

# The **empheq** package<sup>\*</sup> Emphasizing equations in L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub><sup>†</sup>

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## Abstract

The **empheq** package automatically detects several **amsmath** environments and the size of the displayed math material. The user interface makes it easy to add various kinds of visual markup to these equations.

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## 1 Introduction

Users who have wanted to put a system of equations inside boxes has hitherto been forced to use the features of **fancybox** or the `\boxed` command of **amsmath**. Both alternatives have serious limitations though. **fancybox** allows only `eqnarray`-style equations and at the end of the day they aren't all that pretty. Most mathematical typesetting in L<sup>A</sup>T<sub>E</sub>X is done with the aid of **amsmath** anyway, but it only offers the single line quick-fix `\boxed`. What we really want is something that will enable us to do something along the likes of this:

$$\boxed{\tilde{S} = 1 \Rightarrow \begin{cases} a = \int_{-2}^3 tb^t dt & \text{and} \\ c = d - a \end{cases}} \quad (1a)$$

(1b)

---

<sup>\*</sup>This file has version number v0.7, last revised 2003/05/11.

<sup>†</sup>Thanks to Lars Madsen for asking for the subtle feature that evolved into this package.

As you can see, **empheq** can do all the tricks the **cases** package by Donald Arseneau can do and more. It even supports **subequations**—as shown in equations (1a) and (1b)—from **amsmath** without complaining.

In order to combine the best of two worlds the **empheq** package tries to take advantage of the widespread features of **amsmath**. As it should be well known if you read this, **amsmath** has amongst its arsenal of structures **align**, **gather**, **alignat** and **multline**. **empheq** works with these as well as their starred variants.

“But what about **equation**?” you say. **equation** is (in my opinion) merely a poor man’s **gather**. If you really want to use **empheq**’s features on a one-liner (no pun intended) go with **gather**. Anyway the real goal of this package is to do nifty tricks with multi line equations . . .

## 2 Examples

Any options given to **empheq** is passed on to **amsmath**, thus the line

```
\usepackage[⟨options⟩]{empheq}
```

will load **amsmath** with exactly those options. **empheq** doesn’t redefine anything so to use it in an existing document you need only replace **amsmath** with **empheq**—no harm done.

**empheq** is *really* easy to use; you simply put an **empheq** environment around your **amsmath** environment:

```
\begin{empheq}
  \begin{align}
    E&=mc^2 \\
    Y&= \sum_{n=1}^{\infty} \frac{1}{n^2}
  \end{align}
\end{empheq}
```

$$E = mc^2 \tag{2}$$

$$Y = \sum_{n=1}^{\infty} \frac{1}{n^2} \tag{3}$$

Impressed? No? Well then I guess it’s about time I told you about the *optional* argument of the **empheq** environment. It allows you control what material to put on either side of the math and the sort of box to go around it all. That means that we can say

```
\begin{empheq}[boxtype=\fbox]
  \begin{align}
    E&=mc^2 \\
    Y&= \sum_{n=1}^{\infty} \frac{1}{n^2}
  \end{align}
\end{empheq}
```

to obtain the display

$$\boxed{E = mc^2} \tag{4}$$

$$\boxed{Y = \sum_{n=1}^{\infty} \frac{1}{n^2}} \tag{5}$$

This requires the use of the `keyval` package from the tools bundle, which is undoubtedly installed on your system. When using the `keyval` package there are a few things we need to keep in mind. In mathematical typesetting ‘=’ and ‘,’ are quite frequently used, thus requiring the user to enclose them in braces:

```
\begin{empheq}[boxtype=\fbox,
  Left={\mathbf{(a,b)=(c,i)} \rightarrow \empheqlbrace}]
\begin{alignat}{2}
(a,b)&= (\cos^a c, \tan^b i) \quad \quad \quad \text{for } i > 1 \\
(a,b)&= (\arccos x^a, \arctan i^b) \quad \quad \quad \text{for } i \leq 1
\end{alignat}
\end{empheq}
```

$$(a,b) = (c,i) \Rightarrow \begin{cases} (a,b) = (\cos^a c, \tan^b i) & \text{for } i > 1 \\ (a,b) = (\arccos x^a, \arctan i^b) & \text{for } i \leq 1 \end{cases} \quad (6)$$

The same with `cases` from `amsmath` for comparison:

$$(a,b) = (c,i) \Rightarrow \begin{cases} (a,b) = (\cos^a c, \tan^b i) & \text{for } i > 1 \\ (a,b) = (\arccos x^a, \arctan i^b) & \text{for } i \leq 1 \end{cases} \quad (7)$$

Notice that `cases` uses an array for the conditions, so you have to force `\displaystyle` yourself. This is not needed with `empheq` as you’re already using a `\displaystyle` environment such as `gather` etc.

Observe what can be done if we replace `\fbox` with another framed box and add some space on all sides:

```
\definecolor{lightblue}{rgb}{.8, .8, 1}
\begin{empheq}[boxtype={\setlength{\fboxsep}{10pt}%
  \colorbox{lightblue}},
  Right={\empheqrbrace \beta}]
.
.
.
\end{empheq}
```

$$\left. \begin{aligned} a &= \int_{-2}^3 t b^t dt \\ c &= d - a \end{aligned} \right\} \beta \quad (8)$$

As a convenience for the user, it is also possible to declare delimiters with the commands `\DeclareRightDelimiter{<delimiter>}` and its companion `\DeclareLeftDelimiter{<delimiter>}`. For instance the commands `\DeclareRightDelimiter{\rangle}` defines `\empheqrangle` and `\DeclareLeftDelimiter{\langle}` defines `\empheqlangle`. The usage is simple.

```
\begin{empheq}[Right=\empheqrangle,
  Left=\empheqlangle]
```

```

\begin{gather}
a=b \\
c=d
\end{gather}
\end{empheq}

```

$$\left\langle a = b \right\rangle \tag{10}$$

$$\left\langle c = d \right\rangle \tag{11}$$

`\DeclareRightDelimiter` and its companion have an optional argument which controls spacing (default is a negative thinspace), but beware: It will simply overwrite the original definition and it might not look all that pretty as the following example shows:

```

\DeclareRightDelimiter[\>]{\rangle}
\DeclareLeftDelimiter[\mkern-10mu]{\langle}

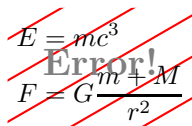
```

$$\rangle a = b \tag{12}$$

$$\langle c = d \tag{13}$$

These examples will have given you a glimpse of the possibilities `empheq` offers. In particular the commands `\empheqlbrace` and `\empheqrbrace` produce braces just tall enough to encompass the display. You can of course use `\big...` delimiters if you want.

