathcal{B}_i}{2}) \\ &= \sum_{i=-\infty}^{\infty} \mathcal{G}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t - \varphi_i)} \quad \left[\mathcal{G}_0 = \mathcal{C}_0, \mathcal{G}_i = \frac{\mathcal{C}_{|i|}}{2} \quad (i \neq 0)\right]\end{aligned} \quad (2.10)$$

^I 由点波源时域 & 驻波场空域合成的, 行波场时空域。

^{II} 基本行波族在空域中存在周期的方向上的正交性, 可由每一时间断面上, 不含时

基本函数族的正交性给定:

$$\begin{aligned}
 & \int_{\Lambda} \cos(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t) \cdot \sin(\mathbf{k}_j \cdot \mathbf{r} - \omega_j t) \cdot d\mathbf{r} \quad (i, j \in \mathbb{N}) \\
 &= \int_{\Lambda} [\cos(\mathbf{k}_i \cdot \mathbf{r}) \cos(\omega_i t) + \sin(\mathbf{k}_i \cdot \mathbf{r}) \sin(\omega_i t)] \cdot \\
 & \quad [\sin(\mathbf{k}_j \cdot \mathbf{r}) \cos(\omega_j t) - \cos(\mathbf{k}_j \cdot \mathbf{r}) \sin(\omega_j t)] \cdot d\mathbf{r} \stackrel{i \neq j}{=} 0 \\
 & \stackrel{i=j}{=} \int_{\Lambda} [\sin^2(\mathbf{k}_i \cdot \mathbf{r}) \sin(\omega_i t) \cos(\omega_i t) - \cos^2(\mathbf{k}_i \cdot \mathbf{r}) \cos(\omega_i t) \sin(\omega_i t) \cdot d\mathbf{r}] \\
 &= - \int_{\Lambda} \cos(2\mathbf{k}_i \cdot \mathbf{r}) \cos(\omega_i t) \sin(\omega_i t) \cdot d\mathbf{r} = 0
 \end{aligned} \tag{2.11}$$

基本行波族在空域上的正交性, 与时间无关:

$$\begin{cases} \int_{\Lambda} \cos(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t) \cdot \cos(\mathbf{k}_j \cdot \mathbf{r} - \omega_j t) \cdot d\mathbf{r} = 0 & (i \neq j; i, j \in \mathbb{N}) \\ \int_{\Lambda} \sin(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t) \cdot \sin(\mathbf{k}_j \cdot \mathbf{r} - \omega_j t) \cdot d\mathbf{r} = 0 & (i \neq j; i, j \in \mathbb{N}^+) \\ \int_{\Lambda} \cos(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t) \cdot \sin(\mathbf{k}_j \cdot \mathbf{r} - \omega_j t) \cdot d\mathbf{r} = 0 & (i, j \in \mathbb{N}) \end{cases} \tag{2.12}$$

- ii 任何时变复色场都可写为行波场的加和 (即其傅里叶级数、傅里叶逆变换成立的原因), 是因对于其级数中任何一个子波系数, 都存在一个傅里叶 (正) 变换, 以给出其值 (完备性):

$$\begin{aligned}
 & \begin{cases} \mathcal{A}_0 = \frac{1}{\Omega} \iiint_{\Omega} \mathfrak{E}(\mathbf{r}, t) \cdot d\mathbf{r} \\ \mathcal{A}_i = \frac{2}{\Omega} \iiint_{\Omega} \mathfrak{E}(\mathbf{r}, t) \cdot \cos(\mathbf{k}_i \cdot \mathbf{r}) \cdot d\mathbf{r} \quad (\mathbf{k}_i, i \neq 0) \\ \mathcal{B}_i = \frac{2}{\Omega} \iiint_{\Omega} \mathfrak{E}(\mathbf{r}, t) \cdot \sin(\mathbf{k}_i \cdot \mathbf{r}) \cdot d\mathbf{r} \end{cases} \\
 & \begin{cases} \mathcal{C}_i = \sqrt{\mathcal{A}_i^2 + \mathcal{B}_i^2} \\ \varphi_i = \arctan \frac{\mathcal{B}_i}{\mathcal{A}_i} \end{cases} \\
 & C_i = \frac{1}{\Omega} \iiint_{\Omega} \mathfrak{E}(\mathbf{r}, t) \cdot e^{-i(\mathbf{k}_i \cdot \mathbf{r})} \cdot d\mathbf{r} \\
 & \mathcal{C}_0 = \mathcal{C}_0, \mathcal{C}_i = \frac{\mathcal{C}_{|i|}}{2} (i \neq 0) \\
 & (\text{where } \Omega = \lambda_x \lambda_y \lambda_z; \iiint_{\Omega} = \int_0^{\lambda_x} \int_0^{\lambda_y} \int_0^{\lambda_z})
 \end{aligned} \tag{2.13}$$

- ⁱⁱ 若 ω_i 与 \mathbf{k}_i 的下标 i 都指代某条单色光, 则 i 不相同的 ω_i 或 \mathbf{k}_i 可以相同。否则若二者的下标表示某频率的单色光, 则要求对于任意 $i \in \mathbb{N}$, 均有 $\omega_i = \frac{2\pi}{T} i$ 、 $\mathbf{k}_i = \frac{2\pi}{\lambda} i \hat{\mathbf{k}}_i$
ⁱⁱⁱ 这里的初始相位 φ 、 \mathbf{r} 和 t 的值, 均参照为量度复色场的时空演化, 所选取的时空坐标系以给定; 复色场 $\mathfrak{E}(\mathbf{r}, t)$ 须是空间周期延拓后的; 且该坐标系下的它且最好还同时是空间上的偶函数场, 以便实现 $\varphi_i = 0$ 、 $|\mathbf{C}| \in \mathbb{R}$ 以简化单色平面波的形式

