Viewing Mathematics on the Internet

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November 8, 2012

Abstract

Summary of the current state of viewing mathematical content on the internet. More specifically, this document reviews the status of MathML browsing.

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1 Overview

Viewing mathematical content on the internet has long required a motivated consumer as well as a willing publisher. By this we mean that, until recently, there has been little native browser support for rendering mathematics. Displaying a page that contains mathematical expressions does not "just work" for most browsers. Anyone interested in viewing mathematical documents must take the initiative and modify the browser environment to achieve this end – hence you read papers like this one. At this time (June 2011), there are signs that that this situation is slowly improving.

In the past, the best chance of a "just works" solution for publishers of mathematical content was to render mathematical expressions to image files and publish these images interspersed among the page text. Needless to say, this is a tedious process that produces spotty results and large (read that slow to download) pages. However, it does produce readable, if not beautiful, content in any browser that can display inline images.

Nonetheless, there is something that seems ad hoc or inelegant about this solution. More fundamentally, substituting images for mathematical expressions eliminates the possibility of interpreting the mathematical content in a meaningful manner.

1.1 Necessary Conditions

An alternate approach to math publication is to develop a specialized markup language for describing mathematical notation, publish mathematical expressions in this markup language, and develop browsers that can parse this language and display appropriately formatted output. This is the long, slow path we are traveling.

1.1.1 A Math Markup Language - MathML

The first crucial step taken down this path was the development of the W3C MathML (Mathematical Markup Language) specification. This specification, initially published in 1998, has gone through three revisions. MathML 2.0 was last revised in October 2003. A candidate recommendation for MathML 3.0 was released in December 2009.

1.1.2 Browser Support

The second requirement for robust mathematics publication, browser support for MathML, was initiated by Mozilla. Firefox's first production release, and all

subsequent releases, have included MathML support. Other browser developers have not been as forthcoming in this area. Subsequent sections of this document discuss the MathML rendering capabilities of each major browser.

1.1.3 Availability of Math Fonts

An important adjunct to development of a mathematical markup language is the availability of fonts capable of rendering mathematical expressions. Mathematics is a specialized language. Most fonts used to print newspapers were not designed to render Maxwell's equations. Subsequent sections of this document contain a fairly detailed review of font support for mathematics (in particular, see Section 7).

1.2 Summary of Browser Support for MathML

For those in a hurry, a brief overview of major browsers (ordered by quality of support for MathML rendering) follows:

- Firefox. Native rendering support has been available since the original production release of Firefox. "Just works" support requires Firefox 3+ and a modern operating system. Other Gecko-based browsers, such as Camino, also inherit this MathML support.
- Safari. Native rendering support was introduced in Safari 5.1 (July 2011). Safari is based on the Apple sponsored WebKit open source project. MathML development is ongoing in WebKit (see here for Webkit's current MathML implementation status). The current production release of MathML support is a little rough around the edges (but improving). It is nonetheless appreciated by mathematically-oriented Safari users.
- Chrome. Native rendering support was introduced in Chrome version 24 (November 2012). Chrome, like Safari, is WebKit based. They share the same MathML implementation.
- Opera. MathML rendering support has been available since Opera 9.5. Opera renders MathML using the MathML for CSS profile, a subset of presentation MathML. As such, its rendering of mathematical notation is somewhat more limited (and quirkier) than Firefox's or Safari's.
- Internet Explorer. No native rendering support (and no ongoing development announced). Historically, the free MathPlayer plugin provides good MathML support for Internet Explorer and has been readily available for

several years. However, the advent of Internet Explorer 9 complicated the situation. At this time, production releases of MathPlayer do not work with IE9 or IE10. This implies Internet Explorer users who require robust MathML support should probably stick with IE7 or IE8 and MathPlayer 2.2 for the time being.

Cut to the chase. For the most robust native rendering of MathML, use a recent release of Firefox. Safari 5.1+ and Chrome 24+ render MathML natively, but the execution is a bit more limited in scope and quality than Firefox. The same can be said of Opera 9.5+ (but more so). Internet Explorer is in a more chaotic state. The "IE constrained" should view MathML publications usingIE6-IE8 with MathPlayer 2.2. Recent releases of IE/MathPlayer are spotty at best, with regard to MathML rendering. Patrons of other browsers have few viable options unless the content provider implements local measures to support these browsers.

1.3 Server Side Approaches to Math Publication

Mathematical content on this site is published via presentation MathML. The MathML source is rendered by the MathJax engine. This software resides on the server and downloads javascript and web fonts to render MathML into publication-quality mathematical expressions on recent versions of all major browsers. At the publisher's discretion, it will also utilize native browser MathML support and locally resident STIX fonts when they are available on the client.

In other words, MathML-based mathematical content is rendered for this site's visitors with no special client-side preparations or browser based MathML support required – which makes the topic of native browser support for MathML somewhat rhetorical.

MathJax is a rapidly maturing product sponsored by several of the same mathematically-oriented publishers that developed the STIX fonts. For more information on the local MathJax implementation, see the final section of this document (Section 8).

Since MathJax is implemented on the server-side by individual publishers, it is not a general solution to the client-side mathematical browsing problem addressed by this document. However, it does provide an easily implemented, robust technique for serious publishers to overcome the lackadaisical attitude of Microsoft, Apple, and Google toward implementation of MathML in particular and internet math publication in general.

2 Firefox

Mozilla was the first browser vendor to seriously deploy MathML support – Firefox 1.0 rendered MathML. Nonetheless, it is recommended that you use the current version of Firefox for the most trouble free math browsing experience. There were enough math rendering bugs in Firefox prior to version 3.5 that you should definitely upgrade your browser if you are still using an ancient incarnation of the software.

In reality, the quality of math rendering is highly dependent upon the fonts available to the browser. If you want decent math displays in recent Firefox releases, use any of these options:

- Use a modern version of Windows (Vista, Windows 7, or Windows 8). Microsoft's Cambria font family is native to these operating systems. The Cambria fonts include Cambria Math which is a stylistically compatible mathematical extension. Windows Firefox users can view MathML quite nicely when the Cambria fonts are available.