If you want you can even create your own box and use it with `empheq`. In the following silly example I have created `\ErrorBox` with `PSTricks` to achieve a disturbing effect:



Remember one thing when creating your own box: Make it symmetrical.

## 3 Implementation

### 3.1 Strategy

Whenever `amsmath` is typesetting a display environment it actually does it twice; the first for the “measuring” phase and the second for the “production” phase. The `empheq` package uses a similar approach:

- Collects the input in a token register for later use.
- Typesets the input in the background and checks certain values to determine the kind of math structure you just typed.
- Based on the given information, alterations are made to various lengths.
- Then the equations are typeset again and stored in a box for easy retrieval.

- Finally the saved box is put into a box of the user's liking. Any material to the right or left of the math structure (added with the `Left` and `Right` keys) are put into the box as well.

Assuming we have found out which `amsmath` structure the user typed, there are still a few things we need to sort out before we proceed.

First of all the equation number should still be aligned with those of the ordinary math structures, which is a problem as soon as the additions we make to the left and the right differ—presumably they will. And when we are in `fleqn` mode, we should make sure that the structure is shifted just enough to the right so that all equations still are right adjusted. Therefore we need to make clever changes to the line width to make sure the margins come out right.

Then assuming we have overcome all of this there's still the final step: Placing the math structure in the appropriate box at the appropriate position. Once again we need to do some manipulation with spacing to make it just right.

### 3.2 Preliminary actions

To avoid clashes with other packages, all private commands will contain the sequence `@emphEQ@`.

We will need `amsmath` of course and it would be nice if `empheq` would recognize all the `amsmath` options so we make that happen. To make sure the user has an updated system the newest release of `amsmath` is required.

`calc` is used to increase readability of the code (thus making it *far* easier to write too) and `keyval` is used for user friendliness. They should all be part of any  $\text{\LaTeX}$  system.

```
1 %<*package>
2 \RequirePackageWithOptions{amsmath}[2000/07/18]
3 \RequirePackage{calc,keyval}
```

```
\if@emphEQ@FLL There are four available layouts for mathematical displays: [fleqn,leqno] (FLL),
\if@emphEQ@FLR [fleqn,reqno] (FLR), [leqno] (L) and [reqno] (R). We create four  $\text{\TeX}$  con-
\if@emphEQ@L ditionals to make the algorithm easier to read as well as to speed up things a
\if@emphEQ@R bit.
```

```
4 \newif\if@emphEQ@FLL
5 \newif\if@emphEQ@FLR
6 \newif\if@emphEQ@L
7 \newif\if@emphEQ@R
```

We then perform a simple test to determine the current mode.

```
8 \if@fleqn
9   \iftagsleft@
10    \@emphEQ@FLLtrue
11  \else
12    \@emphEQ@FLRtrue
13  \fi
14 \else
15   \iftagsleft@
16    \@emphEQ@Ltrue
17  \else
18    \@emphEQ@Rtrue
19  \fi
```

20 \fi

\if@emphEQ@gather \if@emphEQ@align \if@emphEQ@alignat \if@emphEQ@multline \if@emphEQ@NoNumEq

Since we're going to determinate which math structure the user has input, we create some more conditionals to improve speed and readability. Furthermore it will show crucial to know whether or not the equation counter has been stepped since `multline*` and `multline` don't have exactly the same structure.

21 \newif\if@emphEQ@gather  
22 \newif\if@emphEQ@align  
23 \newif\if@emphEQ@alignat  
24 \newif\if@emphEQ@multline  
25 \newif\if@emphEQ@NoNumEq

\@emphEQ@Box \@emphEQ@BoxWidth \@emphEQ@displaywidth \@emphEQ@mathbody

We need a single box to hold the math structure, a length so we can remember the size of the displayed math for later use and a token register for the math environment.

26 \newsavebox{\@emphEQ@Box}  
27 \newlength{\@emphEQ@BoxWidth}  
28 \newlength{\@emphEQ@displaywidth}  
29 \newtoks\@emphEQ@mathbody

\@emphEQ@Left \@emphEQ@Right \@emphEQ@lwd \@emphEQ@rwd

Here are some vital parts: The additional informations the user want to display on either side of the math structure are saved by `\@emphEQ@Left` and `\@emphEQ@Right` and `\@emphEQ@lwd` and `\@emphEQ@rwd` measure the width of them for later use.

30 \newcommand{\@emphEQ@Left}{}\br/>31 \newcommand{\@emphEQ@Right}{}\br/>32 \newlength{\@emphEQ@lwd}  
33 \newlength{\@emphEQ@rwd}

\@emphEQ@boxtype \@emphEQ@boxtypelength \@emphEQ@shadowbox \if@emphEQ@shadowbox

To make sure spacing is right when putting the math structure into a box, we need to know what kind of box it is: The width is extremely important. Often we will have to subtract or add half of an empty (but *not* zero-width) box' width to certain lengths. When using an `\fbox` or `\colorbox` this is just `\fboxrule+\fboxsep`, but when using say, `\doublebox` of `fancybox` fame the necessity arises. `fancybox` also defines `\shadowbox` which needs extra taking care of, since it's asymmetrical unlike most other framed boxes.

Thus we test whether or not `fancybox` has been loaded at the beginning of the document. If it has, we don't lift a finger; if it hasn't, we let `\fbox` be an alias for `\shadowbox`. Then we create a private version of `\shadowbox` for testing purposes and a conditional for the algorithm.

