

# isomath: Math for scientists

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The isomath package enables formatting Greek and Latin letters as symbols for vectors, matrices, and tensors in the typefaces recommended for scientific papers by the International Standard ISO 31.

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## 1 Motivation

Scientific organisations like [IUPAP](#), [IUPAC](#), [NIST](#), [BIPM](#), and others recommend typesetting math according to the International Standard ISO 31 *Quantities and units* [ISO-31].<sup>1</sup>

The traditional *LaTeX math style* deviates in some points from this rules:

- The `\vec` command produces an array accent, while ISO 31 recommends a bold italic typeface for vector symbols.
- Greek letters are excluded from font changes with the math alphabets, while the ISO 31 rules apply equally to letters from the Greek and Latin alphabet.
- There is no provision for typesetting of Greek letters in bold italic style recommended for vectors.
- There is no provision for typesetting letters in sans-serif bold italic recommended for typesetting tensor symbols.

Some of these points are addressed by [related packages](#), however there is currently no package (known to the author) that defines the sans-serif bold italic math alphabet needed for tensor symbols.

## 2 Features

### 2.1 Equal treatment of Latin and Greek letters

This feature is provided by the required package [fixmath](#) which ensures that:

- Both, Greek and Latin letters change shape if a different math alphabet is used.
- By default, uppercase Greek letters are typeset in italic style.

However, *fixmath* works only for Computer Modern. With *isomath*,

- the used math fonts are configurable (using the [rmdefault](#) and [sfdefault](#) options), and
- upright Greek letters can be made available through the common `\math*` alphabets via the [OMLmath](#) options, if the corresponding fonts support the [OML font encoding](#).

**Caution:** Placing Greek letters in a `\math*` macro, e. g. `\mathrm{k\Omega}`, can lead to garbage, as the standard math alphabets are usually taken from text fonts that have

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<sup>1</sup>Summaries of these rules are free available, see [\[typefaces\]](#), [\[checklist\]](#), [\[fonts\\_for\\_symbols\]](#), and [\[SI-brochure\]](#).

ligatures and non-alpha symbols in place of the small Greek letters. Do not use Greek letters in the standard math alphabet commands `mathit`, `mathrm`, `mathbf`, `mathsf`, and `mathtt` unless you use the [OMLmath](#) options.<sup>2</sup>

## 2.2 New math alphabets

New math alphabets are defined:

`\mathbold`: boldface italic (vector and matrix symbols),

`\mathboldsans`: sans-serif bold italic (tensor symbols).

`\mathsans`: sans-serif italic (optional),

The [rmdefault](#) and [sfdefault](#) options set the font family used for these alphabets.

## 2.3 Command aliases

The command aliases `\vectorsym`, `\matrixsym`, and `\tensorsym` allow semantic markup. They print the argument in an ISO-conforming typeface.

## 2.4 Font mappings

Some font definitions are added for font families which have an OML encoded counterpart but no substitution definition in their `*.fd` files.

# 3 Usage

Make sure that LaTeX can find `isomath.sty` and insert the command:

```
\usepackage{isomath}
```

in the document preamble (see also [Examples](#)).

## 3.1 Options

### 3.1.1 rmdefault

Family for serif math fonts (roman and kursive). The default is to use the corresponding text font family (the value of `\rmdefault`). The font must be available in [OML font encoding](#).

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<sup>2</sup>Some packages provide `\up*` or `\var*` macros for upright Greek letters so the above example could be written `\mathrm{k}\upOmega`.

### 3.1.2 sfdefault

Family for sans-serif math fonts. The default is `cmbr` because many sans-serif fonts define the Computer Roman font *cmr* as OML substitution (see [Table 2](#)).

There are only few sans serif [fonts that support the OML encoding](#):

Name	Package	Comment
cmbr	<a href="#">cmbright</a>	<i>Computer Modern Bright</i> , bitmap, slightly lighter than cmss (Type 1 fonts with <a href="#">hfbright</a> )
fav	<a href="#">arev</a>	<i>Arev (Vera Sans)</i> with math extension, large x-height
iwona	<a href="#">iwona</a>	Humanistic Sans Serif, some shapes very similar to roman
hvm	<a href="#">hvmath</a>	<i>Helvetica Math</i> , commercial, free bitmap version
l1cmss	<a href="#">lxfonts</a>	<i>LX Fonts</i> , very wide, excentric, large x-height, new in 2008

### 3.1.3 scaled

As the choice of sans serif math fonts is very limited, the fonts, `fav`, `l1cmss`, and `iwona` can be scaled with the `scaled` option (see [examples](#)).

