

# The `physics` package

Sergio C. de la Barrera  
`physics.tex@gmail.com`

January 31, 2019

## Contents

<b>1</b>	<b>Before you start</b>	<b>1</b>
1.1	The purpose of this package	1
1.2	Other required packages	1
1.3	Using <code>physics</code> in your $\text{\LaTeX}$ document	1
<b>2</b>	<b>List of commands</b>	<b>2</b>
2.1	Automatic bracing	2
2.2	Vector notation	3
2.3	Operators	3
2.4	Quick quad text	4
2.5	Derivatives	5
2.6	Dirac bra-ket notation	6
2.7	Matrix macros	7

## 1 Before you start

### 1.1 The purpose of this package

The goal of this package is to make typesetting equations for physics simpler, faster, and more human-readable. To that end, the commands included in this package have names that make the purpose of each command immediately obvious and remove any ambiguity while reading and editing `physics` code. From a practical standpoint, it is handy to have a well-defined set of shortcuts for accessing the long-form of each of these commands. The commands listed below are therefore defined in terms of their long-form names and then shown explicitly in terms of the default shorthand command sequences. These shorthand commands are meant make it easy to remember both the shorthand names and what each one represents.

### 1.2 Other required packages

The `physics` package requires `xparse` and `amsmath` to work properly in your  $\text{\LaTeX}$  document. The `amsmath` package comes standard with most  $\text{\LaTeX}$  distributions and is loaded by `physics` for your convenience. You may also already have `xparse` installed on your system as it is a popular package for defining  $\text{\LaTeX}$  macros, however, if you are unsure you can either install it again using your local package manager (comes with most distributions) or by visiting the [CTAN](#) online package database, or you could even just try to use `physics`

without worrying about it. Many modern L<sup>A</sup>T<sub>E</sub>X compilers will locate and offer to download missing packages for you.













### 1.3 Using physics in your L<sup>A</sup>T<sub>E</sub>X document

To use the `physics` package, simply insert `\usepackage{physics}` in the preamble of your document, before `\begin{document}` and after `\documentclass{class}`:

```
\documentclass{class}
...
\usepackage{physics}
...
\begin{document}
content...
\end{document}
```

## 2 List of commands

### 2.1 Automatic bracing

<code>\quantity</code>	<code>\qty(\typical)</code> → 	automatic ( ) braces
	<code>\qty(\tall)</code> → 	
	<code>\qty(\grande)</code> → 	
	<code>\qty[\typical]</code> → 	automatic [ ] braces
	<code>\qty \typical </code> → 	automatic     braces
	<code>\qty{\typical}</code> → 	automatic { } braces
	<code>\qty\big{}</code> → 	manual sizing (works with any of the above bracket types)
	<code>\qty\Big{}</code> → 	
	<code>\qty\bigg{}</code> → 	
	<code>\qty\Bigg{}</code> → 	
	<code>\pqty{}</code> ↔ <code>\qty()</code>	alternative syntax; robust and more L <sup>A</sup> T <sub>E</sub> X-friendly
	<code>\bqty{}</code> ↔ <code>\qty[]</code>	
	<code>\vqty{}</code> ↔ <code>\qty  </code>	
	<code>\Bqty{}</code> ↔ <code>\qty{}</code>	
<code>\absolutevalue</code>	<code>\abs{a}</code> → $ a $	automatic sizing; equivalent to <code>\qty a </code> inherits manual sizing syntax from <code>\qty</code>
	<code>\abs\Big{a}</code> → $ a $	
	<code>\abs*\{\grande\}</code> → 	star for no resize
<code>\norm</code>	<code>\norm{a}</code> → $\ a\ $	automatic sizing
	<code>\norm\Big{a}</code> → $\ a\ $	manual sizing
	<code>\norm*\{\grande\}</code> → 	star for no resize
<code>\evaluated</code>	<code>\eval{x}_0^{\infty}</code> → $x \Big _0^{\infty}$	vertical bar for evaluation limits