34 \newcommand{\@emphEQ@boxtype}{}\br/>35 \newlength{\@emphEQ@boxtypelength}  
36 \AtBeginDocument{%  
37 \ifpackageloaded{fancybox}{}{%  
38 \let\shadowbox=\fbox}}  
39 \newcommand{\@emphEQ@shadowbox}{\shadowbox}  
40 \newif\if@emphEQ@shadowbox

\@emphEQ@templength @emphEQ@EqCtr

We are almost ready to go. We only need two temporary little helpers: one length and one counter.

41 \newlength{\@emphEQ@templength}  
42 \newcounter{@emphEQ@EqCtr}

### 3.2.1 Faraway, so close

`\@emphEQ@CloseEnough` When determining the display type we will occasionally have to check if an equation of the form

$$\text{\totwidth@} - \text{\tagshift@} = \text{\linewidth}$$

is true. However small rounding errors *can* occur in `\alignat` so we would rather see if the equation

$$-\delta < \text{\totwidth@} - \text{\tagshift@} - \text{\linewidth} < \delta$$

holds for some sufficiently small  $\delta > 0$  pt. I have used  $\delta = 5$  sp.

```
43 \newcommand{\@emphEQ@CloseEnough}[4]{%
44   \setlength{\@tempdima}{#1-#2}%
45   \ifdim\@tempdima>-5sp
46     \ifdim\@tempdima<5sp
47       #3
48     \else
49       #4
50     \fi
51   \else
52     #4
53   \fi
54 }
```

### 3.3 Saving the input

`\@emphEQ@MainEnv` We start out by saving the input in the token register `\@emphEQ@mathbody`. The method is heavily inspired by `tabularx` ... No need to copy the words of David Carlisle here—his code will do!

```
\end@emphEQ@MainEnv
\@emphEQ@get@body
\@emphEQ@findend
\@emphEQ@EnvName
55 \def\@emphEQ@MainEnv{%
56   \edef\@emphEQ@EnvName{\@currentenv}%
57   {\ifnum0=} \fi
58   \@emphEQ@mathbody{\@emphEQ@get@body
59 }
60 \let\end@emphEQ@MainEnv\relax
61 \long\def\@emphEQ@get@body#1\end{%
62   \@emphEQ@mathbody\expandafter{\the\@emphEQ@mathbody #1}%
63   \@emphEQ@findend
64 }
65 \def\@emphEQ@findend#1{%
66   \def\@tempa{#1}%
67   \ifx\@tempa\@emphEQ@EnvName
68     \expandafter\@emphEQ@PostProcess
69   \else
70     \@emphEQ@mathbody\expandafter{\the\@emphEQ@mathbody\end{#1}}%
71     \expandafter\@emphEQ@get@body
72   \fi
73 }
74 \def\@emphEQ@EnvName{\@emphEQ@MainEnv}
```

`@emphEQ@PostProcess` Now we can go on with the post processing, which is the real workhorse in this package. The first job is to test if we're using a `\shadowbox` and then we set some

amsmath dimensions to zero—amsmath doesn't do this by itself, and for that we can be thankful. Otherwise you wouldn't be reading this now ;-)

```

75 \newcommand*{\@emphEQ@PostProcess}{%
76   \ifx\@emphEQ@boxtype\@emphEQ@shadowbox
77     \@emphEQ@shadowboxtrue
78   \else
79     \@emphEQ@shadowboxfalse
80   \fi
81   \tagshift@=0pt \tagwidth@=0pt \totwidth@=0pt
82   \eqnshift@=0pt \alignsep@=0pt

```

### 3.4 The first pass

We then run the first pass to find out which environment we've got. However we have to store the equation counter because it is stepped in this pass, and we certainly don't want that to happen. As a side effect this will also tell us if the equations are numbered.

If we are to put a brace to the left of the display, it would be rather pleasant to know just how high the structure is, since this will affect the height and more importantly the width the brace: we will need to know the *exact* width of such material. Hence we put it in a box which is easy to measure and fiddle around with. To achieve this we put the contents of the token register `\@emphEQ@mathbody` in a `minipage` inside a `lrbox`. Alas, `lrbox` won't let us escape into display math mode, so we play a dirty trick on it and use a `minipage`, which will let us have our way with it.

The `minipage` starts in horizontal mode and then goes straight to display math mode, thus adding some space before the display math. However there was nothing on the first line in the `minipage` thus leading `TeX` to add a `\abovedisplayskip` before the display. We subtract this as fast as we can! Furthermore it showed in test runs, that an additional 1 pt had to be subtracted in the top—but not in the bottom. It has nothing to do with any of the standard page dimensions or parameters. Strange indeed.

```

83   \setcounter{@emphEQ@EqCtr}{\value{equation}}%
84   \begin{lrbox}{\@emphEQ@Box}%
85     \begin{minipage}{\linewidth}%
86       \vskip-\abovedisplayskip\relax\vskip-1pt\relax
87       \the\@emphEQ@mathbody
88     \end{minipage}%
89   \end{lrbox}%

```

We then look at the equation counter to see if we had any numbered equations and reset it if that was the case. If we used a `multline*` we can detect this by measuring `\tagwidth@`.

```

90   \ifnum\value{equation}=\value{@emphEQ@EqCtr}%
91     \ifdim\tagwidth@>0pt
92       \else
93         \@emphEQ@NoNumEqtrue
94       \fi
95   \else
96     \setcounter{equation}{\value{@emphEQ@EqCtr}}%
97   \fi

```



Now we can determine the various math environments. Firstly we measure an empty `\@emphEQ@boxtype`—we will need this information when the math structure is finally put into a box of this type, but we have to take it into account when calculating the allowable width of multiline displays because we want to use the margins already set for this environment.

```
98 \settowidth{\@emphEQ@boxtypelength}{\@emphEQ@boxtype{}}%
```

The idea is that each of the `amsmath` multiple line environments can be singled out because it uses a certain dimension in a way none of the others use it.

`align`: Uses `\alignsep@` and sets it to something positive. None of the others use it.

`multiline`: Doesn't use `\eqnshift@`.

`gather`: Doesn't use `\tagshift@`.

`alignat`: Can be determined because some dimensions will have special relations e.g., when in `[fleqn,reqno]` mode the equation

$$\text{\totwidth@} - \text{\tagshift@} = \text{\linewidth}$$

holds<sup>1</sup> and similarly for the other three display modes. See the code for these equations.