### 3.1.4 reuseMathAlphabets

The definition of new math alphabets can lead to a “[too many math alphabets used in version normal](#)” error. As a workaround, this option tells `isomath` to re-use the existing `\mathbf` and `\mathsf` alphabets for italic bold and sans-serif bold.<sup>3</sup>

### 3.1.5 OMLmath

With Greek letters defined as `\mathalpha`, the math alphabets are expected to be in [OML font encoding](#). Unfortunately, the standard math alphabets are usually taken from OT1 or T1 encoded fonts that have ligatures and accents in place of the Greek letters.

The following options cause `isomath` to (re)define math alphabets in OML encoding:

`OMLmathrm`, `OMLmathbf`, `OMLmathsf`, `OMLmathsans`, `OMLmathtt`

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<sup>3</sup>To access the upright shapes, the corresponding `\textbf` and `\textsf` commands might be used. However, this toggles the math-mode off and might use a different font, so watch for side-effects.

Setting these options enables access to small Greek letters in different shapes with e.g. `\mathrm{\pi}` **if an OML encoded font is available**. Currently, only the [mathdesign](#) package provides upright [fonts that support the OML encoding](#). Many font packages define an italic font as replacement for a roman font in OML encoding.

With some packages, these options can result in a “[too many math alphabets used in version normal](#)” error.

### 3.2 Examples

- Use *isomath* with the default settings:  
`\usepackage{isomath}`
- Define also a slanted sans-serif math alphabet:  
`\usepackage[OMLmathsans]{isomath}`
- Use the heavier Arev sans serif fonts:  
`\usepackage[sfdefault=fav,scaled=0.875]{isomath}`  
(Adapt the scaling factor to your needs.)
- Redefine the standard `\vec` macro to typeset its argument in *bold italic*:  
`\usepackage{isomath}`  
`\renewcommand{\vec}{\vectorsym}`  
(Use `\bm` or `\boldmath` for the zero and unit vectors, as `\vec{0}` and `\vec{1}` will give undesired results.)
- The [mathdesign](#) package provides an OML encoded *bold roman* font but does not set it up for `\mathbf`. To set it up, write e.g.:  
`\usepackage[charter]{mathdesign}`  
`\usepackage[OMLmathbf]{isomath}`  
Now, e.g. `\mathbf{\pi}` produces a bold upright pi symbol.

See also the `isomath-test.tex` test document.

## 4 Related packages

### 4.1 Requirements

[fixmath](#) by Walter Schmidt defines Greek letters as alphabetic symbols.

[kvoptions](#) (in the [oberdiek](#) bundle) facilitates the setup of package options and provides a key=value interface (based on [keyval](#)).

### 4.2 Recommendations

[cmbright](#) provides *sans serif* and *sans-serif bold* fonts for the `\mathsans` and `\mathboldsans` alphabets that match with Computer Modern and derivatives. Free Type 1 versions of the fonts with [hfbright](#).

[arev](#) provides *sans serif* somewhat heavier letters that are clearly distinguishable from the roman or italic counterparts (important if used to distinguish vectors and tensors). However, Arev has a large x-height, so for most default fonts, either small or capital letters will not match in size.

### 4.3 Alternatives

If the only requirement is a bold italic font for (Latin and Greek) vector symbols, there are established alternatives to *isomath*:

- Packages that support [equal treatment of Latin and Greek](#) and provide the `\mathbold` alphabet (but not `\mathsansbold`) in [OML font encoding](#):

#### Roman

- [eulervm](#) (Euler Math),
- [fixmath](#) (Computer Modern),
- [mathpazo](#) (Palatino),
- [tmmath](#) (TM-Math/Times).

