The HEP-MATH package*

Extended math macros

Jan Hajer†

2022/11/01

Abstract

The HEP-MATH package provides some additional features beyond the MATHTOOLS and AMSMATH packages.

To use the package place `\usepackage{hep-math}` in the preamble.

The MATHTOOLS [1] package is loaded, which in turn loads the $\mathcal{AMS}$-LaTeX AMSMATH [2] package. Horizontal spacing in inline equations and page breaks in block equations are marginally adjusted. Spacing around `\left` and `\right` is fixed with the MLEFTRIGHT package [3].

\left
\right

1 Macros

\mathdef

The `\mathdef{`⟨*name*⟩`}[`⟨*arguments*⟩`]{`⟨*code*⟩`}` macro (re-)defines macros only within math mode without changing the text mode definition.

\i

The imaginary unit `\i` and the differential `\d` are defined using this functionality.

\d

\overline

The `\overline` macro is adjusted to $\overline{\text{work also outside}}$ of math mode using the SOULUTF8 [4] package.

\oset

\overleft

A better looking over left right arrow is defined i.e. $\overleftrightarrow{\partial}$ using a new `\oset{`⟨*over*⟩`}{`⟨*math*⟩`}` functionality.

\overright

Diagonal matrix `\diag`, signum `\sgn`, trace `\tr`, `\Tr`, and `\rank` operators are defined.

\overleftright

The real and imaginary projectors are redefined to look like ordinary operators.

\diag

`\cos` and `\tan` are adjusted to have the same height as `\sin`.

\sgn

`\arccsc` and other inverse trigonometric functions are defined.

\Re

\Im

1.1 Fractions and units

\sin

The correct spacing for units is provided by the macro `\unit[`⟨*value*⟩`]{`⟨*unit*⟩`}`

\cos

\tan

\accsc

\unit

\inv

*This document corresponds to HEP-MATH v1.1.

†jan.hajer@tecnico.ulisboa.pt

from the UNITS package [5] which can also be used in text mode. The macro `\inv[⟨power⟩]{⟨text⟩}` allows to avoid math mode also for inverse units such as $5\,\mathrm{fb}^{-1}$ typeset via `\unit[5]{\inv{fb}}`.

`\nicefrac` `\flatfrac` `\textfrac`

The `\frac{⟨number⟩}{⟨number⟩}` macro is accompanied by `\nicefrac{⟨number⟩}{⟨number⟩}`, `\textfrac{⟨number⟩}{⟨number⟩}`, and `\flatfrac{⟨number⟩}{⟨number⟩}` leading to $\frac{1}{2}$, $1/2$, $1/2$, and $1/2$. The `\textfrac` macro is mostly intended if a font with oldstyle numerals is used.

Some macros of the PHYSICS package [6] are reimplemented with a more conventional typesetting in mind. Finer details about mathematical typesetting can be found in [7].

1.2 Differentials and derivatives

`\differential` `\newderivative` `\newpartialderivative`

The three macros `\differential{⟨symbol⟩}`, `\newderivative{\name}{⟨symbol⟩}`, and `\newpartialderivative{\name}{⟨symbol⟩}` allow to define a differential with correct spacing, a derivative using this differential, and if necessary a partial derivative that can handle three dimensional derivatives.

`\d` `\dv`

These macros are used for the usual differential and derivative, producing dx via `\d x` and

`\dv[f]x`	`\dv*[f]x^n`	`\dv[f]x*^n`	`\dv*[f]x*^n`
$\frac{df}{dx}$	d^nf/dx^n	$\frac{d^nf}{dx^n}$	d^nf/dx^n
`\dv xf`	`\dv*xf`	`\dv x*f`	`\dv*x*f`
$\frac{d}{dx}f$	$d/dx\,f$	$\frac{d}{dx}f$	$d/dx\,f$

via `\dv*[⟨f⟩]{⟨x⟩}*^{⟨n⟩}`. Upright differential can be produced via `\renewcommand{\diffsymbol}{\mathrm d}`.

`\pd` `\pdv`

Similarly a partial differential and derivative are defined that can be used according to `\pdv*[⟨f⟩]{⟨x⟩}*^{⟨a⟩}[⟨y⟩]^{⟨b⟩}[⟨z⟩]^{⟨c⟩}`.

`\pdv[f]x`	`\pdv[f]x[y]`	`\pdv[f]x^3`	`\pdv[f]x^2[y]`
$\frac{\partial f}{\partial x}$	$\frac{\partial^2 f}{\partial x\partial y}$	$\frac{\partial^3 f}{\partial x^3}$	$\frac{\partial^3 f}{\partial x^2\partial y}$
`\pdv[f]x^2[y]^3`	`\pdv[f]x[y]^3`	`\pdv x[y]f`	
$\frac{\partial^5 f}{\partial x^2\partial y^3}$	$\frac{\partial^4 f}{\partial x\partial y^3}$	$\frac{\partial^2}{\partial x\partial y}f$	

`\var` Similarly a functional variation and functional derivative are defined.

`\fdv` `\cancel` `\slashed`

The `\cancel{⟨characters⟩}` macro from the CANCEL package [8] and the `\slashed{⟨character⟩}` macro from the SLASHED package [9] allow to $\cancel{\text{cancel}}$ math and use the Dirac slash notation i.e. $\not\emptyset$, respectively.