### 3.4.1 `[fleqn,leqno]`

```
99 \if@emphEQ@FLL % fleqn and leqno
100 \ifdim\alignsep@>0pt % => align
101 \@emphEQ@aligntrue
102 \setlength{\@emphEQ@displaywidth}{\tagshift@-\@mathmargin}%
103 \else
104 \ifdim\eqnshift@=0pt % => multiline %tagwidth@>
105 \@emphEQ@multlinetrue
106 \if@emphEQ@NoNumEq
107 \setlength{\@emphEQ@displaywidth}{%
108 \linewidth-\multlinegap-\@mathmargin
109 -\@emphEQ@boxtypelength}%
110 \else
111 \setlength{\@emphEQ@displaywidth}{%
112 \linewidth-\tagwidth@-\multlinegap
113 -\multlinetaggap-\@emphEQ@boxtypelength}%
114 \fi
115 \else
116 \ifdim\tagshift@=0pt % => gather
117 \@emphEQ@gathertrue
118 \setlength{\@emphEQ@displaywidth}{%
119 \totwidth@-\@mathmargin}%
120 \else
121 \ifdim\tagshift@=\totwidth@ % => alignat
122 \@emphEQ@alignattrue
123 \setlength{\@emphEQ@displaywidth}{%
```

---

<sup>1</sup>Well almost—they may be off by a few scaled points. See section 3.2.1 for further details.

```

124             \totwidth@-\@mathmargin}%
125         \else
126             %Nothing thus far...
127         \fi
128     \fi
129 \fi
130 \fi
131 \fi

```

### 3.4.2 [fleqn, reqno]

```

132 \if@emphEQ@FLR % fleqn and reqno
133     \ifdim\alignsep@>0pt % => align
134         \@emphEQ@aligntrue
135         \setlength{\@emphEQ@displaywidth}{%
136             \linewidth-\@mathmargin+\tagshift@}%
137     \else
138         \ifdim\eqnshift@=0pt % => multiline
139             \@emphEQ@multlinetrue
140             \if@emphEQ@NoNumEq
141                 \setlength{\@emphEQ@displaywidth}{%
142                     \linewidth-\multlinegap-\@mathmargin
143                     -\@emphEQ@boxtypelength}%
144             \else
145                 \setlength{\@emphEQ@displaywidth}{%
146                     \linewidth-\tagwidth@-\@mathmargin
147                     -\multlinetaggap-\@emphEQ@boxtypelength}%
148             \fi
149         \else
150             \ifdim\tagshift@=0pt % => gather
151                 \@emphEQ@gathertrue
152                 \setlength{\@emphEQ@displaywidth}{%
153                     \totwidth@-\@mathmargin}%
154             \else
155                 \@emphEQ@CloseEnough{\totwidth@-\tagshift@}%
156                 {\linewidth}%
157                 {\@emphEQ@alignattrue
158                 \setlength{\@emphEQ@displaywidth}%
159                 {\totwidth@-\eqnshift@}}}%
160             \fi
161         \fi
162     \fi
163 \fi

```

### 3.4.3 [reqno]

```

164 \if@emphEQ@R % reqno
165     \ifdim\alignsep@>0pt % => align
166         \@emphEQ@aligntrue
167         \setlength{\@emphEQ@displaywidth}{\totwidth@}%
168     \else

```

```

169         \ifdim\eqnshift@=0pt % => multline
170         \@emphEQ@multlinetrue
171         \if@emphEQ@NoNumEq
172             \setlength{\@emphEQ@displaywidth}{%
173                 \linewidth-2\multlinegap
174                 -\@emphEQ@boxtypelength}%
175         \else
176             \setlength{\@emphEQ@displaywidth}{%
177                 \linewidth-\tagwidth@-\multlinegap
178                 -\multlinetaggap-\@emphEQ@boxtypelength}%
179         \fi
180     \else
181         \ifdim\tagshift@=0pt % => gather
182             \@emphEQ@gathertrue
183             \setlength{\@emphEQ@displaywidth}{\totwidth@}%
184         \else
185             \@emphEQ@CloseEnough{\tagshift@}{-\eqnshift@}%
186             {\@emphEQ@alignattrue
187             \setlength{\@emphEQ@displaywidth}{\totwidth@}}}%
188         \fi
189     \fi
190 \fi
191 \fi

```

### 3.4.4 [leqno]

```

192 \if@emphEQ@L % leqno
193     \ifdim\alignsep@>0pt % => align
194         \@emphEQ@aligntrue
195         \setlength{\@emphEQ@displaywidth}{\totwidth@}%
196     \else
197         \ifdim\eqnshift@=0pt % => multline
198             \@emphEQ@multlinetrue
199             \if@emphEQ@NoNumEq
200                 \setlength{\@emphEQ@displaywidth}{%
201                     \linewidth-2\multlinegap
202                     -\@emphEQ@boxtypelength}%
203             \else
204                 \setlength{\@emphEQ@displaywidth}{%
205                     \linewidth-\tagwidth@-\multlinegap
206                     -\multlinetaggap-\@emphEQ@boxtypelength}%
207             \fi
208         \else
209             \ifdim\tagshift@=0pt % => gather
210                 \@emphEQ@gathertrue
211                 \setlength{\@emphEQ@displaywidth}{\totwidth@}%
212             \else
213                 \@emphEQ@CloseEnough{%
214                     \linewidth-\eqnshift@}{\tagshift@}{%
215                     \@emphEQ@alignattrue
216                     \setlength{\@emphEQ@displaywidth}{\totwidth@}}}%
217                 {}%
218             \fi

```

```

219         \fi
220     \fi
221 \fi

```

Phew! That was tedious, but necessary. I wish I could say it got better further down the road, but it doesn't. Now we can measure the width of the additional material on both sides of the math structure. We add braces here and there to avoid any `\thinmuskip`'s.

```

222 \settowidth{\@emphEQ@lwd}{\@emphEQ@Left}%
223         {\vphantom{\usebox{\@emphEQ@Box}}}%
224 \settowidth{\@emphEQ@rwd}{\@emphEQ@Right}%
225         {\vphantom{\usebox{\@emphEQ@Box}}}%

```

### 3.5 The second pass

When we try to create an effect as in the preliminary example there are a few things we need to tell  $\text{\LaTeX}$  for the overall result to be acceptable. If the display math is centered, then the new one should also be centered. This means that when typesetting the math structure for the second time, we need to make adjustments to `\linewidth`, `\mathmargin` etc. for the equation tag to be placed correctly.