物理学家对单色场的数学表达式、复色场的傅里叶展开式, 常采用复数形式; 但同时又希望各单色子波的振幅是实的。

对此, 最合适的一种方法, 是采用 $\sum_{i=-\infty}^{\infty} \mathfrak{E}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t - \varphi_i)}$ 此种形式的展开式。此时, 单色场的表达式¹⁵ 为: $\mathfrak{E}_i(\mathbf{r}, t) = \mathfrak{E}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t - \varphi_i)}$ 。

但有一些“撇脚”的物理学家, 他们在这两个条件的基础上, 还有第三个条件, 那就是要求将各个单色场的初相 φ_i 置零, 即令上述展开式中的各单色子波的 $\varphi_i = 0$; 或令另一复式展开¹⁶ $\sum_{i=-\infty}^{\infty} \mathbf{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)}$ 中的各 $|\mathbf{C}_i| \in \mathbb{R}$ 。

一般来说, 在没有好好解释一番之前, 是不能这么做的。但数学上确实可以做到, 或者说给予善后般的解释。

回到本节最初, 任何一个抽象出的单色场¹⁷, 均来源于某个实际的复色场; 而时变复色场要想傅里叶展开为行波形式的单色场, 首先至少须是空间上的周期函数; 但任何一个实际的复色场几乎都不是周期性函数。这就要求, 在傅里叶展开之前、在分解和抽象出行波式的单色场之前, 必须对实际的复色场进行周期延拓。

15: 单色场的表达式, 来源且仅来源于复色场的展开式, 别无其他出处; 这也是上文讨论各种形式的傅里叶级数的原因。

16: 该展开式本身初相即为零, 然而其振幅不一定是实的。为满足三个条件, 只需 redefine 其下所有单色场的振幅。该操作的效果, 等价于对另一复数形式展开式的每个单色场的初相置零。

17: 单色场表达式因复色场展开式不同而异, 因此单色场只可能是抽象出来的。不同的展开方法可抽象出不同形式的单色场, 但只有当子波振幅是实的时, 抽象出来的单色场才具有物理意义。——比如, 可以抽象出不具有物理意义的单色场, 如 $\sum_{i=-\infty}^{\infty} \mathbf{C}_i e^{i(\mathbf{k}_i \cdot \mathbf{r} - \omega_i t)}$; 也可以抽象出不止一种具有物理意义的单色场表达式, 如实数和复数形式的三种其他傅里叶展开式。

18: 复色场关于 t 既无需为偶函数也不需具有周期性。因为基本行波族的正交性和完备性只要求待分解的复色场在空间上具有周期性。——当然, 不仅无需, 也没法实现; 因为在时间这一维度是只有起点、无终点, 即单端点且单边无界的, 是一条射线, 以至于时间维度的非周期函数, 就只能展为傅里叶积分了; 同时基本函数族从分立变得连续, 失去了“单色子波”这一最小单元, 其子波系数也无法成为一个实数。

19: 正因“万场皆可箱归一化”, 则大多数复色场均可以用三角函数族展开, 至于可否用、是否更适用其他基本函数族展开, 需要看其边界形状是否特殊, 如条状平行平面腔、方形镜共焦腔、圆形镜共焦腔所最终产生的自再现稳定横模, 分别可用更合适的基本函数族描绘。

20: As of now, paragraphs are justified, formatted with `\singlespacing` (from the `setspace` package) and `\frenchspacing`.

既然必须要进行周期延拓, 不如选择偶周期延拓, 并采用合适的坐标系和坐标原点, 使得原时变复色场 (类比 $f(x)$) 所延拓成的 $\mathfrak{E}(\mathbf{r}, t)$ (类比 $g(x)$) 是个空间上的偶周期场¹⁸。

此时 $\mathfrak{E}(\mathbf{r}, t)$ 的实数形式傅里叶级数展开式中, 各 $\mathfrak{R}_i = 0$ 、 $\varphi_i = 0$, 即 $\mathfrak{E}(\mathbf{r}, t)$ 被展成了傅里叶余弦级数; 同时, $\mathfrak{E}(\mathbf{r}, t)$ 的复数形式傅里叶级数展开式中, $C_0 = \mathfrak{A}_0$ 、 $C_i = \frac{\mathfrak{A}_i}{2}$ ($i \neq 0$), 以至于实现了 $|C| \in \mathbb{R}$ 。

物理上, 对于某一有限封闭空间、半无限长时间区间内的复色场, 不管其具体形状如何, 首先, 总可以实现空间上的周期延拓。——因为不论其边界条件如何, 总可以在其边界之外, 套一个长宽高均不小于该复色场区域各维最长径的长方形箱子, 继而总可以¹⁹对闭系复色场的箱子, 施加周期性边界条件 (箱归一化条件)。

其次, 对任意三维封闭的复色场, 总可以实现偶延拓。——因为总可将坐标系坐标原点选在箱子的某一角, 三轴分别贴合共点的三条箱边, 再分别沿 $x-o-y$, $y-o-z$, $z-o-x$ 三个面, 生成该箱子内的场的镜面对称像, 之后再以这 $2^3 = 8$ 个场为单位, 进行空间三个方向的周期延拓。

因此, 对任一封闭空间内的时变复色场, 总可以实现偶周期延拓; 继而总可展开为初相为零、实振幅的, 实数或复数形式的, 平面单色行波场的线性组合 (即傅里叶级数)。

In the future I plan to add more options to set the paragraph formatting (justified or ragged) and the position of the margins (inner or outer in twoside mode, left or right in oneside mode).²⁰

I take this opportunity to renew the call for help: everyone is encouraged to add features or reimplement existing ones, and to send me the results. You can find the GitHub repository at <https://github.com/fmarotta/kaobook>.

