Mathematics

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Chapter 1

The "mathtools" package

Mathematics writing is one of the most advantage of LaTeX compared to common text editors. On a first approach, it looks like a programming language but it is in fact quite intuitive.

The first package which was extremely useful in mathematics writing was `amsmath`. Since then, it has been upgraded by the `mathtools` package that I recommend to use.

1.1 Writing an equation

Writing an equation is simply done thanks to the `equation` environment. Maxwell's equations will be used as examples:

$$\vec{\nabla} \cdot \vec{B} = 0. \tag{1.1}$$

Automatic numbering can be avoided by using the starred version: `equation*`. For instance:

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}.$$

Shorter forms of the unnumbered version are offered by the package: the \[... \] wrapper:

$$\oint_C \vec{E} \cdot \mathrm{d}\vec{l} = -\iint_S \frac{\partial \vec{B}}{\partial t} \cdot \mathrm{d}\vec{S}.$$

Inline equations are equations written in the text. For instance, I could specify that $\vec{B}$ in eq. (1.1) is the magnetic field.

1.2 Grouping equations

Two main environments can be used to group equations : `gather` and `align`. The former groups without aligning, the latter groups and aligns equations.

Example based on `gather`:

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{\jmath} + \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t}, \tag{1.2}$$

which can be written in the integral form by applying the Green theorem

$$\oint_C \vec{B} \cdot \mathrm{d}\vec{l} = \mu_0 \iint_S \vec{\jmath} \cdot \mathrm{d}\vec{S} + \varepsilon_0 \mu_0 \iint_S \frac{\partial \vec{E}}{\partial t} \cdot \mathrm{d}\vec{S}. \tag{1.3}$$

Example based on `align`:

$$\vec{B} = \vec{\nabla} \times \vec{A}, \tag{1.4}$$

$$\vec{E} = -\vec{\nabla} V - \frac{\partial \vec{A}}{\partial t}. \tag{1.5}$$

1.3 Matrices

Matrices can be generated thanks to the `matrix` environment which must be used inside a mathematical equation environment. There are several variants of `matrix` which produce different delimiters surrounding the matrix.

The "mathtools" package offers starred version of the `matrix` environments which allow to pass an optional argument to specify the alignment inside the matrix's columns.

Example for each type of `matrix` environments:

`matrix`

$$\begin{matrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{matrix}$$

`pmatrix`

$$\begin{pmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{pmatrix}$$

`bmatrix`

$$\begin{bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{bmatrix}$$

`Bmatrix`

$$\begin{Bmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{Bmatrix}$$

`vmatrix`

$$\begin{vmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{vmatrix}$$

`Vmatrix`

$$\begin{Vmatrix} x_{11} & x_{12} \\ x_{21} & x_{22} \end{Vmatrix}$$

Also compare

$$\begin{pmatrix} 2 & -3 \\ 42 & 0 \end{pmatrix} \quad \text{VS} \quad \begin{pmatrix} 2 & -3 \\ 42 & 0 \end{pmatrix}$$