

# The Euler Virtual Math Fonts for use with L<sup>A</sup>T<sub>E</sub>X

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v2.7 – 2001/04/10

## Abstract

The Euler math fonts are suitable for math typesetting in conjunction with a variety of popular text fonts which do not provide math character sets of their own. Euler-VM is a set of virtual math fonts based on Euler and CM, accompanied by a macro package for easy use with L<sup>A</sup>T<sub>E</sub>X.

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## 1 The Euler math fonts

‘With Donald Knuth’s assistance and encouragement, Hermann Zapf, one of the premier font designers of this century, was commissioned to create designs for Fraktur and script, and for a somewhat experimental, upright cursive alphabet that would represent a mathematician’s handwriting on a blackboard and that could be used in place of italic. The designs that resulted were named Euler, in honor of Leonhard Euler, a prominent mathematician of the eighteenth century. Zapf’s designs were rendered in METAFONT code by graduate students at Stanford, working under Knuth’s direction. [...] Knuth also noticed that the style of some symbols in the Computer Modern extension font, in particular the

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integral sign, was too slanted to be attractive with Euler, and consequently he prepared a new (partial) extension font for use with Euler.’ [1]

Knuth’s book *Concrete Mathematics* was typeset using the Concrete font family for text and the Euler fonts for math. With  $\text{\LaTeX}$ , the particular math font setup of this book can be mimicked through the package `euler`, see [4]. In the meantime it became obvious that the Euler fonts match other text font families equally well.

Unfortunately, the Euler fonts do not comprise all symbols required for mathematical typesetting with  $\text{\LaTeX}$ . As a result, the `euler` package needs to redefine most of  $\text{\LaTeX}$ ’s math font setup, so that certain symbols are taken from Euler, whereas others must still come from the CM math fonts.

## 2 The Euler-VM fonts

Euler Virtual Math (Euler-VM) is a set of *virtual* fonts based primarily on the Euler fonts, with the missing symbols taken from Computer Modern. Thus Euler-VM can replace  $\text{\LaTeX}$ ’s default CM math fonts. This approach has several advantages over immediately using the *real* Euler fonts, as practiced in the `euler` package: Most noticeably, less  $\text{\TeX}$  resources are consumed, the quality of various math symbols is improved, and there will be far lesser compatibility problems with other packages.

Actually, the reason for creating Euler-VM was the fact that the `euler` package does not provide a usable `\hbar` or `\hslash`, and that one cannot use the `\hslash` from the `amssymb` package, because the latter is CM Roman style. This makes the beautiful Euler fonts more or less unusable for physics and related fields. The only way to fix this was to create virtual fonts, which contain a ‘hand made’ Euler-style `\hslash`. As a side effect, it was possible to make the layout of these fonts compatible with CM Math to a large extent, and—since the style file had to be rewritten anyway—further improvements were introduced.

## 3 Suitable text font families

The main criteria whether you can use the Euler math fonts in conjunction with a certain text font family, are, that the weight (stroke width) and the x-height should not differ too much. Beside the above-mentioned Concrete, the font families Palatino and Melior blend well with Euler—which is not surprising, since they were also designed by H. Zapf. The Euler math fonts have also proven to go sufficiently well with the typefaces Charter, Sabon and Minion. (As to Minion, note section 4.1.1 below!)

Changing the default text fonts families is easy, see [3]: For instance, simply loading the package `palatino` will make  $\text{\LaTeX}$  use Palatino, Helvetica and Courier in place of CM Roman, CM Sans and CM Typewriter.

Do *not* use the Euler math fonts in conjunction with the default Computer Modern text fonts—this is ugly!

## 4 The $\text{\LaTeX}$ package `eulervm`

Loading the `eulervm` package will redefine  $\text{\LaTeX}$ ’s math font setup so that the Euler-VM fonts are used instead of CM Math—roughly said:

- ▷ CM Math Italic is replaced with Euler Roman,
- ▷ CM Calligraphic is replaced with Euler Script,
- ▷ ‘large’ operators and delimiters are replaced with alternative variants matching the Euler style.

## 4.1 Special features

### 4.1.1 The package option `small`

Loading the package with the option `small` will cause the Euler fonts to be loaded at 95% of their nominal size, thus blending better with certain text font families, for instance Adobe Minion. Besides the Euler-VM fonts, this option acts also on the Euler Fraktur fonts, which can be used through the `eufrak` package; any further math fonts used in your document are, however, unaffected.

### 4.1.2 Slashed $h$

The Euler-VM fonts do not provide the symbol `\hbar`. There is, however, a command `\hslash` which produces a slashed Euler-style  $h$ . The command `\hbar` is mapped to this one, too, so that you need not change existing documents for use of the Euler-VM fonts.

