

The HEP-MATH package*

Extended math macros

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Abstract

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

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

The MATHTOOLS [1] package is loaded, which in turn loads the $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$ AMSMATH [2] package. Horizontal spacing in inline equations and page breaks in block equations are marginally adjusted.

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

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

`\overline` A better looking over left right arrow is defined i.e. $\overrightarrow{\partial}$ using a new `\oset{<over>}{<math>}` functionality.

`\oset`

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

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

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

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

`\sgn`

1.1 Fractions and units

`\Re`

`\Im` 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 fb^{-1} typeset via `\unit[5]{\inv{fb}}`.

`\sin`

`\cos` The `\frac{<number>}{<number>}` macro is accompanied by `\nicefrac{<number>}{<number>}`, `\tan` `\textfrac{<number>}{<number>}`, and `\flatfrac{<number>}{<number>}` leading to $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$, 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`

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`\nicefrac`

`\flatfrac`

`\textfrac`

1.2 Differentials and derivatives

`\differential` 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.

`\newpartialderivative`

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

<code>\d</code>	<code>\dv[f]x</code>	<code>\dv*[f]x^n</code>	<code>\dv[f]x*x^n</code>	<code>\dv*[f]x*x^n</code>
<code>\dv</code>	$\frac{df}{dx}$	$d^n f/dx^n$	$\frac{d^n f}{dx^n}$	$d^n f/dx^n$
	<code>\dv x f</code>	<code>\dv*x f</code>	<code>\dv x*f</code>	<code>\dv*x*f</code>
	$\frac{d}{dx} f$	$d/dx f$	$\frac{d}{dx} f$	$d/dx f$

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\mathrm d x} f(x)` such that $\int dx f(x)$.

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

`\pdv`

<code>\pdv[f]x</code>	<code>\pdv[f]x[y]</code>	<code>\pdv[f]x^3</code>	<code>\pdv[f]x^2[y]</code>
$\frac{\partial f}{\partial x}$	$\frac{\partial^2 f}{\partial x \partial y}$	$\frac{\partial^3 f}{\partial x^3}$	$\frac{\partial^3 f}{\partial x^2 \partial y}$
<code>\pdv[f]x^2[y]^3</code>	<code>\pdv[f]x[y]^3</code>	<code>\pdv x[y]f</code>	
$\frac{\partial^5 f}{\partial x^2 \partial y^3}$	$\frac{\partial^4 f}{\partial x \partial y^3}$	$\frac{\partial^2}{\partial x \partial y} f$	

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

`\fdv` 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. $\cancel{\phi}$, respectively.

`\cancel`
`\slashed`

1.3 Paired delimiters

`\abs`

<code>\norm</code>	<code>\abs x</code>	<code>\norm x</code>	<code>\norm[2]x</code>	<code>\norm*[2]x</code>
	$ x $	$\ x\ $	$\ x\ _2$	$\ x\ _2$

`\eval`

<code>\order</code>	<code>\order x</code>	<code>\eval x_0^\infty</code>	<code>\eval* x_0^\infty</code>
	$\mathcal{O}(x)$	$x _0^\infty$	$x _0^\infty$

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

`\comm`

<code>\acomm</code>	<code>\pb xy</code>	<code>\comm xy</code>	<code>\acomm xy</code>
	$\{x, y\}$	$[x, y]$	$\{x, y\}$

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

`\bra` Macros for the bra-ket notation are introduced.

`\ket`

`\braket`

`\ketbra`

`\mel`

`\ev`

`\vev`

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

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

<code>\row</code>	<code>\column{x,y,z}</code>	<code>\row{x,y,z}^\trans</code>
	$\begin{pmatrix} x \\ y \\ z \end{pmatrix}$	$(x, y, z)^\top$

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.

<code>\begin{equation}</code>	<code>left = right \ .</code>	$\boxed{\text{left}} = \boxed{\text{right}} .$	(1)
<code>\end{equation}</code>			

`multline` Use the `multline` environment for longer equations.

<code>\begin{multline}</code>	<code>left = right 1 \\ + right 2 \ .</code>	$\boxed{\text{left}} = \boxed{\text{right 1}}$	
<code>\end{multline}</code>		$\boxed{\text{+ right 2}} .$	(2)

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

<code>\begin{equation} \begin{split}</code>	<code>left &= right 1 \\ &= right 2 \ .</code>	$\boxed{\text{left}} = \boxed{\text{right 1}}$	
<code>\end{split} \end{equation}</code>		$= \boxed{\text{right 2}} .$	(3)

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

<code>\begin{subequations} \begin{align}</code>	<code>left &= right \ , &</code>	$\boxed{\text{left}} = \boxed{\text{right}} ,$	$\boxed{\text{left}} = \boxed{\text{right}} ,$	(4a)
<code>left &= right \ , \\ left &= right \ , &</code>	$\boxed{\text{left}} = \boxed{\text{right}} ,$	$\boxed{\text{left}} = \boxed{\text{right}} .$	(4b)	
<code>left &= right \ .</code>				
<code>\end{align} \end{subequations}</code>				

`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.

<code>\begin{equation} \begin{split}</code>	<code>left &= right 1 \\ right 2 \\ + right 3 \ .</code>	$\boxed{\text{left}} = \boxed{\text{right 1}}$	
<code>\begin{multlined}[t]</code>		$= \boxed{\text{right 2}}$	(5)
<code>\end{multlined}</code>		$\boxed{\text{+ right 3}} .$	
<code>\end{split} \end{equation}</code>			

`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 & \ , \ \ & \boxed{\text{left}} = \boxed{\text{long right}} , & (6a)
le. 2 &= ri. 2 \ , & & \boxed{\text{le. 2}} = \boxed{\text{ri. 2}} , & \boxed{\text{le. 3}} = \boxed{\text{ri. 3}} . & (6b)
\mathllap{le. 3 = ri. 3} & & & & &
\end{alignat}
\end{subequations}

```

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`.