#### Sans serif

- [arev](#) (Arev/Vera Sans),
- [cmbright](#) (CM Bright),
- [hvmath](#) (HV-Math/Helvetica),
- Packages that provide commands which can be used as replacement for `\vec`:
  - [amsbsy](#) (part of [amsmath](#), the near-indispensable adjunct to serious mathematical typesetting in LaTeX) defines `\boldmath`,
  - [bm](#) defines a command `\bm` which makes its argument bold (more careful than [amsbsy](#)'s `\boldmath`). Combining *bm* and *isomath* may lead to the [too many math alphabets used in version normal](#) error.

The `\text` macro from [amsmath](#) can be used to get e.g. upright or sans-serif bold slanted Greek symbols from a text font into a formula.

### 4.4 Conflicts

- “too many math alphabets used in version normal”

This error occurs if the combination of packages tries to load more than 16 fonts into the ‘normal’ math version.

It can be avoided with the [reuseMathAlphabets](#) option (see there for side-effects).

Examples for problematic combinations:

  - The [kpfonts](#), [pxfonts](#), and [txfonts](#) packages define many additional math alphabets.
  - The [bm](#) package normally allocates several symbol fonts for bold and heavy fonts. Their number can be customized by defining `\bmmax` and `\hmmax` before loading the package.
- The [fourier](#) package for math typesetting with Utopia defines its own, incompatible math font encodings. It cannot be used with *isomath* but provides other means to typeset upright or italic Greek (see its documentation).

However, it is possible to use the symbols from [fourier](#) together with math alphabets from another package, e.g [mathdesign](#):

```
\usepackage{fourier}
\usepackage[OMLmathbf,rmdefault=mdput,
            sfdefault=arev,scaled=0.85]{isomath}
```

## 5 Background

### 5.1 Letter symbols

[IUPAC](#)'s [fonts\_for\_symbols] guide says:

2. The overall rule is that symbols representing physical quantities (or variables) are italic, but symbols representing units, or labels, are roman. [...]
3. The above rule applies equally to letter symbols from both the Greek and the Latin alphabet, [...].

In contrast, the standard LaTeX style treats Greek letter symbols

- as invariant operators,
- with lower case italic and upper case upright.

A possible fix (established by [fixmath](#)) is using a common font for Greek and Latin letters. There is one established font encoding providing Latin and Greek letters: the [OML font encoding](#). However,

- [support](#) for OML is limited to a few (mostly italic) fonts.
- The widely supported but non-standard *LGR* font encoding has Greek but no Latin letters, while
- the standard Greek font encoding *T7* is just a “reserved name”.

### 5.2 OML font encoding

The *LaTeX font encodings* guide [encguide] names the OML encoding *TeX math italic* and defines:

The OML encoding contains italic Latin and Greek letters for use in mathematical formulas (typically used for variables) together with some symbols.

The reference to *italic* shape is odd:

- No other font encoding is specific to the font shape.
- The different font selection and the semantic of font features in math do not interfere with the font *encoding*: Both, `\DeclareSymbolFont` and `\DeclareMathAlphabet` require a shape argument. Thus it is possible to set up OML encoded math alphabets in roman {n} as well as italic {it} shape without conflicts.

This seems to be a remnant of pre-NFSS times – there is only one OML encoded font in Knuth’s Computer Modern fonts: *Computer Modern Math Italic* (cmmi) – rather than a necessary restriction.

Proposals:

- Drop the *italic* from the definition. Optionally add an explanation:  
The OML encoding contains Latin and Greek letters for use in mathematical formulas (typically used for variables) together with some symbols. It first appeared in the *Computer Modern Math Italic* (cmmi) font.
- The name *TeX math italic* can be interpreted as “the encoding **of** *Computer Modern Math Italic*” rather than “an encoding **for** math italic” fonts.  
A less confusing name would be *TeX math letters* or *Original/Old Math Letters*. The latter would also explain the acronym OML.

### 5.2.1 Support

Unfortunately, support for the OML encoding is missing for many font families even if the base font contains all Greek letters.

Supported font families can be found searching for `oml*.fd` files and grepping for `DeclareFont.*OML` in `*.sty` files. [Table 1](#) lists the findings for a selection of TeXLive + some additionally installed font packages.

- If there is an alias (substitution) from the text font to a math-variant, only the text font is listed.
- Many text fonts define substitutions also for upright shape, however mapping to an italic variant of the OML encoded font. These are not listed as supporting `m/n` or `bx/n` here.