That process is extremely tedious, but there are only few shortcuts, so we just go through each of the four environments, check each of the four display modes and alter dimensions as we trudge along. First we check if we are trying to put something into an asymmetrical box and then make it symmetrical by removing the size of the shadow.

```

226 \begin{lrbox}{\@emphEQ@Box}%
227 \if@emphEQ@shadowbox
228     \addtolength{\@emphEQ@boxtypelength}{-\shadowsize}%
229 \fi

```

#### 3.5.1 align

```

230 \if@emphEQ@align
231     \if@emphEQ@FLL
232         \begin{minipage}{\linewidth+\@emphEQ@lwd
233             +.5\@emphEQ@boxtypelength}%
234             \addtolength{\@mathmargin}{\@emphEQ@lwd
235                 +.5\@emphEQ@boxtypelength}%
236         \fi
237     \if@emphEQ@FLR
238         \begin{minipage}{\linewidth}%
239             \addtolength{\@mathmargin}{\@emphEQ@lwd
240                 +.5\@emphEQ@boxtypelength}%
241     \fi
242     \if@emphEQ@L
243         \begin{minipage}{\linewidth+\@emphEQ@lwd-\@emphEQ@rwd}%
244     \fi
245     \if@emphEQ@R
246         \begin{minipage}{\linewidth-\@emphEQ@lwd+\@emphEQ@rwd}%
247     \fi
248 \fi

```

### 3.5.2 gather

```

249 \if@emphEQ@gather
250   \if@emphEQ@FLL
251     \begin{minipage}{\linewidth+\@emphEQ@lwd
252       +.5\@emphEQ@boxtypelength}%
253     \addtolength{\@mathmargin}{\@emphEQ@lwd
254       +.5\@emphEQ@boxtypelength}%%
255   \fi
256   \if@emphEQ@FLR
257     \begin{minipage}{\linewidth}%
258     \addtolength{\@mathmargin}{\@emphEQ@lwd
259       +.5\@emphEQ@boxtypelength}%%
260   \fi
261   \if@emphEQ@R
262     \setlength{\@emphEQ@templength}{\linewidth-\totwidth@
263       -\eqnshift@}%
264     \begin{minipage}{\linewidth-\@emphEQ@lwd+\@emphEQ@rwd
265       +\@emphEQ@templength-\eqnshift@}%
266   \fi
267   \if@emphEQ@L
268     \setlength{\@emphEQ@templength}{\linewidth-\totwidth@
269       -\eqnshift@}%
270     \begin{minipage}{\linewidth+\@emphEQ@lwd-\@emphEQ@rwd
271       -\@emphEQ@templength+\eqnshift@}%
272   \fi
273 \fi

```

### 3.5.3 alignat

```

274 \if@emphEQ@alignat
275   \if@emphEQ@FLL
276     \begin{minipage}{\linewidth+\@emphEQ@lwd
277       +.5\@emphEQ@boxtypelength}%
278     \addtolength{\@mathmargin}{\@emphEQ@lwd
279       +.5\@emphEQ@boxtypelength}%%
280   \fi
281   \if@emphEQ@FLR
282     \begin{minipage}{\linewidth}%
283     \addtolength{\@mathmargin}{\@emphEQ@lwd
284       +.5\@emphEQ@boxtypelength}%%
285   \fi
286   \if@emphEQ@L
287     \begin{minipage}{\linewidth+\@emphEQ@lwd-\@emphEQ@rwd}%
288   \fi
289   \if@emphEQ@R
290     \begin{minipage}{\linewidth-\@emphEQ@lwd+\@emphEQ@rwd}%
291   \fi
292 \fi

```

### 3.5.4 multiline

```

293 \if@emphEQ@multiline
294   \if@emphEQ@FLL
295     \begin{minipage}{\linewidth}%
296       \if@emphEQ@NoNumEq
297         \addtolength{\@mathmargin}{\@emphEQ@lwd
298           +.5\@emphEQ@boxtypelength}%
299         \if@emphEQ@shadowbox
300           \addtolength{\@mathmargin}{\shadowsize}
301         \fi%
302       \else
303         \addtolength{\multlinetaggap}{\@emphEQ@lwd
304           +.5\@emphEQ@boxtypelength}%
305         \if@emphEQ@shadowbox
306           \addtolength{\multlinegap}{\shadowsize}%
307         \fi
308       \fi
309       \addtolength{\multlinegap}{\@emphEQ@rwd
310         +.5\@emphEQ@boxtypelength}%
311     \fi
312   \if@emphEQ@FLR
313     \begin{minipage}{\linewidth}%
314       \if@emphEQ@NoNumEq
315         \addtolength{\multlinegap}{\@emphEQ@rwd
316           +.5\@emphEQ@boxtypelength}%
317         \if@emphEQ@shadowbox
318           \addtolength{\multlinegap}{\shadowsize}%
319         \fi
320       \else
321         \addtolength{\multlinetaggap}{\@emphEQ@rwd
322           +.5\@emphEQ@boxtypelength}%
323         \if@emphEQ@shadowbox
324           \addtolength{\multlinetaggap}{\shadowsize}%
325         \fi
326       \fi
327       \addtolength{\@mathmargin}{\@emphEQ@lwd
328         +.5\@emphEQ@boxtypelength}%
329     \fi
330   \if@emphEQ@L
331     \begin{minipage}{\linewidth}%
332       \if@emphEQ@NoNumEq
333         \addtolength{\multlinegap}{.5\@emphEQ@rwd
334           +.5\@emphEQ@lwd+.5\@emphEQ@boxtypelength}%
335         \if@emphEQ@shadowbox
336           \addtolength{\multlinegap}{.5\shadowsize}%
337         \fi
338       \else
339         \addtolength{\multlinetaggap}{\@emphEQ@lwd
340           +.5\@emphEQ@boxtypelength}%
341         \addtolength{\multlinegap}{\@emphEQ@rwd
342           +.5\@emphEQ@boxtypelength}%
343         \if@emphEQ@shadowbox

