The HEP-MATH-FONT package*

Composable math alphabets that follow the text font, and dashed and dotted vector accents

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Abstract

The HEP-MATH-FONT package provides math fonts matching the text fonts of the HEP-FONT package. Its math alphabet commands are composable: bold, upright and the serif, sans-serif and typewriter families can be combined in any order, e.g. `\mathbf{\mathsf{x}}` and `\mathsf{\mathbf{x}}` give the same bold sans-serif x. Math follows the surrounding text, so that math in a sans-serif or bold heading is sans-serif or bold as well. The package also provides vector accents with a dashed and a dotted shaft. With LuaLaTeX and XeLaTeX the package uses the new computer modern (NCM) math fonts, with pdfLaTeX it uses latin modern (LM) and computer modern (CM) fonts combined into virtual fonts.

The package is loaded using `\usepackage{hep-math-font}`. It can be used without the HEP-FONT package, but if both are used the HEP-FONT package has to be loaded first. The main font family of the document has to be chosen before loading this package, so that the operator and symbol fonts match it as well.

1 Math alphabets

The state of a math alphabet consists of three independent parts: the family (serif, sans-serif or typewriter), the weight (medium or bold) and the shape (italic or upright). Each command changes one part of this state and keeps the others. Bold and upright therefore commute with the family commands and with each other, and repeating a command has no further effect. If different families are nested, the innermost family wins. Groups restore the state of the surrounding math. The commands neither change the parsing of fractions, scripts, accents and radicals nor the arguments of macros. They affect Latin and Greek letters, the variant Greek letters, `\partial`, `\nabla`, `\ell`, `\hbar`, the dotless i and j, and digits but not operators, delimiters or accents. The blackboard alphabet of the default `symbols` option is described below. Uniform resource locators typeset by the URL package, and therefore also by HYPERREF and BIBLATEX, keep the letters and digits of their text font.

`\mathbf` `\mathup` `\mathrm` `\mathit`

The `\mathbf{`⟨*math*⟩`}` command adds bold and `\mathup{`⟨*math*⟩`}` adds upright, `\mathit{`⟨*math*⟩`}` returns to italic. The `\mathrm` command is a synonym of `\mathup` and therefore preserves the family and the weight. This deliberately differs from the usual meaning of resetting to medium upright serif and makes `\mathrm` composable. The commands are defined when the package is loaded and again at the beginning of the document, so copies such as `\let\mat\mathbf` work both in the preamble and in `\AtBeginDocument`. The same holds for the Greek letter macros, and redefinitions such as `\renewcommand{\epsilon}{\varepsilon}` in the preamble are kept.

*This document corresponds to HEP-MATH-FONT v2.0.

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Command	Family	Added attributes
`\mathbfup`, `\mathbfrm`	kept	bold, upright
`\mathbfsf`	sans-serif	bold
`\mathsfup`, `\mathsftext`	sans-serif	upright
`\mathbfsfup`	sans-serif	bold, upright
`\mathbftt`	typewriter	bold
`\mathttup`	typewriter	upright
`\mathbfttup`	typewriter	bold, upright

Table 1: Combined math alphabet commands.

`\mathserif` `\mathsf` `\mathtt` The `\mathserif{`⟨*math*⟩`}`, `\mathsf{`⟨*math*⟩`}` and `\mathtt{`⟨*math*⟩`}` commands select the serif, sans-serif and typewriter family, respectively. Upright serif math that keeps the surrounding weight is obtained with `\mathserif{\mathup{`⟨*math*⟩`}}`.

`\mathnormal` The `\mathnormal{`⟨*math*⟩`}` command restores the default state of the surrounding text.

`\mathbfup` `\mathbfsf` `\mathsfup` `\mathbfsfup` `\mathbftt` `\mathttup` `\mathbfttup` The combined commands are listed in table 1. `\mathbfrm` is a synonym of `\mathbfup`, and `\mathsftext` is a synonym of `\mathsfup`.

Formulas start in the family and weight of the surrounding text. Hence the commands `\rmfamily`, `\sffamily`, `\ttfamily`, `\bfseries` and `\mdseries` also affect math, e.g. in headings.

The BM package [1] remains available for bold symbols other than letters and digits.