1.3 Paired delimiters

\abs
\norm
\eval
\order

```
\abs x   \norm x   \norm[2]x   \norm*[2]x
```
$$|x| \qquad \|x\| \qquad \|x\|_2 \qquad \|x\|_2$$

```
\order x   \eval x__o^\infty   \eval* x__o^\infty
```
$$\mathcal{O}(x) \qquad x|_0^\infty \qquad x|_0^\infty$$

\newpair
\comm
\acomm

The \newpair{⟨*name*⟩}{⟨*left delim*⟩} {⟨*right delim*⟩}_{⟨*subscript*⟩}^{⟨*superscript*⟩} macro is defined and used for the definition of (anti-)commutators and Poisson brackets.

```
\pb xy   \comm xy   \acomm xy
```
$$\{x, y\} \qquad [x, y] \qquad \{x, y\}$$

They can easily be redefined using e.g. \newpair\comm\lbrack\rbrack__-.

\bra
\ket
\braket
\ketbra

Macros for the bra-ket notation are introduced.

```
\bra x   \ket x   \braket xy   \ketbra xy
```
$$\langle x| \qquad |x\rangle \qquad \langle x|y\rangle \qquad |x\rangle\langle y|$$

```
\mel xyz   \ev x   \ev[\Omega] x   \vev x
```
$$\langle x|y|z\rangle \qquad \langle x\rangle \qquad \langle \Omega|x|\Omega\rangle \qquad \langle 0|x|0\rangle$$

\mel
\ev
\vev
\column
\row

Macros for row and column vectors are introduced together with a symbol for transpose vectors.

```
\column{x,y,z}   \row{x,y,z}^\trans
```
$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} \qquad (x,\, y,\, z)^{\mathsf{T}}$$

2 Environments

eqnarray

The eqnarray environment is depreciated, the split, multline, align, multlined, aligned, alignedat, and cases environments of the AMSMATH and MATHTOOLS packages should be used instead.

equation

Use the equation environment for short equations.

```
\begin{equation}
  left = right \ .
\end{equation}
```

$$\boxed{\text{left}} = \boxed{\text{right}}\ . \tag{1}$$

multline

Use the multline environment for longer equations.

```
\begin{multline}
  left = right 1 \\
  + right 2 \ .
\end{multline}
```

$$\boxed{\text{left}} = \boxed{\text{right 1}}$$
$$\boxed{+\ \text{right 2}}\ . \tag{2}$$

split Use the split sub environment for equations in which multiple equal signs should be aligned.

```
\begin{equation} \begin{split}
  left &= right 1 \\
  &= right 2 \ .
\end{split} \end{equation}
```

$$\begin{aligned} \boxed{\text{left}} &= \boxed{\text{right 1}} \\ &= \boxed{\text{right 2}} \ . \end{aligned} \tag{3}$$

align Use the align environment for the vertical alignment and horizontal distribution of multiple equations.

```
\begin{subequations} \begin{align}
  left &= right \ , &
  left &= right \ , \\
  left &= right \ , &
  left &= right \ .
\end{align} \end{subequations}
```

$$\boxed{\text{left}} = \boxed{\text{right}} \ , \quad \boxed{\text{left}} = \boxed{\text{right}} \ , \tag{4a}$$

$$\boxed{\text{left}} = \boxed{\text{right}} \ , \quad \boxed{\text{left}} = \boxed{\text{right}} \ . \tag{4b}$$

aligned Use the aligned environment within a equation environment if the aligned equations should be labeled with a single equation number.

multlined Use the multlined environment if either split or align contain very long lines.

```
\begin{equation} \begin{split}
  left &= right 1 \\ &=
  \begin{multlined}[t]
    right 2 \\ + right 3 \ .
  \end{multlined}
\end{split} \end{equation}
```

$$\begin{aligned} \boxed{\text{left}} &= \boxed{\text{right 1}} \\ &= \boxed{\text{right 2}} \\ &\quad \boxed{\text{+ right 3}} \ . \end{aligned} \tag{5}$$

alignat Use the alignat environment together with the \mathhllap macro for the alignment of multiple equations with vastly different lengths.

```
\begin{subequations}
\begin{alignat}{2}
  left &= long right &&  \ , \\
  le. 2 &= ri. 2 \ , &
  \mathhllap{le. 3 = ri. 3} & \ .
\end{alignat}
\end{subequations}
```

$$\boxed{\text{left}} = \boxed{\text{long right}} \ , \tag{6a}$$

$$\boxed{\text{le. 2}} = \boxed{\text{ri. 2}} \ , \qquad \boxed{\text{le. 3}} = \boxed{\text{ri. 3}} \ . \tag{6b}$$

As a rule of thumb if you have to use \notag, \nonumber, or perform manual spacing via \quad you are probably using the wrong environment.

References

[1] L. Madsen, M. Høgholm, W. Robertson, and J. Wright. 'The mathtools package: Mathematical tools to use with amsmath' (2004). CTAN: mathtools.

[2] *LaTeX Team.* 'The amsmath package: AMS mathematical facilities for LaTeX' (1994). CTAN: amsmath. URL: ams.org/tex/amslatex.

[3] H. Oberdiek. 'The mleftright package: Variants of delimiters that act as maths open/close' (2010). CTAN: mleftright.

[4] H. Oberdiek. 'The soulutf8 package: Permit use of UTF-8 characters in soul' (2007). CTAN: soulutf8.
[5] A. Reichert. 'The units and nicefrac packages: Typeset units' (1998). CTAN: units.
[6] S. C. de la Barrera. 'The physics package: Macros supporting the Mathematics of Physics' (2012). CTAN: physics.
[7] E. Gregorio. 'TEX, LATEX and math' (2020). URL: latex - project . org / publications/2020-egreg-TUB-tb127gregorio-math.pdf.
[8] D. Arseneau. 'The cancel package: Place lines through maths formulae' (2013). CTAN: cancel.
[9] D. Carlisle. 'The slashed package: Put a slash through characters' (1987). CTAN: slashed.