

isomath: Math for scientists

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Abstract

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. For this, a *bold italic* and a *sans-serif bold italic* math alphabet are defined.

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1 Introduction

1.1 Motivation

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

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

- The `\vec` command produces an arrow 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 both the Greek and the 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.

1.2 Features

The `isomath.sty` package facilitates the task to abide with ISO 31 when typesetting math with LaTeX:

- Equal treatment of Latin and [Greek in math](#) via [fixmath.sty](#):
 - Greek letters change shape together with Latin letters if a different math alphabet is used.
 - Uppercase Greek letters are typeset in italic style by default.
 - Upright Greek letters can be made available through the `\mathrm` and `\mathbf` alphabets, if the corresponding fonts support the [OML font encoding](#).
- The [command aliases](#) `\vectorsym`, `\matrixsym`, and `\tensorsym` allow semantic markup. They print the argument in an ISO-conforming typeface.
- For this, new [math alphabets](#) are defined:

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

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

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

The family for these fonts is by default taken from the document's `\rmdefault` and `\sfdefault` values. The `\rmdefault=<family>` and `\sfdefault=<family>` [options](#) can be used to override the defaults.

- Missing [font mappings](#) are defined for font families which have an OML encoded counterpart but no substitution definition in their `*.fd` files.

¹Summaries of these rules are free available, see [\[typefaces\]](#), [\[fonts-for-symbols\]](#), and [\[SI-brochure\]](#).

1.3 Usage

Make sure that LaTeX can find `isomath.sty` and insert the command `\usepackage{isomath}` in the document preamble.

1.3.1 Examples

- In many cases (e.g. when `\sfdefault` expands to “cmss”), the `\mathboldsans` alphabet is neither bold nor sans, as “cmss” has no OML encoded variants and maps to “cmmi”.

Use `cmbright` for sans-serif math alphabets:

```
\usepackage[sfdefault=cmbr]{isomath}
```

- Redefine the standard `\vec` macro to typeset its argument in *bold italic*:

```
\usepackage[sfdefault=cmbr]{isomath}
\renewcommand{\vec}{\vectorsym}
```

- The `mathdesign` package provides an OML encoded *bold roman* font but does not set it up for `\mathbf`:

```
\usepackage[charter]{mathdesign}
\usepackage[OMLmathbf,sfdefault=cmbr]{isomath}
```

Now, `\mathbf{\pi}` produces a bold upright pi symbol.

1.4 Related packages

A set of packages at CTAN also defines Greek letters as `\mathalpha` and provide the `\mathbold` alphabet (in OML):

- `arev` (Arev/Vera Sans)
- `cmbright` (CM Bright)
- `eulervm` (Euler Math)
- `fixmath` (Computer Modern)
- `hvmath` (HV-Math/Helvetica)
- `mathpazo` (Palatino)
- `tmmath` (TM-Math/Times)

This package requires and extends `fixmath.sty`.

The `cmbright` package provides *sans serif* and *sans-serif bold* fonts for the `\mathsans` and `\mathboldsans` alphabets that match with Computer Modern and derivatives.

1.4.1 Conflicts

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).

The [kpfonts](#), [pxfonts](#), and [txfonts](#) packages define many additional math alphabets and can only be combined with `isomath`, if the [reuseMathAlphabets](#) option is used.

1.5 Greek in Math

1.5.1 Unicode Math Support

The technical report *Unicode Support for Mathematics* [tr25] lists *alphanumeric symbols encountered in mathematics* in Table 2.1 *Mathematical Alphabets*. It includes Latin and Greek letters in the bold, italic, bold italic, sans-serif bold, and sans-serif bold italic math styles.

The Unicode block [mathematical alphanumeric symbols](#) provides style variants for Latin and Greek letters and digits. It is “to be used for mathematical variables where style variations are important semantically”.

1.5.2 OML font encoding

The OML font encoding is the only established encoding providing Latin and Greek letters in one font:

- LGR is Greek-only,
- T7 is just a “reserved name” for a standard Greek encoding.