To Do

实现 `justify` 和 `margin` 选项。为了与 KOMA-Script 样式保持一致, 它们应该接受一个简单开关作为参数, 其中简单开关应该是 `true` 或 `false`, 或者 KOMA-Script 支持的简单开关的其他标准值之一。有关更多信息, 请参阅 KOMA-Script 文档。

The above box is an example of a kaobox, which will be discussed more thoroughly in 第 7 章 (数学及盒子) 第 31 页. Throughout the book I shall use these boxes to remarks what still needs to be done.

2.2 菊次郎小火车的春天

A bunch of packages are already loaded in the class because they are needed for the implementation. These include:

- etoolbox
- calc
- xifthen
- xkeyval
- xparse

► xstring

Many more packages are loaded, but they will be discussed in due time. Here, we will mention only one more set of packages, needed to change the paragraph formatting (recall that in the future there will be options to change this). In particular, the packages we load are:

- ragged2e
- setspace
- hyphenat
- microtype
- needspace
- xspace
- xcolor (with options `usenames`, `dvipsnames`)

Some of the above packages do not concern paragraph formatting, but we nevertheless grouped them with the others. By default, the main text is justified and formatted with singlespacing and frenchspacing; the margin text is the same, except that the font is a bit smaller.

2.3 Document Structure

We provide optional arguments to the `\title` and `\author` commands so that you can insert short, plain text versions of this fields, which can be used, typically in the half-title or somewhere else in the front matter, through the commands `\@plaintitle` and `\@plainauthor`, respectively. The PDF properties `pdftitle` and `pdfauthor` are automatically set by `hyperref` to the plain values if present, otherwise to the normal values.²¹

There are defined two page layouts, `margin` and `wide`, and two page styles, `plain` and `fancy`. The layout basically concern the width of the margins, while the style refers to headers and footer; these issues will be discussed in 第 6 章 (Page Design) 第 27 页.²²

The commands `\frontmatter`, `\mainmatter`, and `\backmatter` have been redefined in order to automatically change page layout and style for these sections of the book. The front matter uses the `margin` layout and the `plain` page style. In the `mainmatter` the margins are wide and the headings are fancy. In the appendix the style and the layout do not change; however we use `\bookmarksetup{startatroot}` so that the bookmarks of the chapters are on the root level (without this, they would be under the preceding part). In the `backmatter` the margins shrink again and we also reset the bookmarks root.

21: We think that this is an important point so we remark it here. If you compile the document with `pdflatex`, the PDF metadata will be altered so that they match the plain title and author you have specified; if you did not specify them, the metadata will be set to the normal title and author.

22: For now, suffice it to say that pages with the `margin` layout have wide margins, while with the `wide` layout the margins are absent. In `plain` pages the headers and footer are suppressed, while in `fancy` pages there is a header.

侧记是所有 1.5 列布局书籍的一个显著特征。事实上，宽边意味着一些材料可以在那里展示。我们对所有的东西都使用边距：旁注、边注、小目录、引文，为什么不呢？，特殊的盒子和环境。

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3.1 Sidenotes

Sidenotes are like footnotes, except that they go in the margin, where they are more readable. To insert a sidenote, just use the command `\sidenote{Text of the note}`. You can specify a mark^O with `\sidenote[mark]{Text}`, but you can also specify an offset, which moves the sidenote upwards or downwards, so that the full syntax is:

```
\sidenote[offset][mark]{Text}
```

If you use an offset, you always have to add the brackets for the mark, but they can be empty.²⁴ The format of the actual sidenote can be changed with the command `\setsidenotes`, which allows you to modify, for instance, the format of the markers and the separator between the marker and the text of the sidenote.

There was an alternative package, `sidenotes`, which we could have used. In the end we went for `snotez` because it was the one used in Ken Ohori's thesis, which inspired this class. The features are very similar, but one additional thing offered by `snotez` is that the offset can be specified as a multiple of `\baselineskip`. For example, if you want to enter a sidenote with the normal mark and move it upwards one line, type:

```
\sidenote[*-1][O]{Text of the sidenote.}
```

Sidenotes are handled through the `snotez` package, which in turn relies on the `marginnote` package.

O: This sidenote has a special mark, a big O!

24: If you want to know more about the usage of the `\sidenote` command, read the documentation of the `snotez` package.

3.2 Marginnotes

This command is very similar to the previous one. You can create a marginnote with `\marginnote[offset]{Text}`, where the offset argument can be left out, or it can be a multiple of `\baselineskip`, e.g.

```
\marginnote[-12pt]{Text} or \marginnote[*-3]{Text}
```

To Do

A small thing that needs to be done is to renew the `\sidenote` com-

While the command for margin notes comes from the `marginnote` package, it has been redefined in order to change the position of the optional offset argument, which now precedes the text of the note, whereas in the original version it was at the end. We have also added the possibility to use a multiple of `\baselineskip` as offset. These things were made only to make everything more consistent, so that you have to remember less things!

mand so that it takes only one optional argument, the offset. The special mark argument can go somewhere else. In other words, we want the syntax of `\sidenote` to resemble that of `\marginnote`.

We load the packages `marginnote`, `marginfix` and `placeins`. Since `snotex` uses `marginnote`, what we said for `marginnotes` is also valid for `sidenotes`. Side- and margin- notes are shifted slightly upwards (`\renewcommand{\marginnotevadjust}{3pt}`) in order to allineate them to the bottom of the line of text where the note is issued.