	$\backslash eval(x _0^{\infty} \rightarrow \left( x \right _0^{\infty}$	alternate form
	$\backslash eval[x _0^{\infty} \rightarrow \left[ x \right _0^{\infty}$	alternate form
	$\backslash eval[\venti _0^{\infty} \rightarrow \left[ \venti \right _0^{\infty}$	automatic sizing
	$\backslash eval*[\venti _0^{\infty} \rightarrow \left[ \venti \right _0^{\infty}$	star for no resize
$\backslash order$	$\backslash order\{x^2\} \rightarrow \mathcal{O}(x^2)$	order symbol; automatic sizing and space handling
	$\backslash order\Big\{x^2\} \rightarrow \mathcal{O}(x^2)$	manual sizing
	$\backslash order*\{\grande\} \rightarrow \mathcal{O}(\grande)$	star for no resize
$\backslash commutator$	$\backslash comm\{A\}\{B\} \rightarrow [A, B]$	automatic sizing
	$\backslash comm\Big\{A\}\{B\} \rightarrow [A, B]$	manual sizing
	$\backslash comm*\{A\}\{\grande\} \rightarrow [A, \grande]$	star for no resize
$\backslash anticommutator$	$\backslash acomm\{A\}\{B\} \rightarrow \{A, B\}$	same as $\backslash poissonbracket$
$\backslash poissonbracket$	$\backslash pb\{A\}\{B\} \rightarrow \{A, B\}$	same as $\backslash anticommutator$

## 2.2 Vector notation

The default  $\del$  symbol  $\nabla$  used in `physics` vector notation can be switched to appear with an arrow  $\vec{\nabla}$  by including the option `arrowdel` in the document preamble  $\rightarrow \backslash usepackage[arrowdel]{physics}$ .

$\backslash vectorbold$	$\backslash vb\{a\} \rightarrow \mathbf{a}$	upright/no Greek
	$\backslash vb*\{a\}, \backslash vb*\{\theta\} \rightarrow \mathbf{a}, \boldsymbol{\theta}$	italic/Greek
$\backslash vectorarrow$	$\backslash va\{a\} \rightarrow \vec{a}$	upright/no Greek
	$\backslash va*\{a\}, \backslash va*\{\theta\} \rightarrow \vec{a}, \vec{\theta}$	italic/Greek
$\backslash vectorunit$	$\backslash vu\{a\} \rightarrow \hat{a}$	upright/no Greek
	$\backslash vu*\{a\}, \backslash vu*\{\theta\} \rightarrow \hat{a}, \hat{\theta}$	italic/Greek
$\backslash dotproduct$	$\backslash vdot \rightarrow \cdot$ as in $\mathbf{a} \cdot \mathbf{b}$	note: $\backslash dp$ is a protected TeX primitive
$\backslash crossproduct$	$\backslash cross \rightarrow \times$ as in $\mathbf{a} \times \mathbf{b}$	alternate name
	$\backslash cp \rightarrow \times$ as in $\mathbf{a} \times \mathbf{b}$	shorthand name
$\backslash gradient$	$\backslash grad \rightarrow \nabla$	
	$\backslash grad\{\Psi\} \rightarrow \nabla \Psi$	default mode
	$\backslash grad(\Psi+\tall) \rightarrow \nabla(\Psi + \tall)$	long-form (like $\backslash qty$ but also handles spacing)
	$\backslash grad[\Psi+\tall] \rightarrow \nabla[\Psi + \tall]$	
$\backslash divergence$	$\backslash div \rightarrow \nabla \cdot$	note: <code>amsmath</code> symbol $\div$ renamed <code>\divisionsymbol</code>
	$\backslash div\{vb\{a\}\} \rightarrow \nabla \cdot \mathbf{a}$	default mode
	$\backslash div(\vb\{a\}+\tall) \rightarrow \nabla \cdot (\mathbf{a} + \tall)$	long-form
	$\backslash div[\vb\{a\}+\tall] \rightarrow \nabla \cdot [\mathbf{a} + \tall]$	
$\backslash curl$	$\backslash curl \rightarrow \nabla \times$	
	$\backslash curl\{vb\{a\}\} \rightarrow \nabla \times \mathbf{a}$	default mode
	$\backslash curl(\vb\{a\}+\tall) \rightarrow \nabla \times (\mathbf{a} + \tall)$	long-form

	$\text{\curl[\vb{a}+\tall]} \rightarrow \nabla \times [\mathbf{a} + \text{\tall}]$	
$\text{\laplacian}$	$\text{\laplacian} \rightarrow \nabla^2$	
	$\text{\laplacian}\{\Psi\} \rightarrow \nabla^2 \Psi$	default mode
	$\text{\laplacian}(\Psi+\tall) \rightarrow \nabla^2 (\Psi + \text{\tall})$	long-form
	$\text{\laplacian}[\Psi+\tall] \rightarrow \nabla^2 [\Psi + \text{\tall}]$	

## 2.3 Operators

The standard set of trig functions is redefined in `physics` to provide automatic braces that behave like `\qty()`. In addition, an optional power argument is provided. This behavior can be switched off by including the option `notrig` in the preamble  $\rightarrow \text{\usepackage[notrig]{physics}}$ .