[Table 2](#) lists some fonts that define `cmm` as OML substitution. With `isomath`, a better matching substitution can be set using the `rmdefault` or `sfdefault` options.

Table 2: Fonts that support the OML encoding

Name	Family	m/it	bx/it	m/n	bx/n
aer	AE (Almost European)	x	x		
antt	Antykwa Torunska	x	x		
cmr	Computer Modern Roman	x	x		
ccr	Concrete	x	x		
cmbr	Computer Modern Bright	x	x		
hlh	Lucida	x	x		
hfor	CM with old-style digits	x	x		

... continued on next page



Table 2: Fonts that support the OML encoding (... continued)

<b>Name</b>	<b>Family</b>	<b>m/it</b>	<b>bx/it</b>	<b>m/n</b>	<b>bx/n</b>
iwona	Iwona (sans serif)	x	x		
jkp	Kepler Serif	x	x		
jkpl	Kepler Serif	x	x		
jkpvos	Kepler Serif	x	x		
jkplvos	Kepler Serif	x	x		
llcmm	LXfonts (sans serif)	x	x		
lmr	Latin Modern Roman	x	x		
mak	Kerkis	x			
kurier	Kurier	x	x		
mdbch	Math Design Charter	x	x	x	x
mdput	Math Design Utopia	x	x	x	x
mdugm	Math Design Garamond	x	x	x	x
neohellenic	GFS Neohellenic	x			
plcm	CM (PLaTeX)	x			
ptmom	Times (Omega or MB-Times)	x	x		
ptmomu	Times (Omega or MB-Times)	x	x		
ptmcm	Times (psfont)	x			
pxr	Palatino (pxfonts)	x	x		
qpl	Palatino/Pagella (qpxmath)	x	x		
qtm	Times/Termes (qtxmath)	x	x		
txr	Times (txfonts)	x	x		
udidot	Didot (gfsdidot)	x			
ywclm	(greetex)	x	x		
zavm	Arev (Vera Sans-Serif)	x	x		
zesfcm	(efont)	x			
zplm	Palatino (mathpazo)	x	x		
zpple	Palatino	x	x		
ztmcm	Times (mathptmx)	x			
zer	Computer Modern (zefonts)	x	x		

Table 3: Non-CM fonts with `cmm` as OML substitution

<b>Family</b>	<b>Name</b>
bch	Charter (psnfss)
pag	Avant Garde (psnfss)
pbk	Bookman (psnfss)
pcr	Courier (psnfss)
phv	Helvetica (psnfss)
pnc	New Century Schoolbook (psnfss)
ppl	Palatino (psnfss)
ptm	Times Roman (psnfss)
put	Utopia (psnfss)
pzc	Zapf Chancery (psnfss)
uag	Avant Garde (avantgar)
ubk	Bookman (bookman)
ucr	Courier (courier)
ucrs	Courier
unc	New Courier (nctrsbk)
uni	Universal (universa)
uhv	Helvetica (helvetic)
upl	Palatino (palatino)
utm	Times (times)
uzc	Zapf Chancery (zapfchan)

### 5.3 Math in Unicode

Basis for the definition of the Unicode block [mathematical alphanumeric symbols](#), was the consideration outlined in [beeton:2000]:

These alphabets are needed for proper composition of mathematics:

- lightface upright Latin, Greek and digits
- boldface upright Latin, Greek and digits
- lightface italic Latin, Greek and digits
- boldface italic Latin, Greek and digits
- script
- fraktur
- bold fraktur
- open-face (blackboard bold) including digits
- lightface upright sans serif Latin and digits

- lightface italic sans serif Latin
- boldface upright sans serif Latin, Greek, and digits
- boldface italic sans serif Latin and Greek
- monospace Latin and digits

Except for the lightface upright letters and digits, which are to be encoded using the base Unicodes (ASCII for the Latin letters and digits), the alphanumerics are to be placed in a tightly packed block (U+D400–D7FF) in plane 1, so that they can be used for math (most likely via entity names in MathML), but will be very difficult to access for other purposes.

The technical report *Unicode Support for Mathematics* [tr25] lists “alphanumeric symbols encountered in mathematics” in table 2: *Mathematical Alphabets*.