```

```

344             \addtolength{\multlinegap}{\shadowsize}%
345         \fi
346     \fi
347 \fi
348 \if@emphEQ@R
349     \begin{minipage}{\linewidth}%
350         \if@emphEQ@NoNumEq
351             \addtolength{\multlinegap}{.5\@emphEQ@rwd
352             +.5\@emphEQ@lwd+.5\@emphEQ@boxtypelength}%
353             \if@emphEQ@shadowbox
354                 \addtolength{\multlinegap}{.5\shadowsize}
355             \fi
356         \else
357             \addtolength{\multlinetaggap}{\@emphEQ@rwd
358             +.5\@emphEQ@boxtypelength}%
359             \addtolength{\multlinegap}{\@emphEQ@lwd
360             +.5\@emphEQ@boxtypelength}%
361             \if@emphEQ@shadowbox
362                 \addtolength{\multlinetaggap}{\shadowsize}
363             \fi
364         \fi
365     \fi
366 \fi

```

Finally we get to typeset the contents of `\@emphEQ@mathbody` for the second time...

```

367     \vskip-\abovedisplayskip\relax\vskip-1pt\relax
368     \the\@emphEQ@mathbody
369     \end{minipage}%
370 \end{lrbox}%

```

### 3.6 Putting it into the box

Because we were clever to start with—by measuring the width of the display math and storing it in `\@emphEQ@displaywidth`—we can now put it into a box of width `\@emphEQ@displaywidth+\@emphEQ@rwd+\@emphEQ@lwd`. This doesn't apply to multiline though: it has to be set in a box of width `\@emphEQ@displaywidth`.

```

371 \setlength{\@emphEQ@BoxWidth}{\@emphEQ@displaywidth+\@emphEQ@rwd
372                               +\@emphEQ@lwd}%

```

#### 3.6.1 align

```

373 \if@emphEQ@align
374     \if@emphEQ@FLL
375         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][l]{%
376             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
377             $\@emphEQ@Left$%
378             \kern-.5\@emphEQ@boxtypelength%
379             \kern-\@mathmargin
380             \kern-\@emphEQ@lwd
381             \usebox{\@emphEQ@Box}%
382             \kern-\@emphEQ@displaywidth

```

```

383         \kern-\@emphEQ@rwd
384         \kern-\@emphEQ@lwd
385         $\@emphEQ@Right$}}%
386     \fi
387     \if@emphEQ@FLR
388         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][l]{%
389             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
390             $\@emphEQ@Left$%
391             \kern-.5\@emphEQ@boxtypelength%
392             \kern-\@mathmargin
393             \kern-\@emphEQ@lwd
394             \usebox{\@emphEQ@Box}%
395             \kern-\@alignsep@
396             $\@emphEQ@Right$}}%
397     \fi
398     \if@emphEQ@L
399         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][c]{%
400             %\kern\eqnshift@
401             %\kern-\@alignsep@
402             $\@emphEQ@Left$%
403             \kern-\eqnshift@
404             %\kern-\@alignsep@
405             \usebox{\@emphEQ@Box}%
406             %\kern-\eqnshift@
407             \kern-\@alignsep@
408             $\@emphEQ@Right$}}%
409     \fi
410     \if@emphEQ@R
411         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][c]{%
412             $\@emphEQ@Left$%
413             \kern-\eqnshift@
414             \usebox{\@emphEQ@Box}%
415             \kern-\eqnshift@
416             $\@emphEQ@Right$}}%
417     \fi
418 \fi

```

### 3.6.2 alignat

```

419 \if@emphEQ@alignat
420     \if@emphEQ@FLL
421         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][l]{%
422             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
423             $\@emphEQ@Left$%
424             \kern-.5\@emphEQ@boxtypelength
425             \kern-\@mathmargin
426             \kern-\@emphEQ@lwd
427             \usebox{\@emphEQ@Box}%
428             \kern\@mathmargin
429             \kern\@emphEQ@displaywidth
430             \kern-\@linewidth
431             $\@emphEQ@Right$}}%
432     \fi

```



```

433 \if@emphEQ@FLR
434   \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][l]{%
435     \if@emphEQ@shadowbox \kern.5\shadowsize \fi
436     $\@emphEQ@Left$%
437     \kern-.5\@emphEQ@boxtypelength
438     \kern-\@mathmargin
439     \kern-\@emphEQ@lwd
440     \usebox{\@emphEQ@Box}%
441     \kern\@mathmargin
442     \kern\@emphEQ@displaywidth
443     \kern-\linewidth
444     \kern\@emphEQ@lwd
445     \kern.5\@emphEQ@boxtypelength
446     $\@emphEQ@Right$}}%
447 \fi
448 \if@emphEQ@L
449   \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][c]{%
450     $\@emphEQ@Left$%
451     \kern-\eqnshift@
452     \usebox{\@emphEQ@Box}%
453     \kern-\eqnshift@
454     $\@emphEQ@Right$}}%
455 \fi
456 \if@emphEQ@R
457   \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][c]{%
458     $\@emphEQ@Left$%
459     \kern-\eqnshift@
460     \usebox{\@emphEQ@Box}%
461     \kern-\eqnshift@
462     $\@emphEQ@Right$}}%
463 \fi
464 \fi

```

### 3.6.3 gather

```

465 \if@emphEQ@gather
466   \if@emphEQ@FLL
467     \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][l]{%
468       \if@emphEQ@shadowbox \kern.5\shadowsize \fi
469       $\@emphEQ@Left$%
470       \kern-.5\@emphEQ@boxtypelength
471       \kern-\@mathmargin
472       \kern-\@emphEQ@lwd
473       \usebox{\@emphEQ@Box}%
474       \kern-\linewidth
475       \kern\@mathmargin
476       \kern\@emphEQ@displaywidth
477       $\@emphEQ@Right$}}%
478   \fi
479   \if@emphEQ@FLR
480     \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][l]{%
481       \if@emphEQ@shadowbox \kern.5\shadowsize
482       \fi