Example trig redefinitions:

$\text{\sin}$	$\text{\sin}(\text{\grande}) \rightarrow \sin(\text{\grande})$	automatic braces; old <code>\sin</code> renamed <code>\sine</code>
	$\text{\sin}[2](x) \rightarrow \sin^2(x)$	optional power
	$\text{\sin } x \rightarrow \sin x$	can still use without an argument

The full set of available trig functions in `physics` includes:

$\text{\sin}(x)$	$\text{\sinh}(x)$	$\text{\arcsin}(x)$	$\text{\asin}(x)$	$\sin(x)$	$\sinh(x)$	$\arcsin(x)$	$\asin(x)$
$\text{\cos}(x)$	$\text{\cosh}(x)$	$\text{\arccos}(x)$	$\text{\acos}(x)$	$\cos(x)$	$\cosh(x)$	$\arccos(x)$	$\acos(x)$
$\text{\tan}(x)$	$\text{\tanh}(x)$	$\text{\arctan}(x)$	$\text{\atan}(x)$	$\Rightarrow \tan(x)$	$\tanh(x)$	$\arctan(x)$	$\atan(x)$
$\text{\csc}(x)$	$\text{\csch}(x)$	$\text{\arccsc}(x)$	$\text{\acsc}(x)$	$\Rightarrow \csc(x)$	$\csch(x)$	$\arccsc(x)$	$\acsc(x)$
$\text{\sec}(x)$	$\text{\sech}(x)$	$\text{\arcsec}(x)$	$\text{\asec}(x)$	$\sec(x)$	$\sech(x)$	$\arcsec(x)$	$\asec(x)$
$\text{\cot}(x)$	$\text{\coth}(x)$	$\text{\arccot}(x)$	$\text{\acot}(x)$	$\cot(x)$	$\coth(x)$	$\arccot(x)$	$\acot(x)$

The standard trig functions (plus a few that are missing in `amsmath`) are available without any automatic bracing under a new set of longer names:

$\text{\sine}$	$\text{\hyp sine}$	$\text{\arcsine}$	$\text{\asine}$
$\text{\cosine}$	$\text{\hyp cosine}$	$\text{\arccosine}$	$\text{\acosine}$
$\text{\tangent}$	$\text{\hyp tangent}$	$\text{\arctangent}$	$\text{\atangent}$
$\text{\cosecant}$	$\text{\hyp cosecant}$	$\text{\arccosecant}$	$\text{\acosecant}$
$\text{\secant}$	$\text{\hyp secant}$	$\text{\arcsecant}$	$\text{\asecant}$
$\text{\cotangent}$	$\text{\hyp cotangent}$	$\text{\arccotangent}$	$\text{\acotangent}$

Similar behavior has also been extended to the following functions:

$\text{\exp}(\tall)$	$\exp(\tall)$	$\text{\exponential}$
$\text{\log}(\tall)$	$\log(\tall)$	$\text{\logarithm}$
$\text{\ln}(\tall)$	$\ln(\tall)$	$\text{\natural logarithm}$
$\text{\det}(\tall)$	$\det(\tall)$	$\text{\determinant}$
$\text{\Pr}(\tall)$	$\Pr(\tall)$	$\text{\Probability}$

New operators:

$\text{\trace}$ or $\text{\tr}$	$\text{\tr}\rho \rightarrow \text{tr } \rho$ also $\text{\tr}(\tall) \rightarrow \text{tr}(\tall)$	trace; same bracing as trig functions
$\text{\Trace}$ or $\text{\Tr}$	$\text{\Tr}\rho \rightarrow \text{Tr } \rho$	alternate
$\text{\rank}$	$\text{\rank } M \rightarrow \text{rank } M$	matrix rank
$\text{\erf}$	$\text{\erf}(x) \rightarrow \text{erf}(x)$	Gauss error function
$\text{\Res}$	$\text{\Res}[f(z)] \rightarrow \text{Res}[f(z)]$	residue; same bracing as trig functions
$\text{\principalvalue}$	$\text{\pv}\{\int f(z) \, \dd{z}\} \rightarrow \mathcal{P} \int f(z) \, dz$	Cauchy principal value
	$\text{\PV}\{\int f(z) \, \dd{z}\} \rightarrow \text{P.V.} \int f(z) \, dz$	alternate

<code>\Re</code>	$\operatorname{Re}\{z\} \rightarrow \operatorname{Re}\{z\}$	old <code>\Re</code> renamed to <code>\real</code> $\rightarrow \Re$
<code>\Im</code>	$\operatorname{Im}\{z\} \rightarrow \operatorname{Im}\{z\}$	old <code>\Im</code> renamed to <code>\imaginary</code> $\rightarrow \Im$

## 2.4 Quick quad text

This set of commands produces text in math-mode padded by `\quad` spacing on either side. This is meant to provide a quick way to insert simple words or phrases in a sequence of equations. Each of the following commands includes a starred version which pads the text only on the right side with `\quad` for use in aligned environments such as `cases`.

General text:

<code>\qqtext</code>	<code>\qq{}</code>	general quick quad text with argument
	<code>\qq{word or phrase} \rightarrow</code> word or phrase <code>\quad</code>	normal mode; left and right <code>\quad</code>
	<code>\qq*{word or phrase} \rightarrow</code> word or phrase <code>\quad</code>	starred mode; right <code>\quad</code> only

Special macros:

<code>\qcomma</code> or <code>\qc</code>	$\rightarrow,$ <code>\quad</code>	right <code>\quad</code> only
<code>\qcc</code>	$\rightarrow$ c.c. <code>\quad</code>	complex conjugate; left and right <code>\quad</code> unless starred <code>\qcc*</code> $\rightarrow$ c.c. <code>\quad</code>
<code>\qif</code>	$\rightarrow$ if <code>\quad</code>	left and right <code>\quad</code> unless starred <code>\qif*</code> $\rightarrow$ if <code>\quad</code>

Similar to `\qif`:

`\qthen`, `\qelse`, `\qotherwise`, `\qunless`, `\qgiven`, `\qusing`, `\qassume`, `\qsince`,  
`\qlet`, `\qfor`, `\qall`, `\qeven`, `\qodd`, `\qinteger`, `\qand`, `\qor`, `\qas`, `\qin`

## 2.5 Derivatives

The default differential symbol `d` which is used in `\differential` and `\derivative` can be switched to an italic form *d* by including the option `italicdiff` in the preamble  $\rightarrow \text{\usepackage[italicdiff]{physics}}$ .

<code>\differential</code>	<code>\dd</code>	$\rightarrow d$	
	<code>\dd x</code>	$\rightarrow dx$	no spacing (not recommended)
	<code>\dd{x}</code>	$\rightarrow \mathrm{d}x$	automatic spacing based on neighbors
	<code>\dd[3]{x}</code>	$\rightarrow d^3x$	optional power
	<code>\dd(\cos\theta)</code>	$\rightarrow d(\cos\theta)$	long-form; automatic braces
<code>\derivative</code>	<code>\dv{x}</code>	$\rightarrow \frac{d}{dx}$	one argument
	<code>\dv{f}{x}</code>	$\rightarrow \frac{df}{dx}$	two arguments
	<code>\dv[n]{f}{x}</code>	$\rightarrow \frac{d^n f}{dx^n}$	optional power
	<code>\dv{x}(\grande)</code>	$\rightarrow \frac{d}{dx} \left( \text{blue square} \right)$	long-form; automatic braces, spacing
	<code>\dv*{f}{x}</code>	$\rightarrow df/dx$	inline form using <code>\flatfrac</code>
<code>\partialderivative</code>	<code>\pderivative{x}</code>	$\rightarrow \frac{\partial}{\partial x}$	alternate name
	<code>\pdv{x}</code>	$\rightarrow \frac{\partial}{\partial x}$	shorthand name
	<code>\pdv{f}{x}</code>	$\rightarrow \frac{\partial f}{\partial x}$	two arguments
	<code>\pdv[n]{f}{x}</code>	$\rightarrow \frac{\partial^n f}{\partial x^n}$	optional power