The Unicode block [mathematical alphanumeric symbols](#) provides style variants for Latin and Greek letters and digits. It is labelled “to be used for mathematical variables where style variations are important semantically”. [Table 3](#) gives a survey of current LaTeX support.

Table 4: Styles in the [mathematical alphanumeric symbols](#) Unicode block

Style	Symbols <sup>4</sup>	LaTeX macro	Package, Comment
bold	LGD	<code>\mathbf</code>	no Greek
italic	LG	<code>\mathit</code>	no Greek
		<code>\mathnormal</code>	small Greek but old-style digits (upright)
bold italic	LG	<code>\mathbf</code>	fixmath and friends
		<code>\boldsymbol</code>	ams
script (calligraphic)	L	<code>\mathcal</code> or <code>\mathscr</code>	only capital Latin
bold script	L		
fraktur	L	<code>\mathfrak</code>	eufrak
double-struck	L D	<code>\mathbb</code>	bbold, mathbbol, mbboard
		<code>\mathbbm</code>	bbm
		<code>\mathds</code>	dsfont
bold fraktur	L		
sans-serif	L D	<code>\mathsf</code>	no Greek
sans-serif bold	LGD		
sans-serif italic	L	<code>\mathsans</code>	isomath
sans bold italic	LG	<code>\mathboldsans</code>	isomath
monospace	L D	<code>\mathtt</code>	no Greek

*Not in the mathematical alphanumeric symbols block:*

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Table 4: Styles in the [mathematical alphanumeric symbols](#) Unicode block (... continued)

Style	Symbols <sup>4</sup>	LaTeX macro	Package, Comment
plain	LGD	<code>\mathrm</code>	no Greek
		<code>\mathnormal</code>	capital Greek

## 5.4 Conclusions and outlook

It is hoped, that in the future more fonts families will support the OML encoding in normal and bold weight as well as upright and italic shape. This would be a major step towards a LaTeX equivalent of the [Mathematical Alphanumeric Symbols](#) Unicode block.

This should be (relatively) easy to achieve via virtual fonts when the glyphs for the Greek letters already exist. Examples are Latin Modern, Kerkis, GFS-Neohellenic, LX-Fonts and KP-Serif.

Alternatively, the T7 encoding could be used for math alphabets (if it ever happens to materialise).

Upright small Greek letters in `\mathrm` would enable the specification of the constant pi, Myons, Pions, alpha-particles, photons, and neutrinos without special packages. (With [mathdesign](#), this is already possible today.)

## 6 References

- [ISO-31] International Standard 31 *Quantities and units*, (ISO 31-0:1992 to ISO 31-14:1992): [http://www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/catalogue\\_tc\\_browse.htm?commid=46202](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=46202)
- [typefaces] *Typefaces for Symbols in Scientific Manuscripts*: <http://physics.nist.gov/Document/typefaces.pdf>
- [checklist] *SI Unit rules and style conventions* Check List for Reviewing Manuscripts: <http://physics.nist.gov/cuu/Units/checklist.html>
- [fonts\_for\_symbols] *On the use of italic and roman fonts for symbols in scientific text*, (Revised December 1999): [http://old.iupac.org/standing/idcns/fonts\\_for\\_symbols.html](http://old.iupac.org/standing/idcns/fonts_for_symbols.html)
- [SI-brochure] *The International System of Units (SI)*: [http://www.bipm.org/en/si/si\\_brochure/](http://www.bipm.org/en/si/si_brochure/)

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<sup>4</sup>LGD: **L**atin, **G**reek, **D**igits

- [encguide] *LaTeX font encodings:* <http://mirror.ctan.org/macros/latex/doc/encguide.pdf>
- [fntguide] *LaTeX 2e font selection:* <http://mirror.ctan.org/macros/latex/doc/fntguide.pdf>
- [tr25] *Unicode Support for Mathematics*, Unicode Technical Report #25: <http://www.unicode.org/reports/tr25/>
- [beeton:2000] Barbara Beeton: *Unicode and math, a combination whose time has come – Finally!*, TUGBoat, 21#3, 2000. available: <http://www.tug.org/TUGboat/Articles/tb21-3/tb68beet.pdf>.