`\bm` `\mathbb` With the default `symbols=true` the blackboard alphabet is composable as well. The `\mathbb{`⟨*math*⟩`}` command adds blackboard as a fourth part of the state, which applies to Latin letters and digits. The family and the weight apply to the blackboard letters, so that `\mathbf{\mathbb{R}}` and `\mathbb{\mathbf{R}}` give the same bold blackboard $\mathbb{R}$, while the shape has no effect. The blackboard alphabet has no typewriter family and uses the serif shapes instead. With the other values of the `symbols` option `\mathbb` is a decorative alphabet.

`\mathcal` With `symbols=true` and `symbols=ams` the calligraphic alphabet is composable in the same way. The `\mathcal{`⟨*math*⟩`}` command adds calligraphic as a fourth part of the state, which applies to Latin capitals. With LuaLaTeX and XeLaTeX the serif and sans-serif calligraphic capitals share their design, but the strokes of the sans-serif capitals have a uniform width. pdfLaTeX uses the computer modern (CM) calligraphic capitals for the serif family as well, but no sans-serif calligraphic font differs enough from them, so the sans-serif capitals are those of Zapf Chancery, scaled to the same height. Hence `\mathsf{\mathcal{L}}` gives the sans-serif $\mathcal{L}$ next to the serif $\mathcal{L}$, and `\mathbf` gives their bold weight. The upright shape selects the upright Euler script [2] in medium and bold weight, so that `\mathup{\mathcal{L}}` gives $\mathcal{L}$, for the serif and sans-serif families alike. The typewriter family uses the sans-serif capitals. Small letters are not affected. With `symbols=minion` `\mathcal` is a decorative alphabet, and with `symbols=false` it keeps its original definition.

`\mathscr` With `symbols=true` and `symbols=ams` the script alphabet is composable as well and applies to Latin capitals. It uses the RSFS capitals [3] with pdfLaTeX and the stylistic set of the new computer modern (NCM) math fonts, which follows them, with LuaLaTeX and XeLaTeX. The serif and sans-serif families and the bold weight apply as for `\mathcal`, but with pdfLaTeX there is no sans-serif script and the bold capitals are synthesised. The upright shape reduces the slant of the capitals by 0.4 as the RSFSO package [4] does, so that `\mathup{\mathscr{L}}` gives $\mathscr{L}$ next to $\mathscr{L}$. Blackboard, calligraphic and script exclude each other, the innermost of them wins. With `symbols=minion` `\mathscr` is a decorative alphabet, and with `symbols=false` it keeps its

Value	pdfLaTeX	LuaLaTeX and XeLaTeX
`true`	American Mathematical Society (AMS) symbols, composable NCM and BBOLDX blackboard, composable calligraphic and script, Euler fraktur	NCM symbols, composable blackboard, calligraphic and script
`ams`	as `true` with decorative AMS blackboard	as `true` with decorative blackboard
`minion`	MnSymbol, decorative double-stroke blackboard and RSFS script	not supported
`false`	no additional symbol fonts	no script stylistic set

Table 2: Values of the `symbols` option, the default is `true`.

original definition.

`\mathfrak` The decorative alphabet `\mathfrak` keeps its own style. The `\sym`⟨*name*⟩ commands of other packages are not affected by the composable commands.

In bookmarks of the HYPERREF package [5] the alphabet commands and `\bm` keep their argument, so that only the math shifts are removed. The Greek letters, `\partial`, `\nabla`, `\ell`, `\hbar` and the dotless i and j become Unicode characters, where the Greek letters follow their meaning in text.

2 Vector accents

`\dashedvec` `\dottedvec` The `\dashedvec{`⟨*math*⟩`}` and `\dottedvec{`⟨*math*⟩`}` accents are vector arrows with a dashed and a dotted shaft, so that `\dashedvec{x}` and `\dottedvec{x}` give $\vec{x}$ and $\vec{x}$ next to the $\vec{x}$ of `\vec{x}`. Their glyphs are copies of the glyphs of `\vec`, in which only the shaft is cut into dashes or dots. The arrowhead, the size and the placement are therefore those of `\vec`: the accents follow the slant of italic letters, shrink in sub- and superscripts, are bold in the bold math version and can be combined with other accents. Like `\vec` they do not follow the math alphabet commands. The dashed shaft consists of two dashes and the dotted shaft of three dots, but the short and thick shafts of the bold sans-serif fonts only provide space for one dash and two dots. In bookmarks of the HYPERREF package they keep their argument.