  Windows XP users can obtain the Cambria fonts by installing Microsoft Office 2007+, Microsoft's PowerPoint Viewer, or Microsoft's Office Compatibility Pack.

- Use a modern version of OS X. Apple has packaged the STIX fonts with all OS X releases since OS X 10.7 (Lion). For older versions of OS X, Apple's native Apple Symbols font provides support for many Greek and mathematical characters. Mac OS X 10.5+ Firefox users can view MathML reasonably well without supplemental font support.

- Use a modern Linux distribution. Most Linux distributions ship with Firefox as the default browser and provide good coverage of math and Greek symbols in various preinstalled unicode font families for serif and sans serif faces. Linux Firefox users can view MathML reasonably well without supplemental font support.

- Install the STIX fonts. STIX is a consortium of scientific publishers that decided to create a digital font to accurately display all characters required for electronic publication of their periodicals and monographs. The STIX fonts are a serif font face intended to work well with "Times like" typefaces.

In general, it a good idea to download and install the STIX fonts for viewing MathML whenever feasible (OS X 7+ users can ignore this advice). They provide

symbol coverage that is unavailable in most other fonts. As you can see from Table 1 and Table 2, Firefox (3.6 - 16.x) will use the STIX fonts for displaying math when they are available.

Table 1: Firefox 13 - 16.x Default Math Font Preferences

Priority	Font Name
1	MathJax Main
2	STIXNonUnicode
3	STIXSizeOneSym
4	STIXSize1
5	STIXGeneral
6	Asana Math
7	Standard Symbols L
	Symbol (OS X)
	Monotype Symbol (Windows XP)
8	DejaVu Sans
9	Cambria Math

Table 1 illustrates that the most recent versions of Firefox give precedence to the MathJax fonts and use the STIX fonts as a fallback selection. Currently, this change only effects Firefox users with the MathJax fonts installed locally, which is surely a minuscule group. However, it is a harbinger of a new philosophy of Firefox math font support. Future releases of Firefox will natively support use of MathJax web fonts provided by the MathJax CDN (content delivery network). This will, in many cases, alleviate the necessity for local math font installation.

For more information concerning math fonts, see Section 7 of this document. Also, the articles Fonts for Mozilla's MathML engine and Fonts for Mozilla 1.8's MathML engine at the Mozilla developer center are good sources of additional font-related information for Firefox. Note that the latter article only pertains to really old Firefox installations.

3 Internet Explorer

Long story short, Internet Explorer does not currently provide native rendering of MathML. Without supplemental support, mathematical content is often unintelligible.

However, there is a good news/bad news scenario concerning general purpose MathML browsing with Internet Explorer. The good news is a well-established

Table 2: Firefox 3.6 - 12.x Math Font Preferences

Priority	Firefox 3.6	Firefox 4-6	Firefox 7-12
1	STIXGeneral	STIXNonUnicode	STIXNonUnicode
2	DejaVu Serif	STIXSizeOneSym	STIXSizeOneSym
3	DejaVu Sans	STIXSize1	STIXSize1
4	Cambria	STIXGeneral	STIXGeneral
5	Cambria Math	Standard Symbols L Symbol (OS X) Symbol (Windows XP)	Asana Math
6	Times	DejaVu Sans	Standard Symbols L Symbol (OS X) Symbol (Windows XP)
7	Lucida Sans Unicode	Cambria Math	DejaVu Sans
8	OpenSymbol		Cambria Math
9	Standard Symbols L		
10	serif		

plugin for IE6-IE8 called MathPlayer is provided by Design Science, Inc. It is free and you can download it from their web site.

The bad news is Internet Explorer 9 and Internet Explorer 10 break MathPlayer integration. Design Science made a "preview" release of MathPlayer 3.0 in December 2011. MathPlayer 3.0 is billed as IE9 compatible. We have had spotty luck with the product. There have been no recent updates to this "preview" release. It does not claim to be IE10 compatible.

This being the case, Internet Explorer users who require general purpose MathML support would be wise to avoid IE9 and IE10 at the current time. The situation is unfortunate since, in many respects, these browsers are an improvement over their precursors. As too often happens with Microsoft, progress in internet browsing seems to be two steps forward, one step back.

3.1 Observations Concerning MathPlayer

Output produced by MathPlayer improved significantly with release 2.2 of the software (February 2010). This is particularly true with regard to font support and anti-aliased rendering. Recent MathPlayer releases can use the Cambria Math fonts (native to modern versions of Windows) and the STIX mathematical fonts. MathPlayer also provides its own "Euclid" fonts for rendering mathematics on Windows installations where other (read that better) fonts are un-

available. The Euclid fonts by MathPlayer are not of the same quality as the aforementioned fonts.

If you want decent math rendering via MathPlayer:

- Make sure version MathPlayer 2.2+ is installed on your system, and
- Make sure either the Cambria Math font or the STIX fonts are installed on your system.

For more information, see the discussion of math fonts in Section 7 of this document.

MathPlayer 2.2 is incompatible with recent versions of Internet Explorer (IE9 and IE10). On 01 December 2011, Design Sciences issued a "preview" release of MathPlayer 3.0 – which is billed as IE9 compatible. The "preview" release does not make any claims concerningIE10 or Windows 8 compatibility. We have not had much luck with this plug-in for IE9under Windows 7 or IE10 under Windows 8. It could be our problem, or it could be theirs. Nevertheless, there has not been any recent public activity concerning this product.

4 Opera

Rather than parse MathML directly (like Firefox and MathPlayer), Opera's developers elected to render MathML primarily through their CSS parsing engine. Opera implements the W3C's MathML for CSS profile. This standard defines a subset of presentation MathML 3.0 that is amenable to implementation through a CSS stylesheet. In fact, Opera developer George Chavchanidze is one of the principal arbiters of this standard.

This approach results in a pretty good rendering of most pages containing mathematical content. Even when the rendering is less than perfect, you can generally make out the intent of the author when reading mathematics with Opera. However, to date, there are readily observable problems with this approach.

CSS-based MathML rendering support was introduced in Opera 9.5.

