The HEP-MATH package*

Extended math macros

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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 $\mathcal{A}\mathcal{M}\mathcal{S}$-LaTeX AMSMATH [2] package. Horizontal spacing in inline equations and page breaks in block equations are marginally adjusted.

`\left` `\right` Spacing around `\left` and `\right` is fixed with the MLEFTRIGHT package [3].

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

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

`\oset` functionality.

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

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

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

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

`\sgn`

`\Re`

1.1 Fractions and units

`\Im`

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

`\cos`

`\tan` 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.

`\accsc`

`\unit` 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].

`\inv`

*This document corresponds to HEP-MATH v1.3.

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`\flatfrac`

`\textfrac`

1.2 Differentials and derivatives

\differential
\newderivative
\newpartialderivative
\d
\dv

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.

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`
$\frac{df}{dx}$	$d^n f/dx^n$	$\frac{d^n f}{dx^n}$	$^{d^n f}/_{dx^n}$
`\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}`. The differential takes care of the correct spacing as long as it is placed at the end of the integral $\int f(x)\,dx$. In order to archive correct spacing when it is placed at the beginning of the integral it is advisable to place the whole expression in a `\mathop{\int\d x} f(x)` such that $\int dx\, f(x)$.

\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
\fdv

Similarly a functional variation and functional derivative are defined.

\cancel
\slashed

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

1.3 Paired delimiters

\abs
\norm
\eval
\order

`\abs x`	`\norm x`	`\norm[2]x`	`\norm*[2]x`
$\lvert x \rvert$	$\lVert x \rVert$	$\lVert x \rVert_2$	$\left\lVert x \right\rVert_2$

`\order x`	`\eval x_0^\infty`	`\eval* x_0^\infty`
$\mathcal{O}(x)$	$x\vert_0^\infty$	$\left. x \right\vert_0^\infty$

\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`
$\{x, y\}$	$[x, y]$	$\{x, y\}$

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

\bra
\ket
\braket
\ketbra
\mel
\ev
\vev

Macros for the bra-ket notation are introduced.

\bra x	\ket x	\braket xy	\ketbra xy
$\langle x \vert$	$\vert x \rangle$	$\langle x \vert y \rangle$	$\vert x \rangle\langle y \vert$
\mel xyz	\ev x	\ev[\Omega] x	\vev x
$\langle x \vert y \vert z \rangle$	$\langle x \rangle$	$\langle \Omega \vert x \vert \Omega \rangle$	$\langle 0 \vert x \vert 0 \rangle$

\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}
```

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

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}
```

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

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

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 `\mathllap` macro for the alignment of multiple equations with vastly different lengths.

```
\begin{subequations}
\begin{alignat}{2}
  left &= long right && \ , \\
  le. 2 &= ri. 2 \ , &
  \mathllap{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] M. Franz. 'The `soul` package: Hyphenation for letterspacing, underlining, and more' (1998). CTAN: `soul`.

[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`.