Definition The *LaTeX font encodings* guide [encguide] names OML *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.

However, the reference to **italic** seems to be a description of the *state of the art* rather than a necessary restriction:

- The only OML encoded CM font is *Computer Modern Math Italic* (cmmi),
- but generally, font encodings (T1, OT1) are not specific to the font shape.
- Both, `\DeclareSymbolFont` and `\DeclareMathAlphabet` require a `{<shape>}` argument. Thus it is possible to define OML encoded math alphabets in roman {n} as well as italic {it} shape without conflicts.
- A more suitable public name would be *TeX math letters* or *Original/Old Math Letters*. The latter would also explain the acronym OML.

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 by grepping for “`DeclareFont.*OML`”, “`SymbolFont.*OML`” and “`MathAlphabet.*OML`” in `*.sty` files.

Table 1: Fonts supporting the OML font encoding

Name	Family	{m}{it}	{bx}{it}	{m}{n}	{bx}{n}
aer	AE (Almost European)	x	x		

... continued on next page

Table 1: Fonts supporting the OML font encoding (... continued)

Name	Family	$\{\mathbf{m}\}\{\mathbf{it}\}$	$\{\mathbf{bx}\}\{\mathbf{it}\}$	$\{\mathbf{m}\}\{\mathbf{n}\}$	$\{\mathbf{bx}\}\{\mathbf{n}\}$
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		
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			
mdbch	Math Design Charter	x	x	?	x
mdput	Math Design Utopia	x	x	?	x
mdugm	Math Design Garamond	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		
ywclm	(greetex)	x	x		
zavm	Arev (Vera Sans-Serif)	x	x		
zesfcm	(efont)	x			
zplm	Palatino (mathpazo)	x	x		
zppl		x	x		
ztmlm	Times (mathptmx)	x			
zer	Computer Modern (zefonts)	x	x		

Explanations:

- 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 $\{\mathbf{n}\}$, however mapping to an italic variant of the OML encoded font. These are not listed as supporting $\{\mathbf{m}\}\{\mathbf{n}\}$ or $\{\mathbf{bx}\}\{\mathbf{n}\}$ here.

The following fonts define `cmn` as OML substitution. A better matching substitution can be set with the `rmdefault` option.

Table 2: Non-CM fonts with cmm as OML substitution

Family	Name
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)

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

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

2 Implementation

2.1 Identification

```
\NeedsTeXFormat{LaTeX2e}
\ProvidesPackage{isomath}
[2008/10/02 v0.2 typeset math according to International Standard ISO 31]
```

0.1	2008-09-25	first public version.
0.2	2008-10-02	bugfix: a usage example was uncommented; updated documentation; define <code>mathsans</code> only if <code>OMLmathsans</code> is true; option <code>reuseMathalphabets</code> -> <code>reuseMathAlphabets</code> .

2.2 Requirements

2.2.1 `fixmath.sty`

The package `fixmath` by Walter Schmidt defines Greek letters as symbols of type `\mathalpha` and takes them from the “letters” `SymbolFont` in `\mathnormal` (as opposed to “operators” in `fontmath.ltx`).

`fixmath` also defines the `\mathbold` alphabet, setting it to `cmm`. However, this definition will be overwritten with a configurable value for the font family below.)

```
\RequirePackage{fixmath}
```

Caution!

Placing small Greek letters in a math alphabet, e.g. `\mathrm{k\Omega}`, can lead to garbage. If the chosen font supports the [OML font encoding](#), you can use the options for [OML math alphabets](#). Otherwise, place Greek letters outside the math alphabet command. Some packages provide `\up*` or `\var*` macros for upright Greek letters, e.g. `\mathrm{k}\upOmega`.

