1 What is XCharter-Math?

XCharter-Math is an OpenType maths font based on Bitstream Charter meant to be used with XCharter text fonts.

Latin and Greek letters and many maths symbols are borrowed or derived from Michael Sharpe’s XCharter fonts. Other sources for maths glyphs were found in MathDesign (by Paul Pichaureau) and Fourier-GUTenberg (by Michel Bovani).

It requires LuaTeX or XeTeX as engine and the unicode-math package¹.

Please note that the current version (0.60) is experimental, do expect metrics and glyphs to change until version 1.0 is reached. Comments, suggestions and bug reports are welcome!

2 Usage

2.1 Calling \setmathfont

A basic call for XCharter-Math would be:

\usepackage{unicode-math}
\setmathfont{XCharter-Math.otf} % Call by file name or
\setmathfont{XCharter Math} % Call by font name

this loads XCharter-Math as maths font² with the default options, see subsections 3.1 on page 3, 3.2 on page 4 and 3.3 on page 5 for customisation.

Please note that the three sets of text fonts have to be chosen separately, f.i.:

¹Please read the documentation unicode-math.pdf.
²Both calls work equally well with LuaTeX; with XeTeX a call by font name will fail unless the font is declared as a system font.
\setmainfont{XCharter} % rm
\setsansfont{Cabin}[Scale=MatchLowercase] % sf
\setmonofont{Inconsolatazi4}[Scale=MatchLowercase] % tt
otherwise you would get Latin Modern for text fonts.

2.2 Calling xcharter-otf.sty (recommended)

As an alternative to load XCharter-Math you can type:
\usepackage[ options \textsuperscript{3} ]{xcharter-otf}

it loads unicode-math with the default options, sets XCharter-Math as maths font and XCharter Text fonts as Roman fonts (families sf and tt left unchanged) but does a bit more:

1. it loads realscripts for better superscripts;
2. it checks at \begin{document} if packages amssymb or latexsym are loaded and issues warnings in case they are;
3. it provides aliases for glyphs named differently in Unicode, so that latexsym or AMS names are also available;
4. it defines specific maths characters like \varepsilon (\emptyset), \parallelslant (||), \shortparallelslant (\parallel), etc.;
5. it reduces spacing in maths mode: \thinmuskip, \medmuskip and \thickmuskip unless the\loose option is activated.

Apart from the\loose option mentioned above, xcharter-otf.sty provides two options no-text and Scale=\textsuperscript{<decimal>} meant to be used to load the XCharter-Math font together with roman text fonts other than XCharter, while keeping the advantages 1. to 5. pointed in the preceding list, f.i.
\usepackage[no-text,Scale=0.98]{xcharter-otf}
Option no-text can also be useful if XCharter is to be loaded with specific options, f.i.
\usepackage[no-text]{xcharter-otf}
\setmainfont{XCharter}[RawFeature=+onum;+ss01]

3 What is provided?

XCharter-Math provides all glyphs supplied by Fourier-GUTenberg plus all glyphs available in the amssymb and latexsym packages and many more. Therefore, these two packages should not be loaded as they might override XCharter-Math glyphs.

\textsuperscript{3}Possible options are loose, no-text, Scale= or any of the options described in sections 3.1, 3.2 and 3.3.
Sans-serif, typewriter and fraktur alphabets are borrowed from Latin Modern fonts. See in section 3.6 on page 8 how to choose from other maths fonts for these styles. A full list of available glyphs is shown in file unimath-xcharter.pdf.

3.1 Upright or slanted?

Package unicode-math follows \TeX conventions for Latin and Greek letters: in maths mode, the default option (math-style=\TeX) prints Latin letters $a...z A...Z$ and lowercase Greek letters $\alpha...\omega$ slanted (italic) while uppercase Greek letters $\Gamma...\Omega$ are printed upright. This can be changed by option math-style as shown in table 1.

<table>
<thead>
<tr>
<th>Package option</th>
<th>Latin</th>
<th>Greek</th>
</tr>
</thead>
<tbody>
<tr>
<td>math-style=ISO</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
<tr>
<td>math-style=\TeX</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
<tr>
<td>math-style=french</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
<tr>
<td>math-style=upright</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
</tbody>
</table>

Bold letters are printed upright except lowercase Greek letters which are slanted (the default option is bold-style=\TeX). This can be changed by option bold-style as shown in table 2.