3.3 Footnotes

Even though they are not displayed in the margin, we will discuss about footnotes here, since `sidenotes` are mainly intended to be a replacement of them. Footnotes force the reader to constantly move from one area of the page to the other. Arguably, `marginnotes` solve this issue, so you should not use footnotes. Nevertheless, for completeness, we have left the standard command `\footnote`, just in case you want to put a footnote once in a while.¹

3.4 Margintoc

Since we are talking about margins, we introduce here the `\margintoc` command, which allows one to put small table of contents in the margin. Like other commands we have discussed, `\margintoc` accepts a parameter for the vertical offset, like so: `\margintoc[offset]`.

The command can be used in any point of the document, but we think it makes sense to use it just at the beginning of chapters or parts. In this document I make use of a KOMA-Script feature and put it in the chapter preamble, with the following code:

```
\setchapterpreamble[u]{\margintoc}
\chapter{Chapter title}
```

Not only textual stuff can be displayed in the margin, but also figures. Those will be the focus of the next chapter.

The font used in the `margintoc` is the same as the one for the chapter entries in the main table of contents at the beginning of the document.

¹ And this is how they look like. Notice that in the PDF file there is a back reference to the text; pretty cool, uh?



4 Figures and Tables

4.1 Normal figures and tables

可以像插入任何标准 \LaTeX 文档一样插入数字和表。graphicx 包已经加载并配置好了，其图形宽度等于 `textwidth`，并且调整了高度以保持原始的纵横比。正如您所想象的，标题将被很好地放置在页边空白处。这是在 `floatrow` 包的帮助下实现的。

这里有一张蒙娜丽莎的照片（图 4.1）作为例子。标题格式为页边距和边注；如果您想更改标题的某些内容，可以使用 `title` 包中的命令 `command captsetup`。请记住，如果您想引用一个图形，标签必须在标题之后出现！



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Figure 4.1: It's Mona Lisa again. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

虽然标题的格式由 `title` 管理，但是它的位置由 `floatrow` 包处理。取得这样的成绩是很辛苦的，但现在我很满意。在双面模式下，标题以正确的页边距打印。

插入表格和插入数字一样容易，如下面的代码所示：

```

1 \begin{table}
2 \begin{tabular}{c c c c }
3   \toprule
4   col1 & col2 & col3 & col 4 \\\
5   \midrule
6   \multirow{3}{4em}{Multiple row} & cell2 & cell3 & cell4\\
7   cell5 & cell6 & cell7 \\\ & & & \\
8   cell8 & cell9 & cell10 \\\
9   \multirow{3}{4em}{Multiple row} & cell2 & cell3 & cell4 \\\ & & & \\
10  cell5 & cell6 & cell7 \\\ & & & \\
11  cell8 & cell9 & cell10 \\\
12  \bottomrule
13 \end{tabular}
14 \end{table}

```

which results in the useless 表 4.1.

Table 4.1: A useless table.

col1	col2	col3	col 4
Multiple row	cell2	cell3	cell4
	cell5	cell6	cell7
	cell8	cell9	cell10
Multiple row	cell2	cell3	cell4
	cell5	cell6	cell7
	cell8	cell9	cell10

I don't have much else to say, so I will just insert some blind text. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gef-burn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

4.2 Margin figures and tables

可以使用 `marginfigure` 环境插入 Marginfigures。在这种情况下，整个图片被限制在页边空白处，标题在它下面。图 1.1是这样得到的：

```

1 \begin{marginfigure}
2   \includegraphics{monalisa}
3   \caption[The Mona Lisa]{The Mona Lisa.}
4   \labfig{marginmonalisa}
5 \end{marginfigure}

```

There is also the `marginfigure` environment, of which 表 4.2 is an example. Notice how you can place the caption above the table by just placing the `\caption` command before beginning the `tabular` environment. Usually, figure captions are below, while table captions are above. This rule is also respected for normal figures and tables:

the captions are always on the side, but for figure they are aligned to the bottom, while for tables to the top.

Marginfigures and tables can be positioned with an optional offset command, like so:

```
1 \begin{marginfigure}[offset]
2   \includegraphics{images/seaside}
3 \end{marginfigure}
```

Offset ca be either a measure or a multiple of `\baselineskip`, much like with `\sidenote`, `\marginnote` and `\margintoc`. If you are wondering how I inserted this orange bubble, have a look at the `todo` package.

Table 4.2: Another useless table.

col1	col2	col3
Multiple row	cell2	cell3
	cell5	cell6
	cell8	cell9

Improve this part.

4.3 Wide figures and tables



Figure 4.2: 宽阔的海边，宽阔的标题。作品简介: 布什拉·费罗兹 (Bushra Feroz) 著 — 自己的工作, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=68724647>

使用 `figure*` 和 `table*` 环境，您可以插入跨越整个页面宽度的数字。标题将根据口味被置于下方或上方。

您可能已经注意到了本章开头的全宽图像: 但是，它是以一种完全不同的方式设置的，您将在第 6 章中了解到这一点。现在是处理超引用的时候了。

5.1 引用

要引用某人 [1, 2] 非常简单: 只需使用 `\sidecite` 命令。它还没有一个抵消的参数, 但它可能会在未来。如您所见, 该命令支持多个条目, 默认情况下, 它在页边空白处打印引用, 并将其添加到文档末尾的参考书目中。在这个设置中, 我使用了 `biblatex`, 但是我认为这是可行的。[2] 注意, 这些引用与文本没有任何关系, 它们完全是随机的, 因为它们只用于说明特性。

要编译包含引用的文档, 您需要使用一个外部工具, 对于这个类, 这个工具是 `biber`。您需要运行以下命令 (假设您的 `tex` 文件名为 `main.tex`):

```
$ pdflatex main
$ biber main
$ pdflatex main
```

5.2 术语表和索引

`kaobook` 类加载 `glossary` 和 `imakeidx` 包, 您可以使用它们将词汇表和索引添加到您的图书中。例如, 我以前定义了一些术语表条目, 现在我将使用它们, 如下所示: `computer`。 `glossary` 还允许您使用缩略词, 如下所示: 这是完整版Frame per Second (FPS), 这是简短版FPS。这些条目将出现在术语表的后面。

Unless you use `Overleaf` or some other fancy IDE for \LaTeX , you need to run an external command from your terminal in order to compile a document with a glossary. In particular, the commands required are:²⁷

```
$ pdflatex main
$ makeglossaries main
$ pdflatex main
```

Note that you need not run `makeglossaries` every time you compile your document, but only when you change the glossary entries.