	$\text{\p dv}\{x\}(\text{\g grande}) \rightarrow \frac{\partial}{\partial x} \left( \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}} \right)$	long-form
	$\text{\p dv}\{f\}\{x\}\{y\} \rightarrow \frac{\partial^2 f}{\partial x \partial y}$	mixed partial
	$\text{\p dv}\{*\}\{f\}\{x\} \rightarrow \partial f / \partial x$	inline form using <code>\flatfrac</code>
<code>\variation</code>	$\text{\var}\{F[g(x)]\} \rightarrow \delta F[g(x)]$	functional variation (works like <code>\dd</code> )
	$\text{\var}(E-TS) \rightarrow \delta(E-TS)$	long-form
<code>\functionalderivative</code>	$\text{\fdv}\{g\} \rightarrow \frac{\delta}{\delta g}$	functional derivative (works like <code>\dv</code> )
	$\text{\fdv}\{F\}\{g\} \rightarrow \frac{\delta F}{\delta g}$	
	$\text{\fdv}\{V\}(E-TS) \rightarrow \frac{\delta}{\delta V}(E-TS)$	long-form
	$\text{\fdv}\{*\}\{F\}\{x\} \rightarrow \delta F / \delta x$	inline form using <code>\flatfrac</code>

## 2.6 Dirac bra-ket notation

The following collection of macros for Dirac notation contains two fundamental commands, `\bra` and `\ket`, along with a set of more specialized macros which are essentially combinations of the fundamental pair. The specialized macros are both useful and descriptive from the perspective of generating `physics` code, however, the fundamental commands are designed to contract with one another algebraically when appropriate and are thus suggested for general use. For instance, the following code renders correctly<sup>1</sup>

$$\text{\bra}\{\text{\phi}\}\text{\ket}\{\text{\psi}\} \rightarrow \langle \phi | \psi \rangle \quad \text{as opposed to} \quad \langle \phi | \psi \rangle$$

whereas a similar construction with higher-level macros will not contract in a robust manner

$$\text{\bra}\{\text{\phi}\}\text{\dyad}\{\text{\psi}\}\{\text{\xi}\} \rightarrow \langle \phi | \psi \rangle \langle \xi |.$$

On the other hand, the correct output can be generated by sticking to the fundamental commands,

$$\text{\bra}\{\text{\phi}\}\text{\ket}\{\text{\psi}\}\text{\bra}\{\text{\xi}\} \rightarrow \langle \phi | \psi \rangle \langle \xi |$$

allowing the user to type out complicated quantum mechanical expressions without worrying about bra-ket contractions. That being said, the high-level macros do have a place in convenience and readability, as long as the user is aware of rendering issues that may arise due to an absence of automatic contractions.

<code>\ket</code>	$\text{\ket}\{\text{\tall}\} \rightarrow \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}}$	automatic sizing
	$\text{\ket}\{*\}\{\text{\tall}\} \rightarrow \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}}$	no resize
<code>\bra</code>	$\text{\bra}\{\text{\tall}\} \rightarrow \langle \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}}  $	automatic sizing
	$\text{\bra}\{*\}\{\text{\tall}\} \rightarrow \langle \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}}  $	no resize
	$\text{\bra}\{\text{\phi}\}\text{\ket}\{\text{\psi}\} \rightarrow \langle \phi   \psi \rangle$	automatic contraction
	$\text{\bra}\{\text{\phi}\}\text{\ket}\{*\}\{\text{\tall}\} \rightarrow \langle \phi   \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}} \rangle$	contraction inherits automatic sizing
	$\text{\bra}\{\text{\phi}\}\text{\ket}\{*\}\{\text{\tall}\} \rightarrow \langle \phi   \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}} \rangle$	a star on either term in the contraction prohibits resizing
	$\text{\bra}\{*\}\{\text{\phi}\}\text{\ket}\{\text{\tall}\} \rightarrow \langle \phi   \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}} \rangle$	
	$\text{\bra}\{*\}\{\text{\phi}\}\text{\ket}\{*\}\{\text{\tall}\} \rightarrow \langle \phi   \text{\textcolor{blue}{\rule{0.5cm}{0.5cm}}} \rangle$	
<code>\innerproduct</code>	$\text{\braket}\{a\}\{b\} \rightarrow \langle a   b \rangle$	two-argument bracket
	$\text{\braket}\{a\} \rightarrow \langle a   a \rangle$	one-argument (norm)

<sup>1</sup>Note the lack of a space between the bra and ket commands. This is necessary in order for the bra to find the corresponding ket and form a contraction.