```

```

483      $\@emphEQ@Left$%
484      \kern-.5\@emphEQ@boxtypelength
485      \kern-\@mathmargin
486      \kern-\@emphEQ@lwd
487      \usebox{\@emphEQ@Box}%
488      \kern-\linewidth
489      \kern.5\@emphEQ@boxtypelength
490      \kern\@mathmargin
491      \kern\@emphEQ@displaywidth
492      \kern\@emphEQ@lwd
493      $\@emphEQ@Right$}}%
494  \fi
495  \if@emphEQ@L
496      \setlength{\tagwidth@}{\eqnshift@+\@emphEQ@rwd}%
497      \setlength{\@emphEQ@templength}{\linewidth-\totwidth@
498          -\eqnshift@}%
499      \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][c]{%
500          \ifdim\@emphEQ@templength<\tagwidth@
501              \setlength{\tagwidth@}{\@emphEQ@templength
502                  +\@emphEQ@lwd}%
503              \ifdim\tagwidth@<\eqnshift@
504                  \kern-\@emphEQ@templength
505                  \kern\eqnshift@
506              \fi
507          \else
508              \kern-\@emphEQ@lwd
509              \kern\@emphEQ@rwd
510              \kern-\@emphEQ@templength
511              \kern\eqnshift@
512          \fi
513          $\@emphEQ@Left$%
514          \kern-\eqnshift@
515          \usebox{\@emphEQ@Box}%
516          %\kern-\eqnshift@
517          \kern-\@emphEQ@lwd
518          \kern\@emphEQ@rwd
519          \kern-\@emphEQ@templength
520          $\@emphEQ@Right$}}%
521  \fi
522  \if@emphEQ@R
523      \setlength{\tagwidth@}{\eqnshift@+\@emphEQ@rwd}%
524      \setlength{\@emphEQ@templength}{\linewidth-\totwidth@
525          -\eqnshift@}%
526      \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@BoxWidth][c]{%
527          \kern-\@emphEQ@lwd
528          \kern\@emphEQ@rwd
529          \kern\@emphEQ@templength
530          \kern-\eqnshift@
531          $\@emphEQ@Left$%
532          \ifdim\@emphEQ@templength>\tagwidth@
533              \kern-\eqnshift@
534          \else
535              \kern\@emphEQ@lwd
536              \kern-\@emphEQ@rwd

```

```

537         \kern-\@emphEQ@templength
538     \fi
539     \usebox{\@emphEQ@Box}%
540     \kern-\eqnshift@
541     $\@emphEQ@Right$}%
542 \fi
543 \fi

```

### 3.6.4 multiline

multiline is somewhat more difficult because `multiline*` differs on several accounts. Thus we make use of our little test to see if the math structure was numbered to begin with (`\if@emphEQ@NoNumEq`).

```

544 \if@emphEQ@multiline
545     \if@emphEQ@FLL
546         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@displaywidth][l]{%
547             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
548             $\@emphEQ@Left$%
549             \kern-.5\@emphEQ@boxtypelength
550             \kern-\@emphEQ@lwd
551             \if@emphEQ@NoNumEq
552                 \if@emphEQ@shadowbox \kern-\shadowsize \fi
553                 \kern-\@mathmargin
554             \else
555                 \kern-\tagwidth@
556                 \kern-\multlinetaggap
557             \fi
558             \usebox{\@emphEQ@Box}%
559             \kern-\@emphEQ@boxtypelength
560             \if@emphEQ@NoNumEq
561                 \kern-\multlinegap
562             \else
563                 \kern\multlinegap
564             \fi
565             \kern-\@emphEQ@rwd
566             \kern-\@emphEQ@lwd
567             \kern-\@mathmargin
568             $\@emphEQ@Right$}%
569     \fi
570     \if@emphEQ@FLR
571         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@displaywidth][l]{%
572             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
573             $\@emphEQ@Left$%
574             \kern-.5\@emphEQ@boxtypelength
575             \kern-\@emphEQ@lwd
576             \kern-\@mathmargin
577             \usebox{\@emphEQ@Box}%
578             \kern-\@emphEQ@boxtypelength
579             \kern-\@emphEQ@rwd
580             \kern-\@emphEQ@lwd
581             \if@emphEQ@NoNumEq
582                 \kern-\multlinegap
583             \else
584                 \kern-\multlinetaggap

```

```

585         \fi
586         \kern-\@mathmargin
587         \kern-\tagwidth@
588         $\@emphEQ@Right$}}%
589     \fi
590     \if@emphEQ@L
591         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@displaywidth][l]{%
592             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
593             $\@emphEQ@Left$%
594             \kern-.5\@emphEQ@boxtypelength
595             \kern-\@emphEQ@lwd
596             \if@emphEQ@NoNumEq
597                 \kern-\multlinegap
598                 \kern.5\@emphEQ@lwd
599                 \kern-.5\@emphEQ@rwd
600                 \if@emphEQ@shadowbox \kern-.5\shadowsize \fi
601             \else
602                 \kern-\multlinetaggap
603                 \kern-\tagwidth@
604             \fi
605             \usebox{\@emphEQ@Box}%
606             \kern-.5\@emphEQ@boxtypelength
607             \if@emphEQ@NoNumEq
608                 \kern.5\@emphEQ@rwd
609                 \kern-.5\@emphEQ@lwd
610             \fi
611             \kern-\@emphEQ@rwd
612             \kern-\multlinegap
613             $\@emphEQ@Right$}}%
614     \fi
615     \if@emphEQ@R
616         \savebox{\@emphEQ@Box}{\makebox[\@emphEQ@displaywidth][l]{%
617             \if@emphEQ@shadowbox \kern.5\shadowsize \fi
618             $\@emphEQ@Left$%
619             \kern-.5\@emphEQ@boxtypelength
620             \if@emphEQ@NoNumEq
621                 \if@emphEQ@shadowbox \kern-.5\shadowsize \fi
622                 \kern-.5\@emphEQ@rwd
623                 \kern.5\@emphEQ@lwd
624             \fi
625             \kern-\@emphEQ@lwd
626             \kern-\multlinegap
627             \usebox{\@emphEQ@Box}%
628             \kern-.5\@emphEQ@boxtypelength
629             \kern-\@emphEQ@rwd
630             \if@emphEQ@NoNumEq
631                 \kern-\multlinegap
632                 \kern-.5\@emphEQ@lwd
633                 \kern.5\@emphEQ@rwd
634             \else
635                 \kern-\multlinetaggap
636             \fi
637             \kern-\tagwidth@
638             $\@emphEQ@Right$}}%