To create an index, you need to insert the command `\index{subject}` whenever you are talking about ‘subject’ in the text. For instance, at the start of this paragraph I would write `index{index}`, and an entry would be added to the Index in the backmatter. Check it out!

A nomenclature is just a special kind of index; you can find one at the end of this book. To insert a nomenclature, we use the package `nomencl` and add the terms with the command `\nomenclature`. We put then a `\printnomenclature` where we want it to appear.

Also with this package we need to run an external command to compile the document, otherwise the nomenclature will not appear:

[1]: Visscher et al. (2008), ‘Heritability in the genomics era—concepts and misconceptions.’

[2]: James et al. (2013), *An Introduction to Statistical Learning*

[2]: James et al. (2013), *An Introduction to Statistical Learning*

27: These are the commands you would run in a UNIX system; I have no idea on how it works in Windows.

In theory, you would need to run an external command for the index as well, but luckily the package we suggested, `imakeidx`, can compile the index automatically.

```
$ pdflatex main
$ makeindex main.nlo -s nomencl.ist -o main.nls
$ pdflatex main
```

These packages are all loaded in `packages.sty`, one of the files that come with this class. However, the configuration of the elements is best done in the `main.tex` file, since each book will have different entries and styles.

This brief section was by no means a complete reference on the subject, therefore you should consult the documentation of the above package to gain a full understanding of how they work.

Note that the `nomencl` package caused problems when the document was compiled, so, to make a long story short, I had to prevent `scrhack` to load the hack-file for `nomencl`. When compiling the document on Overleaf, however, this problem seem to vanish.

5.3 Hyperreferences

In this class we provide a handy sub-package to help you referencing the same elements always in the same way, for consistency across the book. First, you can label each element with a specific command. For instance, should you want to label a chapter, you would put `\labch{chapter-title}` right after the `\chapter` directive. This is just a convenience, because `\labch` is actually just an alias to `\label{ch:chapter-title}`, so it spares you the writing of ‘ch’. We defined similar commands for many typically labeled elements, including:

- | | |
|------------------------------------|---------------------------------------|
| ▶ Page: <code>\labpage</code> | ▶ Theorem: <code>\labthm</code> |
| ▶ Part: <code>\labpart</code> | ▶ Proposition: <code>\labprop</code> |
| ▶ Chapter: <code>\labch</code> | ▶ Lemma: <code>\lablemma</code> |
| ▶ Section: <code>\labsec</code> | ▶ Remark: <code>\labremark</code> |
| ▶ Figure: <code>\labfig</code> | ▶ Example: <code>\labexample</code> |
| ▶ Table: <code>\labtab</code> | ▶ Exercise: <code>\labexercise</code> |
| ▶ Definition: <code>\labdef</code> | |

Of course, we have similar commands for referencing those elements. However, since the style of the reference should depend on the context, we provide different commands to reference the same thing. For instance, in some occasions you may want to reference the chapter by name, but other times you want to reference it only by number. In general, there are four reference style, which we call plain, vario, name, and full.

The plain style references only by number. It is accessed, for chapters, with `\refch{chapter-title}` (for other elements, the syntax is analogous). Such a reference results in: 第 5 章.

The vario and name styles rest upon the `varioref` package. Their syntax is `\vrefch{chapter-title}` and `\nrefch{chapter-title}`, and they result in: 第 5 章, for the vario style, and: 第 5 章 (参考文献), for the name style. As you can see, the page is referenced in `varioref` style.

The full style references everything. You can use it with `\frefch{chapter-title}` and it looks like this: 第 5 章 (参考文献) 第 21 页.

Of course, all the other elements have similar commands (*e.g.* for parts you would use `\vrefpart{part-title}` or something like that). However, not all elements implement all the four styles. The commands provided should be enough, but if you want to see what is available or to add the missing ones, have a look at the [attached package](#).

设计和附加功能



6 Page Design

6.1 Headings

So far, in this document I used two different styles for the chapter headings: one has the chapter name, a rule and, in the margin, the chapter number; the other has an image at the top of the page, and the chapter title is printed in a box (like for this chapter). There is one additional style, which I used only in the appendix (on page 37); there, the chapter title is enclosed in two horizontal rules, and the chapter number (or letter, in the case of the appendix) is above it.²⁹

Every book is unique, so it makes sense to have different styles from which to choose. Actually, it would be awesome if whenever a kao-user designs a new heading style, he or she added it to the three styles already present, so that it will be available for new users and new books.

The choice of the style is made simple by the `\setchapterstyle` command. It accepts one option, the name of the style, which can be: ‘plain’, ‘kao’, or ‘lines’.³⁰ If instead you want the image style, you have to use the command `\setchapterimage`, which accepts the path to the image as argument; you can also provide an optional parameter in square brackets to specify the height of the image.

