

Package `paracol`: Yet Another Multi-Column Package to Typeset Columns in *Parallel*

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Abstract

This package provides a \LaTeX environment named `paracol` in which you may *switch* and *synchronize* columns by a command `\switchcolumn` and by internal environments `column`, `nthcolumn`, `leftcolumn` and `rightcolumn`. See p. 58 for the table of contents of this manual.

1 Introduction

This document describes the usage of yet another multi-column package named `paracol`. The unique feature of the package is that columns are typeset *in parallel*.

Suppose you are writing a bilingual document whose left column is written in a language, say English, and right column has the translation of the left column in another language, e.g., Japanese. With the `paracol` package you may write an English part of arbitrarily length and then *switch* to its Japanese counterpart to place both parts side by side. Of course you may return to the English writing similarly.

The *column-switching* is always allowed when you complete an outermost level paragraph. You may be unaware whether a column is broken into multiple pages before switching because the package automatically goes back and forward to the correct page and vertical position when you switch the column. Moreover, you may *synchronize* columns so that the tops of the first paragraphs after switching in all columns are vertically aligned. At a synchronization point, you may give a single-column text, for example a common section header, optionally. You may also switch single-column and multi-column in a page arbitrary.

```
\begin{paracol}{2}[\section{Introduction}]
\hbadness5000
This document describes the usage of yet
another multi-column package named
\textsf{paracol}. The unique feature of
the package is that columns are typeset
{\em in parallel.}
```

Suppose you are writing a bilingual document whose left column is written in a language, say English, and right column has the translation of the left column in another language, e.g. Japanese. With the `\textsf{paracol}` package you may write an English part of arbitrary length and then `{\em switch}` to its Japanese counterpart to place both parts side by side. Of course you may return to the English writing similarly.

The column switching is always allowed when you complete an outermost level paragraph. You may be unaware whether a column is broken into multiple pages before switching because the package automatically goes back and forward to the correct page and

This manual itself is an example of two-column documents typeset by `paracol`. Since the author is not familiar with languages other than English and Japanese and the latter should be hardly understood by most of readers, the right column is the translation of the left English column into a computational language. That is, the right column is the `LATEX` source code of the left column¹.

vertical position when you switch the column. Moreover, you may `\em synchronize` columns so that the tops of the first paragraphs after switching in all columns are vertically aligned. At a synchronization point, you may give a single-column text, for example a common section header, optionally. You may also switch single-column and multi-column in a page arbitrary.

This manual itself is an example of two-column documents typeset by `\textsf{paracol}`. Since the author is not familiar with languages other than English and Japanese and the latter should be hardly understood by most of readers, the right column is the translation of the left English column into a computational language. That is, the right column is the `\LaTeX` source code of the left column%
`\footnote{Not really but its essence is shown.}`.

`\switchcolumn`

`\begin{verbatim}`
Here is the source of above.
`\end{verbatim}`¹

2 Basic Usage

Loading the package is very simple. What you have to do is `\usepackage{paracol}` in the preamble. Note that `paracol` can be used with `LATEX 2ε` and does not work with `LATEX 2.09`.

The fundamental means of parallel-column typesetting are the environment `paracol` and the command `\switchcolumn`. The `paracol` environment needs an argument to specify the number of columns. Thus the following is the basic construct for two-parallel-column documents.

```
\begin{paracol}{2}
left column text
\switchcolumn
```

¹Not really but its essence is shown.

`\switchcolumn*[\section{Basic Usage}]`
Loading the package is very simple. What you have to do is `|\usepackage{paracol}|` in the preamble. ...²

```
\switchcolumn
source
\switchcolumn*
The fundamental means of parallel-column
typesetting are the environment |paracol|
and the command |\switchcolumn|. ...
\switchcolumn
source
```

¹This `verbatim` construct is simply referred as to “*source*” hereafter.

²Hereafter, a part of the source code may be omitted like this.

```

    right column text
\switchcolumn
    left column text
\switchcolumn
    right column text
\switchcolumn
    :
\end{paracol}

```

The `\switchcolumn` command may have an optional argument to specify the column number (zero origin) to start. That is, `\switchcolumn[0]` means to switch to the leftmost column, `\switchcolumn[1]` is to start the second column and so on. Thus the `\switchcolumn` without the optional argument may be considered as `\switchcolumn[$i+1 \bmod n$]` where i is the ordinal of the column you are leaving from and n is the number of columns given to `paracol` environment.

3 Column Synchronization

The `\switchcolumn` command may also be followed by a ‘*’ to *synchronize* columns. After you switch from a column to another by `\switchcolumn*` (or `\switchcolumn[i]*`), all the columns are vertically aligned at the bottom of the *deepest* one preceding the command. For example, the previous section has three `\switchcolumn*` commands at which left and right columns are vertically aligned.