<table>
<thead>
<tr>
<th>Package option</th>
<th>Latin</th>
<th>Greek</th>
</tr>
</thead>
<tbody>
<tr>
<td>bold-style=ISO</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
<tr>
<td>bold-style=\TeX</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
<tr>
<td>bold-style=upright</td>
<td>$(a,z,B,X)$</td>
<td>$(\alpha,\beta,\Gamma,\Sigma)$</td>
</tr>
</tbody>
</table>

Other possible customisation: $\nabla$ is printed upright and $\partial$ is printed slanted by default, but nabla=italic and partial=upright can change this.

All these options are offered by the unicode-math package but they can be added to the \setmathfont call\(^4\), for example:

```
\setmathfont{XCharter-Math.otf}[math-style=french,partial=upright]
```

will print for the code

```
\[ \frac{\partial f}{\partial x} = \alpha \symbf{V} + a\nabla\Gamma + \symbf{\beta}M \]
```

\(^4\)IMHO it is easier to add all options to the \setmathfont command.
while the default settings would print

$$\frac{\partial f}{\partial x} = \alpha V + a\nabla \Gamma + \beta M$$

Both shapes remain available anytime: $\uppi, \itpi$ prints $\pi, \pi$.

If your text editor is able to handle Greek letters or maths symbols, they can be entered in the code instead control sequences (i.e. $\alpha, \beta, \Gamma,...$ for $\backslash$alpha, $\backslash$beta, $\backslash$Gamma,...).

### 3.2 Character variants

XCharter-Math provides fourteen “Character Variants” options, listed on table 3, to choose between different glyphs for Greek characters and some others. Alternative calligraphic capitals for E, Q and T have been added (version 0.50) and an alternative italic ν, easier to distinguish from $\nu$ (version 0.51).

<table>
<thead>
<tr>
<th>Default</th>
<th>Variant</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>cv00</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>cv01</td>
<td>$\hbar$</td>
<td>$\hbar$</td>
</tr>
<tr>
<td>cv02</td>
<td>$\emptyset$</td>
<td>$\emptyset$</td>
</tr>
<tr>
<td>cv03</td>
<td>$\epsilon$</td>
<td>$\epsilon$</td>
</tr>
<tr>
<td>cv04</td>
<td>$\kappa$</td>
<td>$\kappa$</td>
</tr>
<tr>
<td>cv05</td>
<td>$\pi$</td>
<td>$\pi$</td>
</tr>
<tr>
<td>cv06</td>
<td>$\varphi$</td>
<td>$\varphi$</td>
</tr>
<tr>
<td>cv07</td>
<td>$\rho$</td>
<td>$\rho$</td>
</tr>
<tr>
<td>cv08</td>
<td>$\zeta$</td>
<td>$\zeta$</td>
</tr>
<tr>
<td>cv09</td>
<td>$\vartheta$</td>
<td>$\vartheta$</td>
</tr>
<tr>
<td>cv10</td>
<td>$\Theta$</td>
<td>$\Theta$</td>
</tr>
<tr>
<td>cv11</td>
<td>$\nu$</td>
<td>$\nu$</td>
</tr>
<tr>
<td>cv12</td>
<td>$w$</td>
<td>$w$</td>
</tr>
<tr>
<td>cv20</td>
<td>$\varepsilon$</td>
<td>$\varepsilon$</td>
</tr>
<tr>
<td>cv21</td>
<td>$\varnothing$</td>
<td>$\varnothing$</td>
</tr>
<tr>
<td>cv22</td>
<td>$\mathcal{T}$</td>
<td>$\mathcal{T}$</td>
</tr>
</tbody>
</table>

For instance, to get $\epsilon$ and $\phi$ typeset as $\epsilon$ and $\varphi$ instead of $\epsilon$ and $\phi$, you can add option `CharacterVariant={3,6}` to the `\setmathfont` call:

```
\setmathfont{XCharter-Math.otf}[CharacterVariant={3,6}]
```

This works for all shapes and weights of these characters: f.i. $\symbf{\epsilon}$, $\symbf{\phi}$ are output as $\epsilon$, $\varphi$ instead of $\epsilon$, $\phi$.

Similarly with `math-style=french`, $\epsilon$ and $\phi$ are output as $\epsilon$ and $\varphi$ (upright).
Please note that curly braces are mandatory whenever more than one “Character Variant” is selected.

Note about $\hbar$ (v 0.43): unicode-math defines $\hbar$ as $\hslash$ (U+210F) while amsmath provides two different glyphs (italic h with horizontal or diagonal stroke). XCharter Math now follows unicode-math; the italic h with horizontal stroke can be printed using $\hslash$ or $\hbar$ together with character variant cv01 or with $\mathbar$ (replacement for AMS’ command $\hbar$).

### 3.3 Stylistic sets

XCharter-Math provides five “Stylistic Sets” options to choose between different glyphs for families of maths symbols.