As previously discussed, the quality of Opera's math rendering depends in large degree upon the fonts available to Opera. If you want a decent math browsing experience with Opera:

- Use a modern version of Windows (Vista, Windows 7, or Windows 8). Microsoft's Cambria font family is native to these operating systems. The Windows Opera users can view MathML quite nicely when the Cambria fonts are available.

For Windows XP, make sure either the Cambria Math font or the STIX fonts are installed on your system.

- Use a modern version of OS X. Apple has packaged the STIX fonts with all OS X releases since OS X 10.7 (Lion). For older versions of OS X, Apple's native Apple Symbols font provides support for many Greek and mathematical characters. Mac OS X 10.5+ Firefox users can view MathML reasonably well without supplemental font support.
- Use a modern Linux distribution. Most Linux distributions provide good coverage of math and Greek symbols in a variety of preinstalled unicode fonts. Linux Opera users can view MathML quite well without supplemental font support.

For more information, see the discussion of math fonts in Section 7 of this document.

5 Safari

Modern versions of Safari – Safari 5.1 and later – provide native rendering of MathML content. Earlier versions of Safari do not support MathML rendering.

Safari Desktop Platform

As you can see from Table 3, Safari 5.1 and subsequent releases will use the STIX fonts for displaying math content if they are available. Not coincidentally, modern version of OS X (i.e. OS X 10.7 and OS X 10.8) ship with STIX 1.0 fonts installed.

Table 3: Safari 5.1+ Default Math Font Preferences

Priority	Font Name
1	STIXGeneral
2	Symbol
3	Times New Roman
4	sans-serif

If you are running Safari on older versions of OS X, the native Apple Symbols font provides pretty good math coverage when the STIX fonts are unavailable. That being said, it is a good idea to install the STIX fonts if you are going

to view MathML content with Safari 5.1+ browsers running under OS X 10.6 or OS X 10.5.

If you are one of the few people running Safari 5.1 on Windows, installation of the STIX fonts is not really optional. If STIX fonts are unavailable, Safari uses the Windows Symbol font for rendering MathML content. One side effect of this font selection is that English text in mathematical expressions is transliterated into Greek characters (i.e. the Windows 7 Symbol font only contains Greek characters).

Safari Mobile Platform

Apple introduced the analog of Safari 5.1 on mobile platforms with the release of iOS 5 in October 2011. Using the fonts included with iOS 5, math symbol coverage was rather spotty. The Apple Symbols font was included in iOS 6 (released in September 2012). This font filled in many of the gaps in native MathML rendering under iOS – although inclusion of the STIX fonts would have been preferable. Installation of third party fonts is not feasible under iOS. See Section 5.1 for additional information concerning mobile webkit math rendering. Table 7 summarizes math symbol coverage in the Apple Symbols font.

5.1 Observations Concerning Webkit and MathML

Apple bases the Safari browser on its WebKit open source project. Lack of MathML support was a longstanding complaint concerning WebKit in technical circles. After years of languishing on Apple's todo list, the WebKit MathML implementation began to show signs of life late in the summer of 2009. As should be the case in the "perfect" open source world, this progress was due primarily to the efforts of an independent developer (Alex Milowski) who tackled the project without any apparent corporate sponsorship. In mid August 2010, largely due to the efforts of Milowski, MathML was enabled in the Webkit nightly builds. As is often the case in the "real" open source world, progress on the Webkit MathML implementation slowed significantly during August 2010 - July 2011 time frame as the primary developer appeared otherwise involved.

Desktop WebKit

Apple felt that the Webkit MathML implementation was sufficiently mature to release into the "wild" with the advent of OS X 10.7. On 20 July 2011, Safari was first released for distribution with MathML enabled (Safari 5.1). Safari's MathML implementation is still a bit rough around the edges, but it is definitely better than the alternative.

For the curious, an image of Mozilla's MathML Torture Test, rendered by Safari 6.0.1 running on OS X 10.8.2, is available here. The image from an alternate, unaffiliated MathML Browser Test is available here. The STIX 1.1 fonts were installed on the system that generated these images.

Mobile WebKit

Apple introduced MathML support to its production version of mobile WebKit with the release of iOS 5 on 12 October 2011. A screenshot of Mozilla's MathML Torture Test rendered on an iPad under iOS 6.0 is available here. An image of the MathML Browser Test rendered on an iPad under iOS 6.0 is available here. Since iOS does not permit the installation of third party fonts, the STIX fonts are not installed on this device. As mentioned elsewhere,iOS 6 ships with the Apple Symbols font. If you peruse these images, it is apparent that this font – though a definite improvement over the iOS 5 fonts – is still missing a few relevant math symbols.

Note that shortcomings in the iPad software used to gather these images resulted in the loss of the extreme right portion of the MathML Browser Test output.

WebKit MathML Implementation Status

You can keep tabs on the progress at the Webkit MathML project status page or the Implement MathML master bug in the WebKit bug tracking software.

6 Chrome

Chrome Desktop Platforms

Recent releases of Chrome – Chrome version 24 and later – provide native rendering of MathML content. Earlier releases of Chrome do not support MathML rendering.

Chrome Desktop Platform MathML Implementation Status

MathML support was introduced into the alpha (Canary) build of Chrome on 29 October 2012 and was introduced into the beta channel on 8 November 2012 with version 24.0.1312.5. As of the publication date of this document, MathML has not been enabled in Chrome's stable release channel. Chrome (like Safari) is based on the WebKit open source project. Safari enabled Webkit's MathML implementation was in July 2011. At that time, the chromium project refrained from releasing MathML support for a variety of ostensible reasons. Apparently, an intrepid Webkit volunteer (Dave Barton) shepherded the development of the chromium-approved MathML implementation in a manner reminiscent of Alex Milowski's role in the original Webkit implementation of MathML. The chromium project is an open source organization that houses and oversees development of Google Chrome.

See Section 5.1 for more information about MathML support in Webkit.

Chrome Mobile Platforms

The story is somewhat different for iOS – where Apple controls which Webkit platform is available to applications. On iOS, the system libraries used by applications for browsing support have shipped with MathML enabled with since October 2011 (iOS 5). Hence, versions of Chrome (and the Google app) running on recent versions of iOS provide nativeMathML rendering.