The *starred* version of `\switchcolumn` may have an optional argument to specify a single-column *spanning text* whose bottom is the vertical alignment point of columns. For example, `\section` commands in this manual are given as optional arguments of `\switchcolumn*` like;

```
\switchcolumn*[\section{Basic Usage}]
```

The `paracol` environment may also start with a spanning text by specifying it as the optional argument of `\begin{paracol}`. For example, at the beginning of this document, the author put;

```
\begin{paracol}{2}[\section{Introduction}]
```

4 Environments for Columns

4.1 Environment column

The `\switchcolumn` is simple but you may prefer to pack the contents of a column in an environ-

```

\switchcolumn[1]*
source
\switchcolumn[0]

```

The `|\switchcolumn|` command may have an optional argument to specify the column number (zero origin) to start. ...

```

\switchcolumn[0]*[%
\section{Column Synchronization}
\label{sec:sync}]

```

The `|\switchcolumn|` command may also be followed by a ‘|*|’ to `{\em synchronize}` columns. ...

The `{\em starred}` version of `|\switchcolumn|` may have an optional argument to specify a multi-column text whose bottom is the vertical alignment points of the columns. ...

```

\switchcolumn
source

```

4.1 Environment column

```

\begin{column*}[%
\section{Environments for Columns}

```

ment. The `column` environment is available for this well-structuralization of L^AT_EX sources for parallel-columned documents. A construct;

```
\begin{column}
  text for a column
\end{column}
```

is (almost) equivalent to;

```
\switchcolumn
  text for a column
```

The `column*` environment is also available for the column synchronization and may have an optional argument for spanning text.

4.2 Environment `nthcolumn`

The `\switchcolumn` can start an arbitrarily specified column with the column number given through its optional argument, but the `column` environment cannot do it. If you want to start *i*-th column, you have to do `\begin{nthcolumn}{i}` (or `nthcolumn*` with an optional argument to synchronize).

4.3 Environments `leftcolumn` and `rightcolumn`

The environments `leftcolumn` and `rightcolumn` (and their starred versions with an optional argument) are available as more convenient means than saying `\begin{nthcolumn}{0}` to switch to the left(most) column and `\begin{nthcolumn}{1}` to the right (but may not be rightmost) one.

```
\label{sec:env}]
\subsection{Environment \texttt{column}}
The |\switchcolumn| is simple but you may
prefer to pack the contents of a column in
an environment. ...
\end{column*}
\begin{column}
  source
\end{column}
```

4.2 Environment `nthcolumn`

```
\begin{nthcolumn*}{1}
  source
\end{nthcolumn*}

\begin{nthcolumn}{0}
\subsection{Environment \texttt{nthcolumn}}
The |\switchcolumn| can start an
arbitrarily specified column with the
column number given through its optional
argument, but the |column| environment
cannot do it. ...
\end{nthcolumn}
```

4.3 Environment `leftcolumn` and `rightcolumn`

```
\begin{leftcolumn*}
\subsection{%
  Environments \texttt{leftcolumn} and \\\
  \texttt{rightcolumn}}
The environments |leftcolumn| and
|rightcolumn| (and their starred versions
with an optional argument) are available as
more convenient means than saying
|\begin{nthcolumn}{0}| to switch to the
left(most) column and ...
\begin{figure*}...\end{figure*}
\begin{figure}[t]...\end{figure}
\end{leftcolumn*}
\begin{rightcolumn}
  source and a figure env
\end{rightcolumn}
```

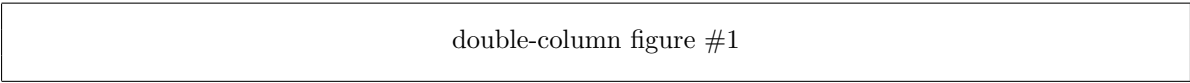


Figure 1: A Double-Column Figure

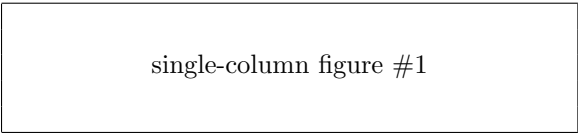


Figure 2: A Single-Column Figure

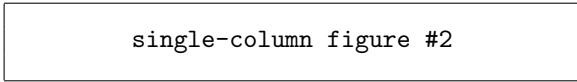


Figure 3: Another Single-Column Figure

5 Floats, Footnotes and Counters

5.1 Figures and Tables

As shown in this page, double-column figures/tables (or those spanned multiple columns if you have three or more) may be placed by `figure*` and `table*` environments as usual². A single-column figure/table will be placed in the column in which you put `figure` and `table`. For example, the body of a `figure` environment in a `leftcolumn` environment is *always* placed in a left column. That is, even if the column of the *current* page does not have enough room to place the figure, it will not be thrown to the right column but will be placed in the left column of the next page³.