	$\backslash\mathrm{braket}\{a\}\{\backslash\mathrm{tall}\} \rightarrow \langle a   \text{box} \rangle$	automatic sizing
	$\backslash\mathrm{braket}*\{a\}\{\backslash\mathrm{tall}\} \rightarrow \langle a   \text{box} \rangle$	no resize
	$\backslash\mathrm{ip}\{a\}\{b\} \rightarrow \langle a   b \rangle$	shorthand name
$\backslash\mathrm{outerproduct}$	$\backslash\mathrm{dyad}\{a\}\{b\} \rightarrow  a\rangle\langle b $	two-argument dyad
	$\backslash\mathrm{dyad}\{a\} \rightarrow  a\rangle\langle a $	one-argument (projector)
	$\backslash\mathrm{dyad}\{a\}\{\backslash\mathrm{tall}\} \rightarrow  a\rangle\langle \text{box}  $	automatic sizing
	$\backslash\mathrm{dyad}*\{a\}\{\backslash\mathrm{tall}\} \rightarrow  a\rangle\langle \text{box}  $	no resize
	$\backslash\mathrm{ketbra}\{a\}\{b\} \rightarrow  a\rangle\langle b $	alternative name
	$\backslash\mathrm{op}\{a\}\{b\} \rightarrow  a\rangle\langle b $	shorthand name
$\backslash\mathrm{expectationvalue}$	$\backslash\mathrm{expval}\{A\} \rightarrow \langle A \rangle$	implicit form
	$\backslash\mathrm{expval}\{A\}\{\backslash\mathrm{Psi}\} \rightarrow \langle \Psi   A   \Psi \rangle$	explicit form
	$\backslash\mathrm{ev}\{A\}\{\backslash\mathrm{Psi}\} \rightarrow \langle \Psi   A   \Psi \rangle$	shorthand name
	$\backslash\mathrm{ev}\{\backslash\mathrm{grande}\}\{\backslash\mathrm{Psi}\} \rightarrow \langle \Psi   \text{box}   \Psi \rangle$	default sizing ignores middle argument
	$\backslash\mathrm{ev}*\{\backslash\mathrm{grande}\}\{\backslash\mathrm{tall}\} \rightarrow \langle \text{box}   \text{box}   \text{box} \rangle$	single star does no resizing whatsoever
	$\backslash\mathrm{ev}**\{\backslash\mathrm{grande}\}\{\backslash\mathrm{Psi}\} \rightarrow \langle \Psi   \text{box}   \Psi \rangle$	double star resizes based on all parts
$\backslash\mathrm{matricelement}$	$\backslash\mathrm{matrixel}\{n\}\{A\}\{m\} \rightarrow \langle n   A   m \rangle$	requires all three arguments
	$\backslash\mathrm{mel}\{n\}\{A\}\{m\} \rightarrow \langle n   A   m \rangle$	shorthand name
	$\backslash\mathrm{mel}\{n\}\{\backslash\mathrm{grande}\}\{m\} \rightarrow \langle n   \text{box}   m \rangle$	default sizing ignores middle argument
	$\backslash\mathrm{mel}*\{n\}\{\backslash\mathrm{grande}\}\{\backslash\mathrm{tall}\} \rightarrow \langle n   \text{box}   \text{box} \rangle$	single star does no resizing whatsoever
	$\backslash\mathrm{mel}**\{n\}\{\backslash\mathrm{grande}\}\{m\} \rightarrow \langle n   \text{box}   m \rangle$	double star resizes based on all parts