### 4.1.3 Bold math alphabet

The package defines a new math alphabet `\mathbold` to typeset math variables, incl. greek, in a bold style, e.g:

`\mathbold{k}`

Do not mix this up with `\mathbf`: The latter will produce characters from the bold *text* font, whereas `\mathbold` will use the bold series of the *Euler* math font.

### 4.1.4 Size of the ‘large’ math symbols

The size of the ‘large’ math symbols is automatically adjusted with respect to the base font size. You need *not* load the extra package `exscale` for this purpose.

## 4.2 Text fonts in math

### 4.2.1 Font families

Function names as well as math accents are taken from the roman text font. This holds for the math alphabets `\mathrm` and `\mathbf`, too. The `eulervm` package determines the default roman font family (i.e. the meaning of the macro `\rmdefault`) at load time and will apply it for the above purposes then. In the same way, the math alphabets `\mathsf` and `\mathtt` are mapped to `\sfdefault` and `\ttdefault`. Thus, you should redefine the default text fonts *before* loading the `eulervm` package!

### 4.2.2 Numbers and punctuation in math mode

The default behaviour is to take the digits, the comma and the period from the default roman text font family. Popular text fonts may, however, not be suitable for typesetting math: Maybe the numeral ‘1’ cannot be distinguished clearly enough from the letter ‘l’, or the style of the numerals does not suit the Euler letters well enough. Furthermore, most text fonts are scaled linearly, so that the digits may become too thin when used in super- or subscripts.

The `eulervm` package provides the option `euler-digits`, which makes the digits, the comma and the period come from Euler Roman in math mode—note that the Euler fonts come with separate designs sizes of 10 pt, 7 pt and 5 pt! The option should be used with care, because entering `$1.23$` will yield a different result than `1.23` then, and you will in each case have to decide whether an input fragment is a math or a non-math entity.

### 4.2.3 The ‘hat’ accent for math

By default, the math accent `\hat` is taken from the text font. With the option `euler-hat-accent`, an alternative one from Euler Fraktur will be used.

### 4.2.4 Encoding

The default text font encoding (i.e. the meaning of the macro `\encodingdefault`) is determined when `eulervm` is loaded; this encoding will then be applied to any text fonts used in math mode (see above.) The `eulervm` package can, however, handle the encodings OT1 (L<sup>A</sup>T<sub>E</sub>X’s default), T1 and LY1 only. If your preferred text font encoding is a different one, or if you want to override the default setting for one reason or another, you have to specify one of the above as a package option, e.g.:

```
\usepackage[OT1]{eulervm}
```

This makes the `eulervm` package use the given encoding for the text fonts in math, without affecting text mode. Be sure that the text fonts are actually available with this encoding!

## 4.3 Using PostScript fonts

CM as well as the Euler fonts are available in both METAFONT and Type1 (PostScript) format. The collection of Type1 fonts distributed by the AMS (or in conjunction with VTeX, resp.) is, however, lacking a few sizes. In contrast to the `euler` package, `eulervm` will *not* make use of these missing fonts; thus you can create documents which do not require any bitmap fonts, and `eulervm` can flawlessly be used for creating PDF output, too.

## 4.4 Options and command summary

Options of the `eulervm` package:

- ▷ `small` Load the Euler fonts at 95% of their nominal size.
- ▷ `euler-digits` Take numerals, comma and period from Euler Roman in math mode.
- ▷ `euler-hat-accent` Use the `\hat` accent from Euler Fraktur.
- ▷ `OT1` Use OT1 encoding for text fonts in math, regardless of the default text font encoding.
- ▷ `T1` ditto, T1
- ▷ `LY1` ditto, LY1

New commands:

- ▷ `\mathbold` A bold Euler-style math alphabet.
- ▷ `\hslash` A slashed Euler-style h.

## 4.5 Known problems and deficiencies

- ▷ The bold math fonts, which can be used through `\boldmath`, are far from perfect. E.g., the bold equals sign of the Euler fonts is actually smaller than the regular one! Thus, the use of `\boldmath` is not recommended; it is only provided for compatibility with standard L<sup>A</sup>T<sub>E</sub>X.
- ▷ Using the double accents from the `amsmath` package requires the `eulervm` package to be loaded with the OT1 option.
- ▷ Regardless of the `euler-digits` option, the `\cdots` macro will always produce dots from Computer Modern Symbols.

## 5 Credits

Fank Jensen's *euler* package [4] served as a model for parts of *eulervm*. The implementation of the OT1, T1 and LY1 options was adopted from Frank Mittelbach's *lucidabr* package [5]. Special thanks to Hraban Ramm for typographical advice.

## References

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