Using the fonts included with iOS 5, math symbol coverage in iOS Chrome is rather spotty. However, the Apple Symbol font was included in iOS 6 (released in September 2012). This font fills in many of the gaps in native MathML rendering under iOS. Installation of third party fonts, such as the STIX fonts, is not feasible under iOS. Section 5.1 provides additional information concerning mobile webkit math rendering. Table 7 summarizes math symbol coverage in the Apple Symbol fonts.

7 Math Fonts

Generally speaking, the quality of the math browsing experience is a function of the quality of the fonts available to the browser. Throughout much of the internet's history, widely available, high quality mathematical fonts have been a rare commodity. However, this situation is improving. The following sections examine both native math font support of the major operating system platforms and a variety of freely available math fonts that allow you to supplement native font support on your operating system of choice.

7.1 STIX Fonts

STIX is a consortium of scientific publishers (the AIP, IEEE, AMS, ACS, APS and Elsevier) that decided in 1995 to compose a common set of digital fonts to accurately display every character required for electronic publication of scientific and mathematical documents. After years of compiling required characters and amending Unicode specifications to comply with these needs, a set of fonts conforming to these specifications was released for testing on 31 October 2007. After a relatively short test period, the beta was closed in January 2008. After an extended period of refinement, the STIX fonts were released into production on 28 May 2010. The initial production release was under the SIL Open Font License, Version 1.1, which essentially makes the fonts royalty free, freely distributable, and freely modifiable (as long as the modified fonts don't use the original names).

Table 4 summarizes the coverage of STIX's "general" unicode mathematical character set. Unlike some mathematical fonts, STIX provides the traditional Roman, bold, italic, and bold italic font variants. As you might expect, these font variants primarily support text displayed in mathematical expressions rather that alternate forms of operators and symbols. In addition to it's "general" fonts, STIX also provides specialized fonts for drawing integrals and other mathematical symbols in a variety of sizes.

The STIX fonts are set in a serif type face that is intended to work well with Times-like fonts. This can lead to subtle font style mismatches when STIX math fonts are used with sans serif text fonts.

In total, 29 font files (open type) are included in Version 1.0 of the STIX distribution. At the time of the release, STIX indicated that it intends to repackage these fonts so that they are suitable for use with Microsoft Office (version 1.1) and LaTeX (version 1.2).

The beta release of STIX version 1.1 was on 6 October 2011. The production release of the STIX version 1.1 fonts was 23 February 2012. The version 1.1 fonts were packaged in two separate configurations:

- The original "STIX General" 29 file bundle, and
- a 5 file "STIX Word" bundle.

The "STIX Word" bundle consists of four text fonts (STIX-Bold, STIX-BoldItalic, STIX-Italic, STIX-Regular), and one symbol font (STIXMath-Regular).

One industrious soul, Kahled Hosny, has packaged the STIX 1.0 fonts as a set of open type fonts (xits-bold, xits-bolditalic, xits-italic, xits-regular, xits-math) suitable for Microsoft Office, XeLaTeX, and LuaTex. He refers to

Table 4: STIX General's Math Coverage

Unicode Block	Description	Coverage
Roman		
U+0370–U+03FF	Greek and Coptic	93 glyphs
U+2070–U+209F	Superscripts and Subscripts	1 glyph
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	61 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	43 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	128 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	254 glyphs
	Glyph Variants	995 glyphs
Bold		
U+0370–U+03FF	Greek and Coptic	93 glyphs
U+2070–U+209F	Superscripts and Subscripts	1 glyph
U+2200–U+22FF	Mathematical Operators	233 glyphs
U+2300–U+23FF	Miscellaneous Technical	15 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	4 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	10 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	57 glyphs
	Glyph Variants	293 glyphs
Italic		
U+0370–U+03FF	Greek and Coptic	92 glyphs
U+2200–U+22FF	Mathematical Operators	2 glyphs
	Glyph Variants	205 glyphs
Bold Italic		
U+0370–U+03FF	Greek and Coptic	92 glyphs
U+2200–U+22FF	Mathematical Operators	2 glyphs
	Glyph Variants	273 glyphs

his packaging as the XITS fonts due to STIX licensing restrictions on naming derivative works and his intended implementation of right to left mathematical typesetting capabilities. A XITS packaging of the STIX 1.1 beta fonts is also available.

The current TeX Live distribution ships with both the STIX and the XITS packaging of the fonts.

7.2 Windows Fonts

7.2.1 Cambria Math

When Microsoft released its Vista operating system on January 31, 2007, it contained several new ClearType fonts commissioned by Microsoft for the occasion. Most germane to the current discussion was the Cambria Math font. A more recent version of this font ships with Windows 7. For people running older Microsoft operating systems, Cambria Math is also installed along with Microsoft Office 2007, Microsoft Office 2010, Microsoft's PowerPoint Viewer, or Microsoft's Office Compatibility Pack.

Given that Cambria Math was initially designed to look best in mathematical documents laid out by Microsoft Office and that it lacks some of the symbols found in the STIX fonts, there has been some inevitable criticism of Cambria Math in typographic circles. However, in the real world, the fact that a highly legible mathematical font optimized for LCD display is available on a large (and growing) number of systems is a boon to publishing mathematics on the internet.

Table 5 summarizes the coverage of Cambria Math's mathematical character set. Cambria Math only provides an upright font variant. It is typically used in conjunction with the other members of Microsoft's Cambria font family. When used in this manner, partial coverage for the bold, italic, and bold italic math font variants is provided by other members of the Cambria family.

7.2.2 Legacy Windows Fonts

Bare bones, legacy Windows installations (pristine XP systems) usually get math symbols from the Lucida Sans Unicode font. As the name implies, this is a sans serif font (like Apple Symbols) with the potential for type style mismatches when used with serif text fonts. Several of the preinstalled fonts on legacy Windows systems have minimal math coverage but have decent coverage of Greek symbols.