3 Options

`symbols` The `symbols=`⟨*value*⟩ option selects the symbol fonts, see table 2. The AMS symbols [6] and MnSymbol [7] are loaded from their packages. The AMS blackboard only contains capitals and the character k. The NCM blackboard of the MATHALPHA package and the BBOLDX blackboard contain capitals, small letters and digits in medium and bold weight. The RSFS script [3] only contains capitals and the double-stroke blackboard [8] contains capitals and the characters h, k and 1. With pdfLaTeX the decorative alphabets are packed into one virtual font family, the four blackboard alphabets into another one and the script and upright calligraphic alphabets into a third one. In this way the `true`, `ams` and `minion` setups use 15, 14 and 15 of the 16 math families of pdfTeX, but additional alphabet packages can still exhaust them. The BM package does not reserve additional families.

`mathsf` With the default `mathsf=sans` the `\mathsf` command selects sans-serif in serif and sans-serif documents. With `mathsf=contrast` it selects the family opposite to the main family of the

Family	pdfLaTeX	LuaLaTeX and XeLaTeX
Serif	LM math and text, CM Unicode	NCM math
Sans-serif	CM sans math, LM sans text and CM Unicode	NCM sans math and text
Typewriter	LM typewriter, CB Greek and CM Unicode	LM typewriter text and NCM mono text
Blackboard	NCM and BBOLDX	NCM math
Calligraphic	LM math, Zapf Chancery and Euler script	NCM math and sans math, Euler math
Script	RSFS	NCM math and sans math
Vector accents	LM math italic or CM sans math italic	NCM math or sans math

Table 3: Fonts of the math alphabets.

document, which simplifies moving math between serif and sans-serif documents. This option also affects the combined commands and repeating `\mathsf` still has no further effect.

`synthetic` With pdfLaTeX some shapes exist in no font and are synthesised by slanting a related shape by the slant of the math italic font, see section 4. With `synthetic=false` the related shapes are used unchanged, that is, the italic shapes instead of the upright ones and vice versa. The bold sans-serif calligraphic and the bold script capitals are synthesised by overprinting the medium ones, and with `synthetic=false` the medium capitals are used. The upright script capitals are synthesised with all engines, and with `synthetic=false` the italic ones are used. Otherwise the option has no effect with LuaLaTeX and XeLaTeX.

`proportional` By default the typewriter alphabets set Latin letters and digits in the proportional latin modern (LM) typewriter, so that names of several letters do not fall apart. With `proportional=false` they use the monospaced typewriter fonts. The typewriter Greek letters are monospaced in both cases.

4 Fonts

The fonts depend on the engine, see table 3. With LuaLaTeX and XeLaTeX the package uses the UNICODE-MATH package [9], and every combination of family, weight and shape uses a font face designed for it, without synthetic bold or slanting, except for the upright script. The typewriter faces are text fonts without a math table, so that some specialised math metrics are not available. With pdfLaTeX the upright and typewriter Greek letters come from the CB Greek and CM Unicode fonts, which share their design.

Some combinations are not available in any font and fall back to related shapes:

- The typewriter `\partial`, `\nabla` and `\ell` use the serif shapes.
- Digits are always upright and lining, but bold and the family apply.
- `\ell` has the same shape in upright and italic.
- The proportional LM typewriter has no italic, so its oblique shapes are used, and there is no proportional typewriter Greek.

With LuaLaTeX and XeLaTeX there are two more fallbacks:

- There is no bold sans-serif blackboard and no bold sans-serif `\ell`, the medium blackboard and the bold serif `\ell` are used instead.
- The medium upright typewriter `\vartheta` uses the serif shape, as the mono face draws it as `\theta`.
- The upright script capitals are slanted back by LUAOTFLOAD or XeTeX, which keep the accent positions of the italic capitals.