StylisticSet=4, alias Style=leqslant, converts large inequalities into their slanted variants, see table 5a.

StylisticSet=5, alias Style=smaller, converts some symbols into their smaller variants, see table 5b.

<table>
<thead>
<tr>
<th>Table 4: Stylistic Sets 4 and 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Style=leqslant (*ss04)</td>
</tr>
<tr>
<td>Command</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>$\leq$</td>
</tr>
<tr>
<td>$\geq$</td>
</tr>
<tr>
<td>$\nleq$</td>
</tr>
<tr>
<td>$\ngeq$</td>
</tr>
<tr>
<td>$\leqq$</td>
</tr>
<tr>
<td>$\geqq$</td>
</tr>
<tr>
<td>$\eqless$</td>
</tr>
<tr>
<td>$\eqgtr$</td>
</tr>
<tr>
<td>$\lesseqqgtr$</td>
</tr>
<tr>
<td>$\gtrqless$</td>
</tr>
<tr>
<td>$\lesseqqgtr$</td>
</tr>
</tbody>
</table>

StylisticSet=6, alias Style=subsetneq, converts some inclusion symbols, as shown in table 6a on the next page.

StylisticSet=7, alias Style=parallelslant, converts “parallel” symbols into their slanted variants, see table 6b on the following page.

To enable Stylistic Sets 4, 6 and 7 for XCharter-Math, you should enter

\setmathfont{XCharter-Math.otf}[StylisticSet={4,6,7}] or \usepackage[Style={leqslant,subsetneq,parallelslant}]{xcharter-otf}

These Style aliases are provided by xcharter-otf.sty.
Table 5: Stylistic Sets 6 and 7

(a) Style=subsetneq (+ss06)

<table>
<thead>
<tr>
<th>Command</th>
<th>Default</th>
<th>Variant</th>
</tr>
</thead>
<tbody>
<tr>
<td>\subsetneq</td>
<td>\⊊ \⊊</td>
<td>\subsetneq</td>
</tr>
<tr>
<td>\supsetneq</td>
<td>\⊋ \⊋</td>
<td>\supsetneq</td>
</tr>
<tr>
<td>\subsetneqq</td>
<td>\⫋ ⫋</td>
<td>\subsetneqq</td>
</tr>
<tr>
<td>\supsetneqq</td>
<td>\⫌ ⫌</td>
<td>\supsetneqq</td>
</tr>
</tbody>
</table>

(b) Style=parallelslant (+ss07)

<table>
<thead>
<tr>
<th>Command</th>
<th>Default</th>
<th>Variant</th>
</tr>
</thead>
<tbody>
<tr>
<td>\parallel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\nparallel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\shortparallel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\nshortparallel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

then, \([x\leq y \quad A \subsetneq B \quad D \parallel D']\] will print as

\(x \leq y \quad A \subsetneq B \quad D \parallel D'\)

instead of

\(x \leq y \quad A \subsetneq B \quad D \parallel D'\)

StylisticSet=3, alias Style=upint, converts integrals signs into their upright variants, see table 6.

Table 6: Style=upint (+ss03)

<table>
<thead>
<tr>
<th>Command</th>
<th>\int</th>
<th>\iint</th>
<th>\iiint</th>
<th>\iiiint</th>
<th>\oint</th>
<th>\oiint</th>
<th>\oiiint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>∫</td>
<td>∬</td>
<td>∭</td>
<td>⨌</td>
<td>∮</td>
<td>∯</td>
<td>∯ ∰</td>
</tr>
<tr>
<td>Upright</td>
<td>∫</td>
<td>∬</td>
<td>∭</td>
<td>⨌</td>
<td>∮</td>
<td>∯</td>
<td>∯ ∰</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Command</th>
<th>\intclockwise</th>
<th>\awint</th>
<th>\varointclockwise</th>
<th>\ointctrclockwise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>∍</td>
<td>∍</td>
<td>∍</td>
<td>∍</td>
</tr>
<tr>
<td>Upright</td>
<td>∍</td>
<td>∍</td>
<td>∍</td>
<td>∍</td>
</tr>
</tbody>
</table>

3.4 Other font features

To get oldstyle numbers in maths, the feature +onum is available:

`\setmathfont{XCharter-Math.otf}[Numbers=OldStyle]` or
`\usepackage[Style=fulloldstyle]{xcharter-otf}`

0123456789, \textbf{0123456789}

\footnote{These Style aliases are provided by xcharter-otf.sty.}
3.5 Standard \LaTeX\ math commands

All standard \LaTeX\ maths commands, all \texttt{amssymb} commands and all \texttt{latexsym} commands are supported by XCharter-Math, for some of them loading \texttt{xcharter-otf.sty} is required.