Let us make some examples. In this book, I begin a normal chapter with the lines:

```
1 \setchapterstyle{kao}
2 \setchapterpreamble[u]{\margintoc}
3 \chapter{Title of the Chapter}
4 \labch{title}
```

In Line 1 I choose the style for the title to be ‘kao’. Then, I specify that I want the margin toc. The rest is ordinary administration in \LaTeX , except that I use my own `\labch` to label the chapter. Actually, the `\setchapterpreamble` is a standard KOMA-Script one, so I invite you to read about it in the KOMA documentation. Once the chapter

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- 6.2 Headers & Footers 28
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- 6.5 Numbers & Counters 29
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29: To be honest, I do not think that mixing heading styles like this is a wise choice, but in this document I did only to show you how they look.

30: Plain is the default \LaTeX title style; the other ones are self explanatory.

31: The `\margintoc` has to be specified at every chapter. Perhaps in the future this may change; it all depends on how this feature will be welcomed by the users, so keep in touch with me if you have preferences!

style is set, it holds until you change it.³¹ Whenever I want to start a chapter with an image, I simply write:

```
1 \setchapterimage[7cm]{path/to/image.png} % Optionally specify the
   height
2 \setchapterpreamble[u]{\margintoc}
3 \chapter{Catchy Title} % No need to set a chapter style
4 \labch{catchy}
```

6.2 Headers & Footers

Headers and footers in KOMA-Script are handled by the `scrlayer-scrpage` package. There are two basic style: ‘`scrheadings`’ and ‘`plain.scrheadings`’. The former is used for normal pages, whereas the latter is used in title pages (those where a new chapter starts, for instance) and, at least in this book, in the front matter. At any rate, the style can be changed with the `\pagestyle` command, *e.g.* `\pagestyle{plain.scrheadings}`.

In both stles, the footer is completely empty. In `plain.scrheadings`, also the header is absent (otherwise it wouldn’t be so plain...), but in the normal style the design is reminiscent of the ‘kao’ style for chapter titles.

To Do

The `twoside` class option is still unstable and. As always, any help will be greatly appreciated.

6.3 Table of Contents

Another important part of a book is the table of contents. By default, in kaobook there is an entry for everything: list of figures, list of tables, bibliographies, and even the table of contents itself. Not everybody might like this, so we will provide a description of the changes you need to do in order to enable or disable each of these entries. In the following 表 6.1, each item corresponds to a possible entry in the TOC, and its description is the command you need to provide to have such entry. These commands are specified in the attached [style package](#),³² so if you don’t want the entries, just comment the corresponding lines.

Of course, some packages, like those for glossaries and indices, will try to add their own entries. In such cases, you have to follow the instructions specific to that package. Here, since we have talked about glossaries and notations in 第 5 章, we will briefly see how to configure them.

For the glossaries package, use the ‘`toc`’ option when you load it: `\usepackage[toc]{glossaries}`. For `nomencl`, pass the ‘`intoc`’ option at the moment of loading the package. Both glossaries and `nomencl` are loaded in the attached [‘packages’ package](#).

32: In the same file, you can also choose the titles of these entries.

In a later section, we will see how you can define your own floating environment, and endow it with an entry in the TOC.

Entry	Command to Activate
Table of Contents	<code>\setuptoc{toc}{totoc}</code>
List of Figs and Tabs	<code>\PassOptionsToClass{toc=listof}{\@baseclass}</code>
Bibliography	<code>\PassOptionsToClass{toc=bibliography}{\@baseclass}</code>

Table 6.1: Commands to add a particular entry to the table of contents.

Additional configuration of the table of contents can be performed through the packages `etoc`, which is loaded because it is needed for the `margintocs`, or the more traditional `tocbase`. Read the respective documentations if you want to be able to change the default TOC style.³³

33: (And please, send me a copy of what you have done, I'm so curious!)

6.4 Page Layout

Besides the page style, you can also change the width of the content of a page. This is particularly useful for pages dedicated to part titles, where having the 1.5-column layout might be a little awkward, or for pages where you only put figures, where it is important to exploit all the available space.

In practice, there are two layouts: 'wide' and 'margin'. The former suppresses the margins and allocates the full page for contents, while the latter is the layout used in most of the pages of this book, including this one. The wide layout is also used automatically in the front and back matters.

To change page layout, use the `\pagelayout` command. For example, when I start a new part, I write:

```
1 \pagelayout{wide}
2 \addpart{Title of the New Part}
3 \pagelayout{margin}
```

6.5 Numbers & Counters

In this short section we shall see how dispositions, sidenotes and figures are numbered in the `kaobook` class.

By default, dispositions are numbered up to the section. This is achieved by setting: `\setcounter{secnumdepth}{1}`.

The sidenotes counter is the same across all the document, but if you want it to reset at each chapter, just uncomment the line

```
\counterwithin*{sidenote}{chapter}
```

in the `styles/style.sty` package provided by this class.

Figure and Table numbering is also per-chapter; to change that, use something like:

```
\renewcommand{\thefigure}{\arabic{section}.\arabic{figure}}
```

6.6 White Space

One of the things that I find most hard in \LaTeX is to finely tune the white space around objects. There are not fixed rules, each object needs its own adjustment. Here we shall see how some spaces are defined at the moment in this class.

Attention! This section may be incomplete.