2.2.2 `kvoptions.sty`

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

```
\RequirePackage{kvoptions}
```

2.3 Options

2.3.1 `rmdefault`

Alternative family for roman math fonts. The default is to use the corresponding text font family (`\rmdefault`) in OMS encoding. [Table 2](#) lists some fonts where a different setting is advised.

```
\DeclareStringOption[\rmdefault]{rmdefault}
```

2.3.2 `sfdefault`

Alternative family for sans-serif math fonts. The default is to use the corresponding text font family (`\sfdefault`) in OMS encoding.

Computer Modern Sans Serif (cmss) has no OMS encoded variant. Nor have many derivatives (lmss, aess, ...). Actually, there are only a few OML-encoded sans-serif fonts (all slanted/italic):

zavm: [arev](#) (Vera Sans with math extension, large x-height)
cmbr: [cmbright](#) (Computer Modern Bright, slightly lighter than cmss)
iwona: [iwona](#) (Humanistic Sans Serif, some shapes very similar to roman)
hvm: [hvmath](#) (Helvetica Math, commercial, free bitmap version)
llcmm: [lxfonts](#) (LX Fonts, very wide, excentric, large x-height, new in 2008)

For most fonts (especially CM and related), `[sfdefault=cmbr]` is the recommended setting.

```
\DeclareStringOption[\sfdefault]{sfdefault}
```

TODO Allow scaling?

2.3.3 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.

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).

```
\DeclareBoolOption{reuseMathAlphabets}
```

Caution!

Do not use `reuseMathAlphabets` together with the `OMLmathbf` or `OMLmathsf` options.

2.3.4 OML math alphabets

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 encoded fonts that have ligatures and non-alpha symbols in place of the small Greek letters.

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

```
\DeclareBoolOption{OMLmathrm}
\DeclareBoolOption{OMLmathbf}
\DeclareBoolOption{OMLmathsf}
\DeclareBoolOption{OMLmathsans}
\DeclareBoolOption{OMLmathtt}
```

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, support for the [OML font encoding](#) is rather limited:

- only the [mathdesign](#) fonts support *bold roman* in OML encoding, while
- many font packages define an italic font as OML replacement for a roman font.

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

Process the options with `kvoptions` extensions:

\ProcessKeyvalOptions*

2.4 Declarations

2.4.1 Math alphabets

In math, LaTeX uses “absolute” fontnames instead of a selection by family, shape, and weight because typefaces have a semantic meaning [fntguide]. This correlates with the [Unicode math support](#) where the [mathematical alphanumeric symbols](#) block defines distinct Unicode characters for in Greek and Latin letters in different typefaces.

Isomath defines a math alphabet for every required font variant and optionally re-defines the standard math alphabets in [OML font encoding](#). Unfortunately, the number of math alphabets in one math version is limited to 16, so we have to be carefull not to exceed this.

mathbold The *italic bold* math alphabet is named \mathbold like in [related packages](#). With the [reuseMathAlphabets](#) option, \mathfb is redefined and \mathbold made an alias (overwriting existing definitions):

```
\ifisomath@reuseMathAlphabets
  \DeclareMathAlphabet{\mathbf}{OML}{\isomath@rmdefault}{bx}{it}
  \def\mathbold{\mathbf}
\else
  \DeclareMathAlphabet{\mathbold}{OML}{\isomath@rmdefault}{bx}{it}
\fi
```

mathsans For *italic sans-serif*, we define a new alphabet named \mathsans (in analogy to \mathbold). As this typeface is not required by ISO 31, it is only defined if the OMLmathsans option is set:

```
\ifisomath@OMLmathsans
  \DeclareMathAlphabet{\mathsans}{OML}{\isomath@sfdefault}{m}{it}
\fi
```

mathboldsans A *sans serif slanted bold* alphabet is needed for tensor symbols. With the [reuseMathAlphabets](#) option, \mathsf is redefined and \mathboldsans made an alias:

```
\ifisomath@reuseMathAlphabets
  \DeclareMathAlphabet{\mathsf}{OML}{\isomath@sfdefault}{bx}{it}
  \def\mathboldsans{\mathsf}
\else
  \DeclareMathAlphabet{\mathboldsans}{OML}{\isomath@sfdefault}{bx}{it}
\fi
```