Another caution about float placement is that you have to be careful when you try to put a top-float explicitly with `t`-option or implicitly without placement option (i.e., `tbp` in most classes) and to synchronize columns. The rule is as follows; after you synchronize columns in a page, the page cannot have top-floats any more. When you synchronize columns, `paracol` fixes a virtual horizontal line in the page as the synchronization barrier. Thus no top-floats can-

²See Section 11 for the appearance order issue of double-column floats.

³Or some farther page if L^AT_EX cannot solve the placement problem wisely.

Table 1: A Single-Column Table

| | | |
|--------|---------|-------|
| An | example | of |
| single | column | table |

5.1 Figures and Tables

```
\begin{leftcolumn*}[\section{%
  Floats, Footnotes and Counters}]
\begin{table}[b]
\caption{A Single-Column Table}
\centerline{\begin{tabular}[t]{|l|c|r|}
\hline
An&example&of\\\hline
single&column&table\\\hline
\end{tabular}}
\end{table}
```

`\subsection{Figures and Tables}`
 As shown in this page, double-column figures/tables (or those spanned multiple columns if you have three or more columns) may be placed by `figure*` and `table*` environments as usual³. ...

5.2 Footnotes and Marginal Notes

Footnotes are also put at the bottom of the column in which `|\footnote|` commands and their references reside (like `this\footnote{...}`), as shown in page~2 and this page. Marginal notes behave similarly like what you are seeing in the left margin

³Another example of footnote.

Table 2: Another Single-Column Table

| | |
|---------|---------|
| Another | example |
| of | single |
| column | table |

not be added above the line⁴. Therefore, the author put two `figure` environments for the figures shown in this page into the `leftcolumn*` and `rightcolumn` environment for the previous section.

5.2 Footnotes and Marginal Notes

Footnotes are also put at the bottom of the column in which `\footnote` commands and their references reside (like this⁵), as shown in page 2 and this page. Marginal notes behave similarly like what you are seeing in the left margin of this sentence and the right marginal note in this page⁶.

5.3 Local and Global Counters

You probably found that the numbering of figures and tables is *global* while that of footnotes are *local*. That is, the figure in the right column of the previous page has number 3 following its left-column counterpart Figure 2. The tables in the page are also numbered as 1 and 2 crossing the column boundary. However, the footnotes in each column have their own numbering sequence. Moreover, the footnote numbers in left columns are typeset in roman font while those in right columns have italic shapes. Similarly, subsection numbering is local and the headings in right columns have typewriter-face numbers.

This happens because the author declared the counters `figure` and `table` are *global* in the preamble of this document by saying;

```
\globalcounter{figure}
\globalcounter{table}
```

and do nothing about `footnote` and `subsection` counters. By default, all the counters except for `page` are local to columns. The value of a local counter of a column is saved somewhere when you leave the column, and it is restored when you revisit the column. The initial values of the local counters are the values they have at `\begin{paracol}`. After you close the `paracol` environment, the values of the leftmost

⁴Even if you have enough space above, sorry.

⁵Unless you specify to make footnotes *page-wise* as explained in Section 7.6 and 8.

⁶If you have three or more columns, marginal notes of the second or succeeding columns are placed in the right margin in default setting. The `paracol` package solves the placement problem of marginal notes from two or more columns sharing a side margin by moving some of them down if they conflict over the space with each other.

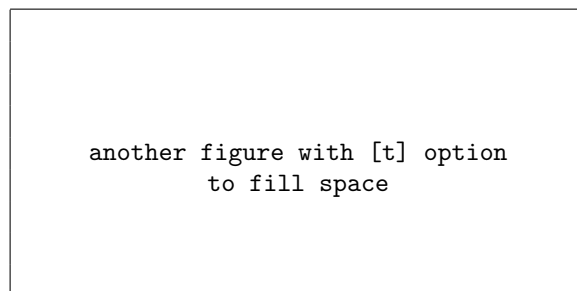


Figure 4: Another Figure with [t] Option

of this sentence\marginpar{\raggedright
An example of marginal note.} and the right
marginal note in this
page\footnote{...}. ...

5.3 Local and Global Counters

You probably found that the numbering of figures and tables is `\emph{global}` while that of footnotes are `\emph{local}`. ...

```
\end{leftcolumn*}
\begin{rightcolumn}
source.
\end{rightcolumn}
```

Another
example
of
marginal
note.