## 2.7 Matrix macros

The following matrix macros produce unformatted rows and columns of matrix elements for use as separate matrices as well as blocks within larger matrices. For example, the command  $\backslash\mathrm{identitymatrix}\{2\}$  which has also has the shortcut  $\backslash\mathrm{imat}\{2\}$  produces the elements of a  $2 \times 2$  identity matrix  $\begin{smallmatrix} 1 & 0 \\ 0 & 1 \end{smallmatrix}$  without braces or grouping. This allows the command to also be used within another matrix, as in:

$$\begin{array}{l} \backslash\mathrm{begin}\{\mathrm{pmatrix}\} \\ \backslash\mathrm{imat}\{2\} \backslash\backslash a \ \& \ b \\ \backslash\mathrm{end}\{\mathrm{pmatrix}\} \end{array} \quad \Rightarrow \quad \begin{pmatrix} 1 & 0 \\ 0 & 1 \\ a & b \end{pmatrix}$$

To specify elements on the right of left sides of our  $\backslash\mathrm{imat}\{2\}$  sub-matrix we use the grouping command  $\backslash\mathrm{matrixquantity}$  or  $\backslash\mathrm{mqty}$  to effectively convert  $\backslash\mathrm{imat}\{2\}$  into a single matrix element of a larger matrix:

$$\begin{array}{l} \backslash\mathrm{begin}\{\mathrm{pmatrix}\} \\ \backslash\mathrm{mqty}\{\backslash\mathrm{imat}\{2\}\} \ \& \ \backslash\mathrm{mqty}\{a\backslash\backslash b\} \backslash\backslash \backslash\mathrm{mqty}\{c \ \& \ d\} \ \& \ e \\ \backslash\mathrm{end}\{\mathrm{pmatrix}\} \end{array} \quad \Rightarrow \quad \begin{pmatrix} 1 & 0 & a \\ 0 & 1 & b \\ c & d & e \end{pmatrix}$$

The extra  $\backslash\mathrm{mqty}$  groups were required in this case in order to get the  $a$  and  $b$  elements to behave as a single element, since  $\backslash\mathrm{mqty}\{\backslash\mathrm{imat}\{2\}\}$  also acts like a single matrix element (the same can be said of the grouped  $c$  and  $d$  elements). Finally, the outermost  $\mathrm{pmatrix}$  environment could have also been replaced with the physics macro  $\backslash\mathrm{mqty}()$ , allowing the above example to be written on one line:

$$\backslash\mathrm{mqty}(\backslash\mathrm{mqty}\{\backslash\mathrm{imat}\{2\}\} \ \& \ \backslash\mathrm{mqty}\{a\backslash\backslash b\} \backslash\backslash \backslash\mathrm{mqty}\{c \ \& \ d\} \ \& \ e) \quad \Rightarrow \quad \begin{pmatrix} 1 & 0 & a \\ 0 & 1 & b \\ c & d & e \end{pmatrix}$$