Various wide accents are also supported:

\begin{itemize}
  \item \texttt{\wideoverbar} and \texttt{\mathunderbar}\footnote{\texttt{\overline} and \texttt{\underline} are not font related, they are based on \texttt{\rule}.}
    \begin{align*}
      \overline{x} \quad \overline{xy} \quad \overline{xyz} \quad \overline{A \cup B} \quad \overline{A \cup (B \cap C) \cup D} \quad m + n + p
    \end{align*}
  \item \texttt{\widehat} and \texttt{\widetilde}
    \begin{align*}
      \widehat{x} \quad \widehat{xx} \quad \widehat{xxxx} \quad \widehat{xxxxx} \quad \widehat{xxxxxx} \quad \widehat{xxxxxxx}
    \end{align*}
  \item \texttt{\widecheck} and \texttt{\widebreve}
    \begin{align*}
      \widecheck{x} \quad \widecheck{xxxx} \quad \widecheck{xxxxxx} \quad \widecheck{x} \quad \widecheck{xxxx} \quad \widecheck{xxxxxx}
    \end{align*}
  \item \texttt{\overparen} and \texttt{\underparen}
    \begin{align*}
      \overparen{x} \quad \overparen{xy} \quad \overparen{xyz} \quad \overparen{A \cup B} \quad \overparen{A \cup (B \cap C) \cup D} \quad \overparen{\frac{x + y}{2}} \quad \overparen{\frac{a + b + \ldots + z}{26}}
    \end{align*}
  \item \texttt{\overbrace} and \texttt{\underbrace}
    \begin{align*}
      \overbrace{a} \quad \overbrace{ab} \quad \overbrace{abc} \quad \overbrace{abcd} \quad \overbrace{abcde} \quad \overbrace{\frac{a + b + c}{3}} \quad \overbrace{\frac{a + b + \ldots + z}{26}}
      \underbrace{a} \quad \underbrace{ab} \quad \underbrace{abc} \quad \underbrace{abcd} \quad \underbrace{abcde} \quad \underbrace{\frac{a + b + c}{3}} \quad \underbrace{\frac{a + b + \ldots + z}{26}}
    \end{align*}
  \item \texttt{\overbracket} and \texttt{\underbracket}
    \begin{align*}
      \overbracket{a} \quad \overbracket{ab} \quad \overbracket{abc} \quad \overbracket{abcd} \quad \overbracket{abcde} \quad \overbracket{\frac{a + b + c}{3}} \quad \overbracket{\frac{a + b + \ldots + z}{26}}
      \underbracket{a} \quad \underbracket{ab} \quad \underbracket{abc} \quad \underbracket{abcd} \quad \underbracket{abcde} \quad \underbracket{\frac{a + b + c}{3}} \quad \underbracket{\frac{a + b + \ldots + z}{26}}
    \end{align*}
  \item \texttt{\overrightarrow} and \texttt{\overleftarrow}
    \begin{align*}
      \overrightarrow{v} \quad \overrightarrow{\vec{M}} \quad \overrightarrow{vv} \quad \overrightarrow{AB} \quad \overrightarrow{ABC} \quad \overrightarrow{ABCD} \quad \overrightarrow{ABCD} \quad \overrightarrow{ABCDEFGH}
      \overleftarrow{v} \quad \overleftarrow{\vec{M}} \quad \overleftarrow{vv} \quad \overleftarrow{AB} \quad \overleftarrow{ABC} \quad \overleftarrow{ABCD} \quad \overleftarrow{ABCD} \quad \overleftarrow{ABCD} \quad \overleftarrow{ABCDEFGH}
    \end{align*}
\end{itemize}
\overrightharpoon{v} \quad \overrightharpoon{M} \quad \overrightharpoon{vv} \quad \overrightharpoon{AB} \quad \overrightharpoon{ABC} \quad \overrightharpoon{ABCD} \quad \overrightharpoon{ABCDEFGH}.