Space around figures and tables

```
\renewcommand\FBaskip{.4\topskip}
\renewcommand\FBbskip{\FBaskip}
```

Space around captions

```
\captionsetup{
  aboveskip=6pt,
  belowskip=6pt
}
```

Space around displays (*e.g.* equations)

```
\setlength\abovedisplayskip{6pt plus 2pt minus 4pt}
\setlength\belowdisplayskip{6pt plus 2pt minus 4pt}
\abovedisplayskip 10\p@ \@plus2\p@ \@minus5\p@
\abovedisplayshortskip \z@ \@plus3\p@
\belowdisplayskip \abovedisplayskip
\belowdisplayshortskip 6\p@ \@plus3\p@ \@minus3\p@
```

7.1 定理

尽管大多数人抱怨看到一本充满公式的书，数学却是许多书的重要组成部分。在这里，我们将说明一些可能性。我们认为定理、定义、注释和例子都应该在阴影的背景下加以强调；然而，颜色不应该是沉重的眼睛，所以我们选择了一种淡黄色。³⁵

定义 7.1.1 *Let (X, d) be a metric space. A subset $U \subset X$ is an open set if, for any $x \in U$ there exists $r > 0$ such that $B(x, r) \subset U$. We call the topology associated to d the set τ_d of all the open subsets of (X, d) .*

定义 7.1.1 是非常重要的。我不是在开玩笑，但是我插入这个短语只是为了说明如何引用定义。下面的语句在不同的环境中反复出现。

定理 7.1.1 *A finite intersection of open sets of (X, d) is an open set of (X, d) , i.e τ_d is closed under finite intersections. Any union of open sets of (X, d) is an open set of (X, d) .*

命题 7.1.2 *A finite intersection of open sets of (X, d) is an open set of (X, d) , i.e τ_d is closed under finite intersections. Any union of open sets of (X, d) is an open set of (X, d) .*

引理 7.1.3 *A finite intersection¹ of open sets of (X, d) is an open set of (X, d) , i.e τ_d is closed under finite intersections. Any union of open sets of (X, d) is an open set of (X, d) .*

¹ I'm a footnote

您可以安全地忽略定理...的内容，我假设，如果您对课本中的定理感兴趣，那么您已经了解了一些关于添加它们的经典方法。这些示例应该只显示您在这个类中可以做的所有事情。

推论 7.1.4 (Finite Intersection, Countable Union) *A finite intersection of open sets of (X, d) is an open set of (X, d) , i.e τ_d is closed under finite intersections. Any union of open sets of (X, d) is an open set of (X, d) .*

Proof. 证明留给读者作为一个简单的练习。提示:

水厂共当而面三张，白家决空给意层般，单重总歼者新。每建马先口住月大，究平克满现易手，省否何安苏京。两今此叫证程事元七调联派业你，全它精据闻属医拒严力步青。厂江内立拉清义边指，况半严回和得话，状整度易芬列。再根心应得信飞往清增，至例联集采家同严热，地手蠢持查受立询。统定发几满斯究后参边增消与内关，解系之展习历李还也村酸。制周心值示前她志长步反，和果使标电再主它这，即务解早八战根交。是中文之象万影报头，与劳工许格主部确，受经更奇小极准。形程记持件志各质天因时，据据极清总命所风式，气

7.1 定理 31
7.2 Boxes & Environments . . . 32
7.3 Experiments 33

35: 这里的所有框都是相同的颜色，因为我们不希望我们的文档看起来像Harlequin。

You can even insert footnotes inside the theorem environments; they will be displayed at the bottom of the box.

太束书家秀低坟也。期之才引战对已公派及济，间究办儿转情革统将，周类弦具调除声坑。两了济素料切要压，光采用级数本形，管县任其坚。切易表候完铁今断土马他，领先往样拉口重把处千，把证建后苍交码院眼。较片的集节片合构进，入化发形机已斯我候，解肃飞口严。技时长次土员况属写，器始维期质离色，个至村单原否易。重铁看年程第则于去，且它后基格并下，每收感石形步而。

□

Here is a random equation, just because we can:

$$x = a_0 + \frac{1}{a_1 + \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4}}}}$$

定义 7.1.2 Let (X, d) be a metric space. A subset $U \subset X$ is an open set if, for any $x \in U$ there exists $r > 0$ such that $B(x, r) \subset U$. We call the topology associated to d the set τ_d of all the open subsets of (X, d) .

例 7.1.1 Let (X, d) be a metric space. A subset $U \subset X$ is an open set if, for any $x \in U$ there exists $r > 0$ such that $B(x, r) \subset U$. We call the topology associated to d the set τ_d of all the open subsets of (X, d) .

备注 7.1.1 Let (X, d) be a metric space. A subset $U \subset X$ is an open set if, for any $x \in U$ there exists $r > 0$ such that $B(x, r) \subset U$. We call the topology associated to d the set τ_d of all the open subsets of (X, d) .

As you may have noticed, definitions, example and remarks have independent counters; theorems, propositions, lemmas and corollaries share the same counter.

备注 7.1.2 Here is how an integral looks like inline: $\int_a^b x^2 dx$, and here is the same integral displayed in its own paragraph:

$$\int_a^b x^2 dx$$

We provide two files for the theorem styles: `plaintheorems.sty`, which you should include if you do not want coloured boxes around theorems; and `mdftheorems.sty`, which is the one used for this document.³⁶ Of course, you will have to edit these files according to your taste and the general style of the book.

36: The plain one is not showed, but actually it is exactly the same as this one, only without the yellow boxes.

7.2 Boxes & Custom Environments ³⁷

37: Notice that in the table of contents and in the header, the name of this section is 'Boxes & Environments'; we achieved this with the optional argument of the section command.

Say you want to insert a special section, an optional content or just something you want to emphasise. We think that nothing works better than a box in these cases. We used `mdframed` to construct the ones shown below. You can create and modify such environments by editing the provided file `environments.sty`.