Redefine standard alphabets Redefine standard alphabets in [OML font encoding](#) if the corresponding [OML math alphabets](#) option is true:

```
\ifisomath@OMLmathrm
  \SetMathAlphabet{\mathrm}{normal}{OML}{\isomath@rmdefault}{n}{n}
\fi
\ifisomath@OMLmathbf
```

```

\SetMathAlphabet{\mathbf}{normal}{OML}{\isomath@rmdefault}{b}{n}
\fi
\ifisomath@OMLmathsf
\SetMathAlphabet{\mathsf}{normal}{OML}{\isomath@sfdefault}{n}{n}
\fi
\ifisomath@OMLmathtt
\SetMathAlphabet{\mathtt}{normal}{OML}{\ttdefault}{n}{n}
\fi

```

2.4.2 Command aliases

The following macros allow semantic markup of mathematical symbols. The argument is typeset as proposed by ISO 31 and [\[typefaces\]](#).

\vectorsym Symbols for vectors are typeset *boldface italic*:

```
\newcommand{\vectorsym}{\mathbf}
```

For easier writing or to make existing documents conform to the standard, you might want to re-define the standard `\vec` command after loading this package (cf. the [Examples](#) section).

\matrixsym Symbols for matrices are typeset *boldface italic*, i. e. in the same face as vectors.

```
\newcommand{\matrixsym}{\mathbf}
```

\tensorsym Symbols for tensors are *sans-serif bold italic*:

```
\newcommand{\tensorsym}{\mathboldsans}
```

2.4.3 Font mappings

Some font packages provide a matching math font but do not define a substitution in their `*.fd` files.

We define the substitutions needed for the math alphabet definitions in this package. Ideally, these should become part of a more complete set of definitions in the package's `*.fd` files:

Mathpazo (Palatino) ppl -> zplm

```

\DeclareFontFamily{OML}{ppl}{\skewchar\font127}
\DeclareFontShape{OML}{ppl}{m}{it}{<->ssub * zplm/m/it}{}
\DeclareFontShape{OML}{ppl}{bx}{it}{<->ssub * zplm/b/it}{}

```

Arev (arev): fav -> zavm

```

\DeclareFontFamily{OML}{fav}{}
\DeclareFontShape{OML}{fav}{m}{it}{<->ssub * zavm/m/it}{}
\DeclareFontShape{OML}{fav}{bx}{it}{<->ssub * zavm/b/it}{}

```

LX Fonts (lxfnts): llcmss -> llcmm

```

% repeat font declarations from lxfnts.sty
\DeclareFontFamily{OML}{llcmm}{\skewchar\font'177}
\DeclareFontShape{OML}{llcmm}{m}{it}{<->lcmmi8}{}
\DeclareFontShape{OML}{llcmm}{bx}{it}{<->lcmmib8}{}

```

```

\DeclareFontFamily{OML}{\llcmss}{}
\DeclareFontShape{OML}{\llcmss}{m}{it}{<-> ssub * llcmm/m/it}{}
\DeclareFontShape{OML}{\llcmss}{bx}{it}{<-> ssub * llcmm/bx/it}{}

```

No declarations below this point:

```

\endinput

```

3 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
- [typefaces] *Typefaces for Symbols in Scientific Manuscripts*:
<http://physics.nist.gov/Document/typefaces.pdf>
- [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
- [SI-brochure] *The International System of Units (SI)*:
http://www.bipm.org/en/si/si_brochure/
- [encguide] *LaTeX font encodings*:
<http://dante.ctan.org/CTAN/macros/latex/doc/encguide.pdf>
- [fntguide] *LaTeX 2e font selection*:
<http://dante.ctan.org/CTAN/macros/latex/doc/fntguide.pdf>
- [tr25] *Unicode Support for Mathematics*, Unicode Technical Report #25:
<http://www.unicode.org/reports/tr25/>