Table 5: Cambria Collection's Math Coverage

Unicode Block	Description	Coverage
Cambria Math		
U+0370–U+03FF	Greek and Coptic	122 glyphs
U+1F00–U+1FFF	Greek Extended	233 glyphs
U+2070–U+209F	Superscripts and Subscripts	17 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	208 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	28 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	126 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	254 glyphs
	Glyph Variants	3639 glyphs
Cambria Bold		
U+0370–U+03FF	Greek and Coptic	75 glyphs
U+2070–U+209F	Superscripts and Subscripts	28 glyphs
U+2200–U+22FF	Mathematical Operators	14 glyphs
	Glyph Variants (not all math)	358 glyphs
Cambria Italic		
U+0370–U+03FF	Greek and Coptic	75 glyphs
U+2070–U+209F	Superscripts and Subscripts	28 glyphs
U+2200–U+22FF	Mathematical Operators	14 glyphs
	Glyph Variants (not all math)	348 glyphs
Cambria Bold Italic		
U+0370–U+03FF	Greek and Coptic	75 glyphs
U+2070–U+209F	Superscripts and Subscripts	28 glyphs
U+2200–U+22FF	Mathematical Operators	14 glyphs
	Glyph Variants (not all math)	361 glyphs

Table 6: Lucida Sans Unicode's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	78 glyphs
U+2070–U+209F	Superscripts and Subscripts	28 glyphs
U+2200–U+22FF	Mathematical Operators	242 glyphs
U+2300–U+23FF	Miscellaneous Technical	10 glyphs

7.3 Apple Fonts

As of OSX 10.7 (Lion), released 20 July 2011, Apple desktop operating systems have shipped with the STIX fonts installed. OS X 10.7 included Version 1.0 of the STIX fonts. Hence, modern Apple systems provide a comprehensive, world-class, mathematical character set. The STIX fonts are set in a serif type face that is intended to work well with Times-like fonts. This can lead to subtle font style mismatches when STIX math fonts are used with sans serif text fonts. The STIX fonts are described in detail in Section 7.1 of this document.

7.3.1 Apple Symbols

The Apple Symbols font has provided support for an extensive mathematical character set since OSX 10.5 (Leopard), released 26 October 2007. Table 7 summarizes the coverage of Apple Symbols' mathematical character set.

Table 7: Apple Symbols' Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	79 glyphs
U+1F00–U+1FFF	Greek Extended	14 glyphs
U+2070–U+209F	Superscripts and Subscripts	29 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	232 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	37 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	128 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	251 glyphs
U+1D400–U+1D7FF	Mathematical Alphanumeric Symbols	10 glyphs
	Glyph Variants (not all math related)	1163 glyphs

Apple Symbols is a sans serif font face. This can lead to font style mismatches when serif text fonts are used with Apple Symbols math fonts.

7.3.2 Other Apple Fonts

Many additional fonts installed by default on modern OS X systems provide rudimentary mathematical symbol coverage and extensive coverage of the Greek alphabet. Table 8 summarizes the coverage of one such font, Apple's Times font (originally developed by Linotype).

Table 8: Apple Times' Math Coverage

Unicode Block	Description	Coverage
U+0374–U+03F3	Greek and Coptic	78 glyphs
U+1F00–U+1FFE	Greek Extended	233 glyphs
U+2200–U+22FF	Mathematical Operators	12 glyphs
	Glyph Variants (not all math related)	169 glyphs

7.4 Linux Fonts

Although this section is entitled "Linux Fonts", it could just as easily be called "Free Fonts" because all the fonts we discuss are distributed without charge and are readily available in formats that are amenable to any major operating system. However, various combinations of these fonts are often preinstalled by Linux distributions.

The default font set of a modern Linux distribution (if there is such a thing) provides sufficient mathematical notation and symbol support to provide a decent mathematics viewing experience "out of the box". Furthermore, virtually all of the fonts distributed with Linux provide their own glyphs for Greek characters.

Font usage statistics cited in this section were as of April 2012. They were compiled by code style.

7.4.1 DejaVu Fonts

The most common Linux fonts containing significant math coverage are the DejaVu fonts. The DejaVu font family consists of three typefaces: DejaVu Sans, DejaVu Serif, and DejaVu Mono. Both the DejaVu Sans and DejaVu Serif fonts are encountered on 97 percent of Linux desktops. The accompanying tables (Table 9 and Table 10 respectively) summarize their coverage of mathematical notation.

It is also worth noting that the DejaVu fonts (like the STIX fonts) have bold, italic, and bold italic variants which also provide significant math coverage. For the sake of brevity, we will spare you the details. Suffice it to say, the math coverage in these variants is less extensive than their upright counterparts, and roughly equivalent to their STIX counterparts.

Table 9: DejaVu Sans' Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	134 glyphs
U+1F00–U+1FFF	Greek Extended	223 glyphs
U+2070–U+209F	Superscripts and Subscripts	42 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	65 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	9 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	13 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	72 glyphs

Table 10: DejaVu Serif's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	120 glyphs
U+1F00–U+1FFF	Greek Extended	244 glyphs
U+2070–U+209F	Superscripts and Subscripts	42 glyphs
U+2100–U+214F	Letterlike Symbols	32 glyphs
U+2200–U+22FF	Mathematical Operators	100 glyphs
U+2300–U+23FF	Miscellaneous Technical	35 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	5 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	1 glyph
U+2A00–U+2AFF	Supplemental Mathematical Operators	4 glyphs
U+1D400–U+1D7FF	Mathematical Alphanumeric Symbols	55 glyphs

7.4.2 GNU Free Fonts

The GNU FreeFont family consists of three typefaces: FreeSans, FreeSerif, and FreeMono. The fonts contain extensive math coverage and are found on approximately 85 percent of Linux desktop installations. Table 11 summarizes the mathematical coverage of one of the fonts, FreeSerif. The other faces have similar coverage. Most of the glyphs used by LaTeX are available in the GNU FreeFonts.