盒子标题

她已道接收面学上全始，形万然许压己金史好，力住记赤则引秧。处高方据近学级素专，者往构支明系状委起查，增子束孤不般前。

相斗真它增备听片思三，听花连次志平品书消情，清市五积群面县
 开价现准此省持给，争式身在南决就集般，地力秧众团计。日车治
 政技便角想持中，厂期平及半干速区白土，观合村究研称始这少。
 验商眼件容果经风中，质江革再的采心年专，光制单万手斗光就，
 报却蹦杯材。内同数速果报做，属马市参至，入极将管医。但强质
 交上能只拉，据特光农无五计据，来步孤平葡院。江养水图再难气，
 做林因列行消特段，就解屈罐盛。定她识决听人自打验，快思月断
 细面便，事定什呀传。边力心层下等共命每，厂五交型车想利，直
 下报亲积速。元前很地传气领权节，求反立全各市状，新上所走值
 上。明统多表过变物每区广，会王问西听观生真林，二决定助议苏。
 格节基全却及飞口悉，难之规利争白观，证查李却调代动斗形放数
 委同领，内从但五身。当了美话也步京边但容代认，放非边建按划
 近些派民越，更具建火法住收保步连。

如果设置了计数器，甚至可以创建自己的编号环境。

注释 7.2.1

术厂美义据那张别安响物，县交极长选行值深专质，眼心段极型新。
 格形连候眼王本加还题但，流但作基白具地机系，总严录件杰报前
 易。际取通主农题议需之从业少，江以受断件扮伴自。不度传间品
 全，青层自内治子，其询体员种。领角速院术计目化每具，体这常
 住更实记，在应争却根陕员。自传不展持心方约厂，济件过所转特
 济，外达才部至局。习例件气保候府社它，算际小毛相角方车次场
 马，难切龙弦制形界办。感头两华交务毛林回都节业点，两群月具
 受们即积生。调直给这着风火能圆商一，知易众美布会亲军千，件
 声坑志支较学。农六斯南何记子机量各然，快写线信权间越部色，
 象照屈型部物治地长。难要技第对老共达质标压心，才种日自针豆
 助养。政快下正型究条东话加争行整便，些改民流花按低重伸你。
 院心没离则收称革局，七件小收月通示布，导外员林村增。革电认
 速志海再事满传海，京深二百明家打开识连，林备转刷位体置进义。
 治风理年构族业酸整要第，认取历难丽园变队。

7.3 Experiments

也可以在盒子里包装边注。我们鼓励大胆的读者尝试自己的实验，并让我知道结果。

我相信许多其他特殊的事情是可能的与类 `kaobook` 类。在开发过程中，我努力使它尽可能灵活，这样就可以不费太大力气地添加新特性。因此，我希望你们能在这门课的写作中找到最好的方式来表达自己，写一本书，写一篇报告或者写一篇论文，我也很想看看你们可以尝试的任何实验的结果。

title of margin note

使用 `kaobox` 盒子的边注。
 (实际上, `kaobox` 是在 `marginnote` 里面!)

附录



Heading on Level 0 (chapter)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gef-burn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

A.1 Heading on Level 1 (section)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gef-burn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

A.1.1 Heading on Level 2 (subsection)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gef-burn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 3 (subsubsection)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text,

you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 4 (paragraph) Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

A.2 Lists

A.2.1 Example for list (itemize)

- ▶ First item in a list
- ▶ Second item in a list
- ▶ Third item in a list
- ▶ Fourth item in a list
- ▶ Fifth item in a list

Example for list (4*itemize)

- ▶ First item in a list
 - First item in a list
 - * First item in a list
 - First item in a list
 - Second item in a list
 - * Second item in a list
 - Second item in a list
- ▶ Second item in a list

A.2.2 Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list
4. Fourth item in a list
5. Fifth item in a list

Example for list (4*enumerate)

1. First item in a list
 - a) First item in a list
 - i. First item in a list
 - A. First item in a list
 - B. Second item in a list
 - ii. Second item in a list
 - b) Second item in a list
2. Second item in a list

A.2.3 Example for list (description)

First item in a list
Second item in a list
Third item in a list
Fourth item in a list
Fifth item in a list

Example for list (4*description)

First item in a list
 First item in a list
 First item in a list
 First item in a list
 Second item in a list
 Second item in a list
 Second item in a list
Second item in a list

参考文献

Here are the references in citation order.

- [1] Peter M Visscher, William G Hill, and Naomi R Wray. ‘Heritability in the genomics era—concepts and misconceptions.’ In: *Nat. Rev. Genet.* 9.4 (2008), pp. 255–266. DOI: [10.1038/nrg2322](https://doi.org/10.1038/nrg2322) (cited on page 21).
- [2] Gareth James et al. *An Introduction to Statistical Learning*. 2013 (cited on page 21).

Greek letters with pronunciation

Character	Name	Character	Name
α	alpha AL-fuh	ν	nu NEW
β	beta BAY-tuh	ξ, Ξ	xi KSIGH
γ, Γ	gamma GAM-muh	\omicron	omicron OM-uh-CRON
δ, Δ	delta DEL-tuh	π, Π	pi PIE
ϵ	epsilon EP-suh-lon	ρ	rho ROW
ζ	zeta ZAY-tuh	σ, Σ	sigma SIG-muh
η	eta AY-tuh	τ	tau TOW (as in cow)
θ, Θ	theta THAY-tuh	υ, Υ	upsilon OOP-suh-LON
ι	iota eye-OH-tuh	ϕ, Φ	phi FEE, or FI (as in hi)
κ	kappa KAP-uh	χ	chi KI (as in hi)
λ, Λ	lambda LAM-duh	ψ, Ψ	psi SIGH, or PSIGH
μ	mu MEW	ω, Ω	omega oh-MAY-guh

Capitals shown are the ones that differ from Roman capitals.

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