\underleftarrow{v} \quad \underleftarrow{M} \quad \underleftarrow{vv} \quad \underleftarrow{AB} \quad \underleftarrow{ABC} \quad \underleftarrow{ABCD} \quad \underleftarrow{ABCDEFGH}

\underrightarrow{v} \quad \underrightarrow{M} \quad \underrightarrow{vv} \quad \underrightarrow{AB} \quad \underrightarrow{ABC} \quad \underrightarrow{ABCD} \quad \underrightarrow{ABCDEFGH}

\underleftarrow{v} \quad \underleftarrow{M} \quad \underleftarrow{vv} \quad \underleftarrow{AB} \quad \underleftarrow{ABC} \quad \underleftarrow{ABCD} \quad \underleftarrow{ABCDEFGH}

Finally \widearc{AMB} and \overrightarc{AMB} (loading xcharter-otf.sty is required)

\begin{align*}
\widearc{AMB} \\
\overrightarc{AMB}
\end{align*}

### 3.6 Mathematical alphabets

- All Latin and Greek characters are available in italic, upright, bold and bold italic via the \texttt{\symit{}}, \texttt{\symup{}}, \texttt{\symbf{}}, or \texttt{\symbfit{}} commands.

- Calligraphic alphabet (\texttt{\symscr{}}, \texttt{\symcal{}}, or \texttt{\mathcal{}} command), uppercase: $\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$ also in boldface (\texttt{\symbfscr{}}, \texttt{\symbfcal{}} or \texttt{\mathbfcal{}} command): $\mathbfcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$

- Blackboard-bold alphabet (\texttt{\symb{}}, or \texttt{\mathbb{}} command):

  \begin{align*}
  &\mathbb{ABCDEFGHJKLMNOPQRSTUVWXYZ} \\
  &\mathbb{abcdefghijklmnopqrstuvwxyz} \quad 0123456789
  \end{align*}

- Fraktur alphabet is borrowed from Latin Modern, medium and bold (\symfrak{} or \symbffrak{} commands):

\begin{align*}
&\mathfrak{ABCDEFGHIJKLMNOPQRSTUVWXYZ} \quad \mathfrak{abcdefghijklmnopqrstuvwxyz} \\
&\mathfrak{ABCDEFGHIJKLMNOPQRSTUVWXYZ} \quad \mathfrak{abcdefghijklmnopqrstuvwxyz}
\end{align*}

but this can overwritten, i.e.

\begin{verbatim}
\setmathfont{Asana-Math.otf}[range=frak,Scale=MatchUppercase]
$\symfrak{ABCDEFGHIJKLMNOPQRSTUVWXYZ} \quad \mathfrak{abcdefghijklmnopqrstuvwxyz}$
\end{verbatim}
Sans serif alphabet is borrowed from Latin Modern, ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz but it can be borrowed from another maths font, i.e.

\setmathfont{STIXTwoMath-Regular.otf}[range={sfup,sfit}, Scale=MatchUppercase]
\symsfup{ABCD...klm}\quad\symsfit{NOPQ...xyz}

Typewriter alphabet is borrowed from Latin Modern, ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz but it can be borrowed from another maths font, i.e.

\setmathfont{STIXTwoMath-Regular.otf}[range=tt, Scale=MatchUppercase]
\symtt{ABCDE...XYZ abcde...xyz}

Like Latin Modern, XCharter-Math provides only four lowercase latin letters in script (or calligraphic) shape: ℵ, ℽ, ℽ, ℴ (\mscre, \mscrg, \ell, \mscro).
All others (range "1D4B6 to "1D4CF) have to be borrowed from another maths font if needed, i.e.

\setmathfont{LibertinusMath-Regular.otf}%
[rangle="1D4B6-"1D4CF, Scale=MatchLowercase]

3.7 Bold variant

In case short maths formulas have to be printed in section titles, a limited bold variant has been added in version 0.35. Example of usage:
\setmathfont{XCharter-Math-Bold.otf}[version=bold, options]
\section{\texttt{\mathversion{bold} Einstein's equation $E=mc^2$}}

It is also possible to use the \boldmath command:
\setmathfont{XCharter-Math-Regular.otf}[BoldFont=XCharter-Math-Bold.otf]
\section{\boldmath Einstein's equation $E=mc^2$}
3.8 Missing symbols

XCharter-Math does not aim at being as complete as STIXTwoMath-Regular or Cambria, the current glyph coverage compares with TeXGyre maths fonts. In case some symbols do not show up in the output file, you will see warnings in the .log file, for instance:

Missing character: There is no \( \leftrightarrow \) (U+2964) in font XCharterMath

Borrowing them from a more complete font, say Asana-Math, is a possible workaround:

\setmathfont{Asana-Math.otf}[range={"2964},Scale=1.02]

scaling is possible, multiple character ranges are separated with commas:

\setmathfont{Asana-Math.otf}[range={"294A-"2951,"2964,"2ABB-"2ABE}]

Let’s mention albatross, a useful tool to find out the list of fonts providing a given glyph: f.i. type in a terminal “albatross U+2964”, see the manpage or albatross-manual.pdf.

4 Acknowledgements

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