The GNU FreeFonts, like the STIX fonts, have bold, italic, and bold italic variants which also provide significant math coverage. As is typically the case, the math character set of these variants is less extensive than their upright coun-

Table 11: GNU FreeSerif's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	134 glyphs
U+1F00–U+1FFF	Greek Extended	233 glyphs
U+2070–U+209F	Superscripts and Subscripts	34 glyphs
U+2100–U+214F	Letterlike Symbols	77 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	113 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	40 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	68 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	27 glyphs
U+1D400–U+1D7FF	Mathematical Alphanumeric Symbols	996 glyphs

terparts.

7.4.3 Liberation fonts

In 2007, Red Hat commissioned the Ascender Corp font foundry to create a set of fonts, dubbed the Liberation fonts – Liberation Sans, Liberation Serif, and Liberation Mono – that are metric equivalents of the common Microsoft fonts: Times New Roman, Arial, and Courier New. Metric equivalence implies that the Liberation fonts have identical horizontal spacing to the Microsoft fonts. When Liberation fonts are substituted for the Microsoft fonts, a line of text is laid out in an identical manner. Red Hat's motivation for this "act of generosity" was Microsoft's refusal to license its popular fonts on the Linux platform, which caused inconsistent cross platform display of office documents.

The Liberation fonts have recently (July 2012) received a facelift by the Fedora Project. The revised fonts, dubbed Liberation 2.0, are based on Google's Chrome OS Croscore fonts (which were, in turn, based on the original Liberation fonts). The main impetus for this change was to resolve issues with the licensing terms of the original Liberation fonts, which impeded "community based" font enhancements.

In any event, both flavors of the Liberation fonts provide poor mathematical symbol coverage. Table 12 summarizes the coverage of the Liberation 2.0 Serif font, which is known as Tinos in the Chrome OS/Crosscore world. Mathematical coverage is equally spotty in the Liberation Sans (Armino) and Liberation Mono (Cousine) typefaces.

Table 12: Liberation Serif's Math Coverage

Unicode Block	Description	Coverage
U+0374–U+03F3	Greek and Coptic	127 glyphs
U+1F00–U+1FFE	Greek Extended	233 glyphs
U+2200–U+22FF	Mathematical Operators	17 glyphs

For the record, the Liberation fonts (first version) are installed on 89 percent of Linux desktops.

7.4.4 Ubuntu Fonts

In 2010, the Dalton Maag type foundry delivered new sans serif typefaces to Canonical for use as the signature font for its Ubuntu Linux distribution. These fonts – called simply the Ubuntu Font Family - have limited math symbol coverage. As with most Linux fonts, Ubuntu has significant coverage of Greek characters. In math coverage, these fonts are similar to the Liberation fonts or the Postscript fonts. Table 13 summarizes the coverage of the Ubuntu Regular font.

Table 13: Ubuntu Font's Math Coverage

Unicode Block	Description	Coverage
U+0374–U+03F3	Greek and Coptic	71 glyphs
U+1F00–U+1FFE	Greek Extended	233 glyphs
U+2200–U+22FF	Mathematical Operators	14 glyphs
	Private Area (several math related)	49 glyphs
	Glyph Variants (most not math related)	72 glyphs

The Ubuntu fonts are installed on 63 percent of Linux desktops.

7.4.5 PostScript Fonts

When Adobe introduced Postscript in 1984, they defined 35 core fonts (in 10 typefaces) that must be present in all Postscript interpreters. The Ghostscript fonts are commercial quality implementations of the Postscript core fonts that were donated to the Ghostscript project in 1996 by the URW++ Design &

Development type foundry of Hamburg. The Tex Gyre fonts are a recent incarnation of the "Ghostscript" fonts that are packaged and extended by the Polish type foundry GUST e-font. They are discussed in Section 7.5.3.

The relationship between the original Postscript core fonts, their Ghostscript counterparts, and their more recent Tex Gyre implementation is described in Table 14.

Table 14: PostScript Core Font Mapping

Postscript Core Font	Ghostscript Font	Open Type Font
ITC Bookman[1]	URW Bookman L	Tex Gyre Bonum
New Century Schoolbook[2]	URW Century Schoolbook L	Tex Gyre Schola
ITC Avant Garde Gothic[3]	URW Gothic L	Tex Gyre Adventor
Courier[4]	URW Nimbus Mono L	Tex Gyre Cursor
Times[5]	URW Nimbus Roman No9 L	Tex Gyre Termes
Helvetica[6]	URW Nimbus Sans L	Tex Gyre Heros
Palatino[7]	URW Palladio L	Tex Gyre Pagella
n/a	n/a	Tex Gyre Pagella Math
Symbol	Standard Symbol L	n/a
Zapf Chancery	URW Chancery L	n/a
Zapf Dingbats	Dingbats	n/a

[1] Designed by Alexander Phemister in 1860. (Miller & Richard)
[2] Designed by Morris Fuller Benton in 1919. (ATF)
[3] Designed by Herb Lubalin and Tom Carnase in 1970. (ITC)
[4] Designed by Howard G. (Bud) Kettler in 1955. (IBM)
[5] Designed by Starling Burgess and Victor Lardent in 1932. (Monotype)
[6] Designed by Max Miedinger and Eduard Hoffman in 1957. (Haas)
[7] Designed by Hermann Zapf in the 1940's. (Stempel)

In general, these fonts alone do not provide adequate coverage for mathematical publication. They were not designed for publishing advanced mathematics and must be augmented by one of the more comprehensive math fonts. However, it should be noted that the Ghostscript "Standard Symbol L" (Table 15) does provide basic math coverage. Furthermore, the recent "Tex Gyre Pagella Math" extension (Table 18) provides comprehensive math support for Tex Gyre's Paagella (Palatino) font.

The Ghostscript fonts are among the most universal of the Linux fonts. In a recent survey – URW Chancery L, Century Schoolbook L, URW Gothic L, Nimbus Sans L, URW Bookman L, URW Palladio L, Nimbus Mono L, Nimbus

Table 15: Standard Symbol L's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	48 glyphs
U+2000–U+206F	General Punctuation	3 glyphs
U+2200–U+22FF	Mathematical Operators	39 glyphs
U+2300–U+23FF	Miscellaneous Technical	4 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	20 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	26 glyphs
	Private Area (most math related)	37 glyphs
	Glyph Variants (most not math related)	4 glyphs

Roman No9 L – i.e. the Ghostscript fonts, were installed on more than 98% of the monitored Linux desktops.