```

```

639 \fi
640 \fi

```

### 3.6.5 The final step

At last here comes the good part! We are now ready to place the box containing all of our math material. If we have used a `multline` we have to do a few kerning tricks but at least we would seem to know the drill by now... To make sure vertical spacing is ok, we put it all into a simple math environment `\[...\]`.

```

641 \[
642   \if@emphEQ@align
643     \if@emphEQ@L
644       \kern-\alignsep@
645       \kern\eqnshift@
646     \fi
647   \fi
648   \if@emphEQ@gather
649     \if@emphEQ@L
650       \kern-\@emphEQ@templength
651       \kern\eqnshift@
652       \kern\@emphEQ@rwd
653       \kern-\@emphEQ@lwd
654     \fi
655     \if@emphEQ@R
656       \setlength{\tagwidth@}{\eqnshift@+\@emphEQ@rwd}%
657       \ifdim\@emphEQ@templength>\tagwidth@
658         \kern-\@emphEQ@templength
659         \kern\eqnshift@
660         \kern\@emphEQ@lwd
661       \else
662         \kern\@emphEQ@templength
663         \kern-\eqnshift@
664         \kern\@emphEQ@rwd
665         \kern-\@emphEQ@lwd
666       \fi
667     \fi
668   \fi
669   \if@emphEQ@multline
670     \if@emphEQ@NoNumEq
671       % naught
672     \else
673       \if@emphEQ@FLL
674         \kern-\@mathmargin
675         \kern\tagwidth@
676         \kern\multlinetaggap
677       \fi
678       \if@emphEQ@L
679         \kern\tagwidth@
680         \kern\multlinetaggap
681       \fi
682     \fi
683     \if@emphEQ@R
684       \kern-\tagwidth@
685       \kern-\multlinetaggap

```

```

686          \kern\multlinegap
687          \fi
688      \fi
689  \else

```

If we are using a `\shadowbox` in centered display mode, I would rather that the `shadowsize` is ignored when placing the box. Reason: I think it looks better. Judge for yourself:

$$a = b \tag{14}$$

$$\Phi(x) = \int_{-\infty}^x e^{-t^2/2} dt \tag{15}$$

$$a = b$$

$$\Phi(x) = \int_{-\infty}^x e^{-t^2/2} dt$$

$$\tag{16}$$

$$\tag{17}$$

```

690      \if@emphEQ@shadowbox
691          \if@emphEQ@R
692              \kern\shadowsize
693          \fi
694          \if@emphEQ@L
695              \kern\shadowsize
696          \fi
697      \fi
698  \fi
699  \@emphEQ@boxtype{\usebox{\@emphEQ@Box}}%
    After all is done, we empty out the added material and the boxtype.
700      \gdef\@emphEQ@Left{}\gdef\@emphEQ@Right{}%
701      \gdef\@emphEQ@boxtype{}%
702  \}%
703  \ifnum0='{ \fi}%
704  \expandafter\end\expandafter{\@emphEQ@EnvName}%
705 }

```

### 3.7 Going public...

```

boxtype  In order to simplify the user interface, we make use of keyval. We define three
Left     keys to be used along with a more accessible version of @emphEQ@MainEnv.
Right    706 \define@key{empheq}{boxtype}{\renewcommand\@emphEQ@boxtype{#1}}
empheq   707 \define@key{empheq}{Left}{\def\@emphEQ@Left{#1}}
         708 \define@key{empheq}{Right}{\def\@emphEQ@Right{#1}}
         709 \newenvironment{empheq}[1] [] {\setkeys{empheq}{#1}\@emphEQ@MainEnv}%
         710         {\end@emphEQ@MainEnv\ignorespacesafterend}%

```

```

\DeclareLeftDelimiter  It might come in handy to have delimiters of the appropriate size available to cover
\DeclareRightDelimiter the math display as in (1). Therefore we define two commands that will create
                        such delimiters once and for all. Use this as an inspiration for further kinds of
                        delimiters.

```

```

711 \newcommand{\DeclareLeftDelimiter}[2] [\!]{%
712     \@namedef{empheq\expandafter\@gobble\string#2}{

```

```

713 \left#2
714 \vphantom{\usebox{\@emphEQ@Box}}%
715 \right.#1}}
716 \newcommand{\DeclareRightDelimiter}[2][\!]{%
717 \@namedef{empheq\expandafter\@gobble\string#2}{%
718 #1\left.
719 \vphantom{\usebox{\@emphEQ@Box}}}%
720 \right#2}}%
721 \DeclareRightDelimiter{\rbrace}
722 \DeclareLeftDelimiter{\lbrace}
723 \end{package}

```

## 4 Bugs and shortcomings

If you are to use `align` to create two alignment columns, then don't use it with `empheq` yet. Try with an `alignat` instead and all will be well. This will be fixed in upcoming versions as well as support for `flalign` though this is probably not the most sought after. `\intertext` shouldn't be used either.

Should you have any suggestions or bug reports then feel free to contact me at `moho01ab@student.cbs.dk`. Please put 'empheq' in the subject line.

## Change History

v0.5	General: First experimental and very limited release . . . . .	1	v0.7	\@emphEQ@MainEnv: Added use of token register to remove the need for an extra \write and verbatim . . . . .	7
v0.6	\@emphEQ@CloseEnough: Added a test for lengths being almost identical . . . . .	7	General: Added further examples and changed existing ones . . . .	2	
v0.6a	General: Minor updates to documentation. . . . .	1	\DeclareLeftDelimiter: Added delimiter interface . . . . .	22	
v0.6b	General: Added example for changing margins inside the boxtyp. . . .	3	\DeclareRightDelimiter: Added delimiter interface . . . . .	22	
			empheq: Changed the user interface slightly . . . . .	22	