With pdfLaTeX there are other fallbacks:

- The typewriter `\vartheta`, `\phi`, `\varrho` and `\varpi` use the serif shapes.
- There is no bold `\varkappa`, the medium shape is used instead.
- There is no bold Zapf Chancery and no bold RSFS, the bold sans-serif calligraphic and the bold script capitals are synthesised, see the `synthetic` option.
- There is no sans-serif script, the sans-serif and typewriter families use the RSFS capitals.
- `\varTheta` uses the shape of `\Theta`.
- The upright `\partial`, `\varpi` and `\varkappa`, the upright sans-serif `\vartheta`, `\phi` and `\varrho`, the italic `\nabla` and the italic typewriter `\varepsilon` are synthesised, see the `synthetic` option.

5 Virtual fonts

For pdfLaTeX the package uses six virtual font families, one for each family and weight, and two more for the proportional typewriter, at the sizes 5 pt, 7 pt and 10 pt. Each font contains the italic shapes in its lower and the upright shapes in its upper half. The virtual fonts refer to installed fonts and to base fonts derived from them, and copy their metrics, including italic corrections and the kerns for accents. The base fonts whose names start with `hep-` contain CM Unicode and LM text fonts in an encoding of their Greek letters and h-bar. The base fonts whose names start with `hepslant-` are slanted copies of installed fonts. The map file hep-math-font.map declares the base fonts, and the map file hep-math-font-fallback.map declares the slanted copies without slant for `synthetic=false`. The package loads the map file itself. The `hepbb` virtual fonts contain the four blackboard alphabets of `symbols=true`. Two `hepdecor` virtual fonts contain the decorative alphabets and the four calligraphic alphabets in medium and bold weight, and four more are used for `symbols=minion`. The `hepscript` virtual fonts contain the italic and upright script and the upright calligraphic alphabets in medium and bold weight.

The dashed and dotted vector accents are part of the TrueType font hepaccent.ttf, which is derived from the vector accents of the LM, CM sans-serif and NCM math fonts. pdfLaTeX uses it through the TeX font metric (TFM) file hepaccent.tfm and the encoding file hepaccent.enc, and the `hepalpha` virtual fonts contain the accents after the italic shapes. LuaLaTeX and XeLaTeX use the font directly, so that it is the only generated file they need.

The TFM and virtual font (VF) files are generated with the script hep-math-font-vf.py, which is extracted together with the package.

```
tex hep-math-font.ins
python3 hep-math-font-vf.py
```

The script reads the glyph table from hep-math-font.sty in the current directory and writes the TFM and VF files, the accent font, the encoding files hep-math-font.enc and hepaccent.enc

and the two map files there. It requires the fontTools library, the KPSEWHICH, PLTOTF and VPTOVF programs and the fonts listed above.

The script also writes the file hep-math-font-vf.def, which records the version of the package file the fonts were generated from. For a local installation all generated files have to be placed next to the document. In a TDS tree hep-math-font-vf.def belongs next to the package file into tex/latex/hep-math-font, the TFM files into fonts/tfm/public/hep-math-font, the VF files into fonts/vf/public/hep-math-font, the accent font into fonts/truetype/public/hep-math-font, the encoding files into fonts/enc/dvips/hep-math-font and the map files into fonts/map/pdftex/hep-math-font.

Without the generated fonts the package still works, with fewer features. If pdfLaTeX does not find hep-math-font-vf.def, the package warns and keeps the standard math alphabets, which use the LM fonts of the main family. They are not composable, the combined commands select the nearest standard alphabet, the decorative alphabets are the AMS blackboard, Euler fraktur and RSFS, and the Greek letters are not affected by the alphabet commands. If the file belongs to another version of the package file, the virtual fonts may contain other glyphs than the package expects. This is an error, after which the package also keeps the standard math alphabets. If the accent font is missing, the vector accents fall back to `\vec` with a warning. The math fonts, operators and symbols of all engines are not affected.

References

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[4] M. Sharpe. 'The `rsfso` package: A mathematical calligraphic font based on rsfs' (2013). CTAN: `rsfso`.

[5] *LaTeX3 Project.* 'Hypertext marks in LaTeX: a manual for `hyperref`: Extensive support for hypertext in LaTeX' (1995). CTAN: `hyperref`. GitHub: `latex3/hyperref`.

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[9] K. Hosny, W. Robertson, P. Stephani, and J. Wright. 'The `unicode-math` package: Unicode mathematics support forXeTeX and LuaTeX' (2006). CTAN: `unicode-math`.