7.4.6 Font Sources

The fonts discussed in this section are packaged by virtually all Linux distributions, even if they are not loaded onto the system during a distribution's default installation procedure. Hence, most Linux users can, and probably should, install these fonts through their distribution's package management system.

We referenced the upstream source of each font during our discussion. The upstream font publishers package their fonts in an operating system neutral manner. If the proper procedures are followed, fonts obtained from these sources can be installed on any desktop platform.

Various commercial sites also provide access to common Linux fonts packaged in a platform independent manner. One such site, Font Squirrel, provides vendor neutral access to many common free fonts.

7.5 TeX Fonts

As you might have observed from the preceding sections, the major commercial type foundries have not expended much effort on developing mathematical typefaces. From time to time, software houses will commission the development of math fonts, but the type shops rarely develop mathematical fonts for their own purposes. This is true for the obvious reason – scientific/mathematical publishing is a niche market that, for the most part, has developed its own publication solutions.

For the last 25 years, Donald Knuth's TeX software, and its offspring, have played a major role in publishing mathematically oriented documents. TeX was originally developed to typeset technical documents and pays particular attention to the subtleties of mathematical layout. Many scientific journals accept articles for publication authored in various TeX-centric formats.

Due to this heritage, modern TeX distributions provide a variety of mathematical symbol fonts. The traditional math fonts and packaging formats utilized by TeX can, with the proper massaging, be used to display math in browsers. However, discussion of these fonts and techniques for accomplishing this task are an arcane topic outside the scope of this document. In all likelihood, you already know how to use traditional TeX fonts with your browser if it is the optimal way for you to get the job done.

However, some of the more recent variants of TeX – particularly XeTeX, LuaTeX, and their offspring – utilize fonts implemented in modern Unicode character sets and OpenType formats. These fonts can be easily used on current desktop operating systems in non-TeX environments.

7.5.1 Asana Math

The Asana Math font was developed by Apostolos Syropoulos for the TeX project. It is intended to support font processing features available in XeTeX and LuaTeX. Asana Math is a Paltino compatible typeface and is packaged in OpenType format. It contains all mathematical symbols included in current version of the Unicode specification. Its OpenType format is compatible with recent releases of Microsoft Word. As such, it can serve as a Cambria Math replacement. As seen in Section 2, recent versions of Firefox support Asana Math for native MathML rendering.

Table 16 summarizes the mathematical symbol coverage of Asana-Math.

7.5.2 Latin Modern

The Latin Modern font family is a recent incarnation of Donald Knuth's Computer Modern fonts. They are produced by the Polish type foundry GUST e-font. The publishers bundle the these fonts in two packages: Latin Modern and Latin Modern Math. The fonts are implemented in the Unicode character set and packaged in OpenType formats.

Table 17 summarizes the mathematical symbol coverage of the Latin Modern Math font. As you might assume, this font family contains all math symbols required for traditional TeX math publication.

Table 16: Asana-Math's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	83 glyphs
U+2000–U+206F	General Punctuation	33 glyphs
U+2070–U+209F	Superscripts and Subscripts	34 glyphs
U+2100–U+214F	Letterlike Symbols	71 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	53 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	45 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	128 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	256 glyphs
U+1D400–U+1D7FF	Mathematical Alphanumeric Symbols	996 glyphs
	Supplementary Private Use Area B	654 glyphs

Table 17: Latin Modern's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	54 glyphs
U+2000–U+206F	General Punctuation	26 glyphs
U+2100–U+214F	Letterlike Symbols	42 glyphs
U+2200–U+22FF	Mathematical Operators	172 glyphs
U+2300–U+23FF	Miscellaneous Technical	40 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	7 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	30 glyphs
U+1D400–U+1D7FF	Mathematical Alphanumeric Symbols	872 glyphs

7.5.3 TeX Gyre

The TeX Gyre font families are modern incarnations of the Ghostscript fonts (which are, in turn, implementations of PostScript's core fonts). Section 7.4.5 provides additional information on this subject.

The TeX Gyre fonts are produced by the Polish type foundry GUST e-font. They are implemented in the Unicode character set and packaged in an OpenType format. The publishers bundle these fonts into eight typefaces intended for nontechnical content: Adventor, Bonum, Chorus, Cursor, Heros, Pagella, Schola, and Termes. One mathematical font, TeX Gyre Pagella Math, is available. The Pagella typeface is TeX Gyre's Palatino equivalent. Obviously, Pagella

Math is a Palatino compatible math symbol font.

Table 17 summarizes the mathematical symbol coverage of the TeX Gyre Pagella Math font.

Table 18: Pagella-Math's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	55 glyphs
U+2000–U+206F	General Punctuation	33 glyphs
U+2200–U+22FF	Mathematical Operators	237 glyphs
U+2300–U+23FF	Miscellaneous Technical	50 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	20 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	26 glyphs
U+1D400–U+1D7FF	Mathematical Alphanumeric Symbols	989 glyphs
	Glyph Variants (many not math related)	1901 glyphs

7.6 Other Math Fonts

Several recently developed mathematical fonts also deserve mention. Although the STIX and Cambria fonts are our recommended solutions to the mathematical font problem, there are valid reasons to consider additional options. All fonts in this section are freely distributed.

7.6.1 MathJax Fonts

The MathJax fonts are derived from Donald Knuth's Computer Modern fonts. They are provided in a variety of formats (eot, otf, svg, and woff) that are suitable for download on demand service from the web. We are not aware of any independent packaging of these fonts. You must download the entire MathJax distribution and extract the fonts manually to install them locally.

This state of affairs is not too surprising since the MathJax fonts are intended for use as web fonts. MathJax provides the fonts through its content delivery network for remote access via @font-face CSS directives.

We mention them primarily because Firefox 13+ supports local access to the MathJax fonts. In fact, the MathJax fonts are now the Firefox's highest priority default math font. This appears to be an intermediate step to providing native MathML support for remote MathJax web fonts in Firefox.

