Mathematics

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Overview

1. Useful packages
2. Writing equations
3. Grouping equations
4. Matrices
5. Laying out the mathematics

Packages for mathematics

Some packages very useful for mathematics are listed here below:

- `mathtools` which is mainly an upgrade of the very well-known `amsmath` package.

Equations

The main LaTeX environment to write an equation is... `equation`. As an example:

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

The starred version disables numbering:

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

There are also shorter forms thanks to:

- the \[...\] wrapper surrounding the equation,
- the double $$ symbol surrounding the equation (plain TEX, deprecated, should not be used).

However, I recommend the use of the `equation` environment because it highlights the mathematics in the LATEX code and for its versatility between the numbered and the unnumbered version.

Inline equations

It is sometimes useful to write mathematics inside a text, for instance to describe the variable $\vec{B}$ appearing in eq. (1). To do so, the mathematical formula must be wrapped by single $ signs.
Recommendation: try to not abuse of inline equations because they

- can be difficult to read in the text,
- could "ruin" the line space,
- cannot be numbered so it is not possible to refer to them.

Grouping equations

No alignment inside the group

Tool: `gather` environment, double backslash (\\) before starting a new equation.
Example with the local equation from Ampere theorem:

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{j} + \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t}, \tag{2}$$

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

$$\oint_C \vec{B} \cdot \mathrm{d}\vec{l} = \mu_0 \iint_S \vec{j} \cdot \mathrm{d}\vec{S} + \varepsilon_0 \mu_0 \iint_S \frac{\partial \vec{E}}{\partial t} \cdot \mathrm{d}\vec{S}. \tag{3}$$

Text can be written between equations thanks to the `intertext` and `shortintertext` commands.

Grouping equations

Alignment inside the group

Tool: `align` environment, double backslash (\\) before starting a new equation, ampersand (&) to indicate where the alignment is performed. Examples with the vector potential:

$$\vec{B} = \vec{\nabla} \times \vec{A} \tag{4}$$

$$\vec{E} = -\vec{\nabla} V - \frac{\partial \vec{A}}{\partial t} \tag{5}$$

The `intertext` and `shortintertext` commands are also available. The alignment is generally performed on the equal sign.

Matrices

Types of matrices

Matrices can be written by using a `matrix`-like environment inside a mathematical equation environment such as the ones presented here above. Several types of matrices exist. They differ with the type of delimiters surrounding the matrix:

`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`

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

Matrices

Alignment

By default, numbers are centred in each column of a matrix:

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

A starred version of each `matrix` environment offers an optional argument where the alignment can be provided through a letter: `c` for center, `r` for right and `l` for left. Example with right alignment:

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

Package options for layout modification

It is possible to change the layout of equations thanks to package options:

- position of equation numbers
  - on the right (default) with the `reqno` option,
  - on the left with the `leqno` option.