<code>\matrixquantity</code>	$\backslash\mqty\{a \& b \ \backslash\ c \& d\} \rightarrow \begin{matrix} a & b \\ c & d \end{matrix}$ $\backslash\mqty(a \& b \ \backslash\ c \& d) \rightarrow \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ $\backslash\mqty*(a \& b \ \backslash\ c \& d) \rightarrow \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ $\backslash\mqty[a \& b \ \backslash\ c \& d] \rightarrow \left[ \begin{matrix} a & b \\ c & d \end{matrix} \right]$ $\backslash\mqty a \& b \ \backslash\ c \& d  \rightarrow \left  \begin{matrix} a & b \\ c & d \end{matrix} \right $ $\backslash\pm\mqty\{\} \leftrightarrow \backslash\mqty()$ $\backslash\mathbb{P}\mqty\{\} \leftrightarrow \backslash\mqty*()$ $\backslash\mathbb{B}\mqty\{\} \leftrightarrow \backslash\mqty[]$ $\backslash\mathbb{V}\mqty\{\} \leftrightarrow \backslash\mqty  $	<p>groups a set of matrix elements into a single object</p> <p>parentheses</p> <p>alternate parentheses</p> <p>square brackets</p> <p>vertical bars</p> <p>alternative syntax; robust and more L<sup>A</sup>T<sub>E</sub>X-friendly</p>
<code>\smallmatrixquantity</code>	$\backslash\smqty\{a \& b \ \backslash\ c \& d\} \rightarrow \begin{matrix} a & b \\ c & d \end{matrix}$ $\backslash\smqty() \text{ or } \backslash\spmqty\{\}$ $\backslash\smqty*() \text{ or } \backslash\mathbb{P}\mqty\{\}$ $\backslash\smqty[] \text{ or } \backslash\mathbb{B}\mqty\{\}$ $\backslash\smqty   \text{ or } \backslash\mathbb{V}\mqty\{\}$	<p>the <code>\smallmatrix</code> form of <code>\mqty</code></p> <p>small version of <code>\mqty()</code></p> <p>small version of <code>\mqty*()</code></p> <p>small version of <code>\mqty[]</code></p> <p>small version of <code>\mqty  </code></p>
<code>\matrixdeterminant</code>	$\backslash\mdet\{a \& b \ \backslash\ c \& d\} \rightarrow \begin{vmatrix} a & b \\ c & d \end{vmatrix}$ $\backslash\smdet\{a \& b \ \backslash\ c \& d\} \rightarrow \begin{vmatrix} a & b \\ c & d \end{vmatrix}$	<p>matrix determinant</p>
<code>\identitymatrix</code>	$\backslash\imat\{n\}$ $\backslash\smqty(\backslash\imat\{3\}) \rightarrow \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$	<p>small matrix determinant</p> <p>elements of <math>n \times n</math> identity matrix</p>
<code>\xmatrix</code>	$\backslash\xmat\{x\}\{n\}\{m\}$ $\backslash\smqty(\backslash\xmat\{1\}\{2\}\{3\}) \rightarrow \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$ $\backslash\smqty(\backslash\xmat*\{a\}\{3\}\{3\}) \rightarrow \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$ $\backslash\smqty(\backslash\xmat*\{a\}\{3\}\{1\}) \rightarrow \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}$ $\backslash\smqty(\backslash\xmat*\{a\}\{1\}\{3\}) \rightarrow (a_1 \ a_2 \ a_3)$	<p>formatted with <code>\mqty</code> or <code>\smqty</code></p> <p>elements of <math>n \times m</math> matrix filled with <math>x</math></p> <p>formatted with <code>\mqty</code> or <code>\smqty</code></p> <p>star for element indices</p> <p>as a vector with indices</p>
<code>\zeromatrix</code>	$\backslash\zmat\{n\}\{m\}$ $\backslash\smqty(\backslash\zmat\{2\}\{2\}) \rightarrow \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$	<p><math>n \times m</math> matrix filled with zeros</p> <p>equivalent to <code>\xmat\{0\}\{n\}\{m\}</code></p>
<code>\paulimatrix</code>	$\backslash\pmat\{n\}$ $\backslash\smqty(\backslash\pmat\{0\}) \rightarrow \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ $\backslash\smqty(\backslash\pmat\{1\}) \rightarrow \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ $\backslash\smqty(\backslash\pmat\{2\}) \rightarrow \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$ $\backslash\smqty(\backslash\pmat\{3\}) \rightarrow \begin{pmatrix} i & 0 \\ 0 & -i \end{pmatrix}$	<p><math>n^{\text{th}}</math> Pauli matrix</p> <p><math>n \in \{0, 1, 2, 3 \text{ or } x, y, z\}</math></p>
<code>\diagonalmatrix</code>	$\backslash\dmat\{a,b,c,\dots\}$ $\backslash\mqty(\backslash\dmat\{1,2,3\}) \rightarrow \begin{pmatrix} 1 & & \\ & 2 & \\ & & 3 \end{pmatrix}$ $\backslash\mqty(\backslash\dmat[0]\{1,2\}) \rightarrow \begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$ $\backslash\mqty(\backslash\dmat\{1,2\&3\}\backslash\&4\&5\}) \rightarrow \begin{pmatrix} 1 & & & \\ & 2 & 3 & \\ & & & \\ & & 4 & 5 \end{pmatrix}$	<p>specify up to eight diagonal or block diagonal elements</p> <p>optional argument to fill spaces</p> <p>enter matrix elements for each block as a single diagonal element</p>
<code>\antidiagonalmatrix</code>	$\backslash\admat\{a,b,c,\dots\}$ $\backslash\mqty(\backslash\admat\{1,2,3\}) \rightarrow \begin{pmatrix} & & 1 \\ & 2 & \\ 3 & & \end{pmatrix}$	<p>same as syntax as <code>\dmat</code></p>