7.6.2 Symbola

The Symbola font by George Douros is a pretty good unicode-based math font that provides extensive math coverage in a serif font face. It is available at the Greek site Unicode Fonts for Ancient Scripts. It is also prepackaged for many Linux distributions. Symbola's biggest flaw – in the current context – is that it does not contain a bold font variant (at least in a form that Firefox can use). This results in mixed font faces appearing in mathematical expressions that contain both bold and regular font weights. Symbola's coverage of mathematical characters is summarized in Table 19.

Table 19: Symbola's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	135 glyphs
U+2070–U+209F	Superscripts and Subscripts	48 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	256 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	48 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	128 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	256 glyphs
	Glyph Variants (not all math)	1353 glyphs

7.6.3 Irianis ADF Math

Irianis ADF Math is a font created by the Arkandis Digital Foundry. Irianis Math was designed to augment ADF's Irianis font family, much like Cambria Math enhances the Cambria font family. Irianis Math, like many of the other mathematical fonts that have been examined, is a serif typeface. However, like Symbola, Irianis Math suffers from lack of matching bold characters accessible by Firefox (unless it is used in conjunction with other members of the Irianis family — a highly unlikely scenario in the current web design environment). Its coverage of mathematical characters is summarized in Table 20.

The lack of bold math font variants mentioned in the preceding discussion can be corrected by tweaking Firefox's preferences. However, these procedures are outside the scope of this document and typically not of interest to a casual observer of mathematics.

Table 20: Irianis ADF Math's Math Coverage

Unicode Block	Description	Coverage
U+0370–U+03FF	Greek and Coptic	127 glyphs
U+2070–U+209F	Superscripts and Subscripts	22 glyphs
U+2200–U+22FF	Mathematical Operators	256 glyphs
U+2300–U+23FF	Miscellaneous Technical	37 glyphs
U+27C0–U+27EF	Miscellaneous Mathematical Symbols-A	7 glyphs
U+2980–U+29FF	Miscellaneous Mathematical Symbols-B	13 glyphs
U+2A00–U+2AFF	Supplemental Mathematical Operators	85 glyphs
	Glyph Variants	865 glyphs

7.7 Font Rendering by Browser

Table 21 summarizes the quality of mathematics output, by font, for various combinations of platforms and browsers. Three things to keep in mind when examining this table:

1) We are not evaluating the overall quality of the MathML layout, only the availability of reasonably compatible font styles and how nicely the fonts are rendered. That is, is there a mixture of serif and sans serif text in a single expression? Are the characters sharp and clear? Are the characters blurry? Do they appear thin or stretched? For example, the STIX fonts are rated as good quality when rendered by Safari on OS X — even though our CSS based MathML rendering with Safari can not adequately handle "stretchy" operators.

2) The font's appearance on an LCD display is evaluated. It does not consider printed page or CRT rendition quality.

3) The evaluation is completely subjective, based solely on our opinion. Others may feel differently. We have, however, actually observed a variety of test pages under each of these configurations.

Design Science's Euclid fonts were tested on Windows 7 by installing an old version of the software (i.e. MathPlayer 2.1d) that can only use MathPlayer's native font set. The current release of MathPlayer uses Cambria Math or STIX fonts, when they are available, in lieu of Euclid.

8 Viewing Math at Vismor.com

Mathematical content on this site is published using presentation MathML. If you are browsing this site with a recent version of any major browser, you should

Table 21: Evaluation of Math Font Rendering On LCD Devices

Font	Platform	Browser	Quality
STIX	Windows 7	IE 8 / MathPlayer	Good
		Firefox 8.01	Good
		Opera 11.60	Good
		Safari 5.1	Adequate
		Chrome 16.0.912.63	Good
	OS X 10.7.2	Safari 5.1	Good
		Firefox 8.01	Good
		Chrome 16.0.912.63	Good
		Opera 11.60	Good
	Ubuntu 11.10	Firefox 8.0	Good
		Chrome 16.0.912.63	Good
Cambria Math	Windows 7	IE 8 / MathPlayer	Good
		Firefox 8.01	Good
		Safari 5.1	Good
		Chrome 16.0.912.63	Good
		Opera 11.60	Good
OS X Native (Apple Symbols)	OS X 10.7.2	Safari 5.1	Good
		Firefox 8.01	Good
		Chrome 16.0.912.63	Good
		Opera 11.60	Good
Linux Native (DejaVu Family)	Ubuntu 11.10	Firefox 8.0	Good
		Chrome 16.0.912.63	Good
Euclid (Design Science)	Windows 7	IE 8 / MathPlayer	Adequate
Lucida Sans Unicode	Windows 7	Firefox 8.01	Adequate
Symbola	OS X 10.7.2	Firefox 8.01	Adequate
	Ubuntu 11.10	Firefox 8.0	Adequate
Irianis ADF Math	OS X 10.7.2	Firefox 8.01	Adequate
	Ubuntu 11.10	Firefox 8.01	Adequate

have a pretty good math viewing experience. We use MathJax to render mathematical expressions. MathJax allows browsers with native MathML support (i.e. Firefox) to process the MathML internally, which increases the rendering speed. Otherwise, it uses javascript to render mathematical content.

MathJax provides its own web font for math rendering, so no font installations are required on the browsing device. If you have the STIX fonts installed locally, MathJax will use them. This will speed up math rendering somewhat, since the web fonts don't have to download. If you are using Firefox, several other math fonts (including Cambria) are recognized by this site and are used if they are locally available.

A note concerning Internet Explorer 6. As is indicated on our home page, we haven't used IE6 for many years, we don't target the IE6 platform, and can't, in general, vouch for this site's rendering on that platform. However, MathJax does render mathematical expressions under IE6. Recent, cursory tests indicate a satisfactory browsing experience with Internet Explorer 6.

If you are constrained from using one of the many functional viewing options by your organization's IT policies, or you have philosophical objections to javascript, sorry. When all else fails, this site's document download area contains paginated, typeset PDF versions of all the articles housed in our Documents section.