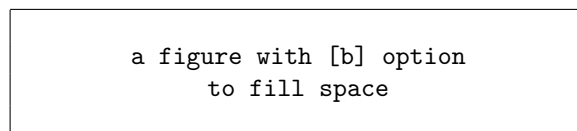


Figure 5: A Figure with [b] Option

column are used for the rest of your document until you start new `paracol` environment. On a restart, local counters in a column have the values they had at the last `\end{paracol}`, except for those which have been modified outside the environment because the modifications are *broadcasted* to local counters in all columns. You will see the effect of this inter-environment counter value conservation in the footnote numbers in the right column in page 5 and 9.

This broadcasting of a local counter value can be done explicitly in `paracol` environments by a command `\synccounter{ctr}`. This command makes `ctr` in all columns have the value of that in the column in which the command appears. In addition, another command `\syncallcounters` performs this broadcasting for all local counters.

If you make a counter global by the command `\globalcounter`, the save/restore operations are not performed to the counter and thus it is globally incremented by `\[ref]stepcounter` or commands such as `\caption` and `\section`. Note that the value of a global counter depends on the place where it is incremented (or set) in the *source code* rather than where it appears in the output. Thus if the author put a `table` environment here to increment `table` counter, the right-column table at the bottom of page 5 would be Table 3 because its `table` environment does not appear yet in the source code. Note that, however, though the counter `page` is global as expected, its numbering is consistent among all columns as far as you refer to the value by `\pageref{label}` and/or see the values in table of contents, etc.

Another counter which the author made global in this document is `section`. As explained in Section 3, an optional spanning text of column-switching is considered as in the leftmost column. Since `\section` commands in this document are always given in spanning texts, so far, it seems unnecessary to make `section` global because it is incremented correctly in the leftmost column. However, the stepping `section` has a side effect to reset its descendent counter `subsection` and referred to from `\thesubsection` command. Thus if `section` were local, the right-column subsections in Section 4 would be numbered as “0.1”, “0.2” and “0.3” because the local value of `section` would be zero. Moreover, the right-column subsections of this section would be “0.4”, “0.5” and “0.6” because stepping `section` local to the left column would not reset `subsection` local to the right column.

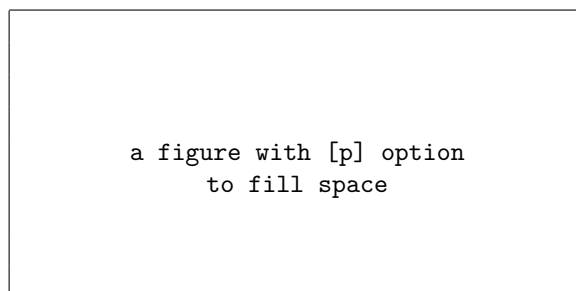


Figure 6: A Figure with [p] Option

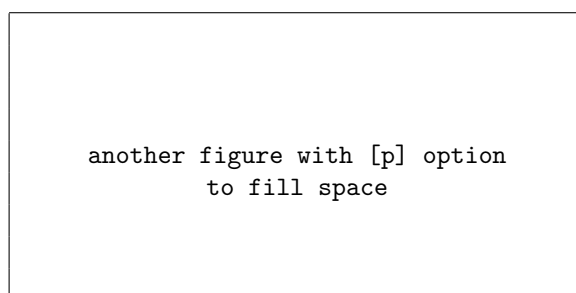


Figure 7: Another Figure with [p] Option

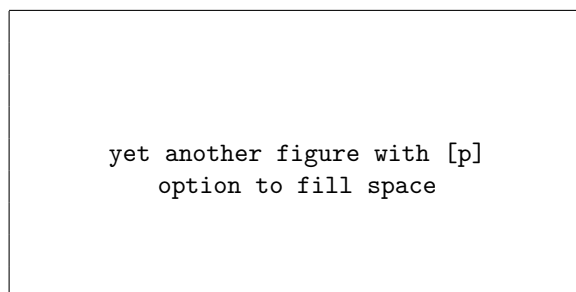


Figure 8: Yet Another Figure with [p] Option

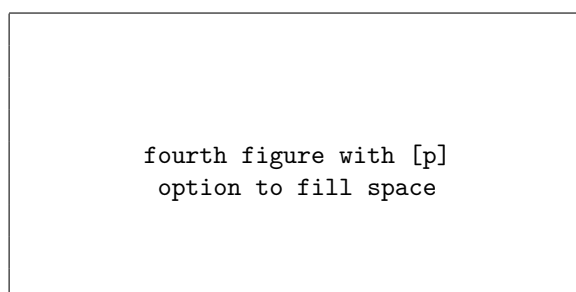


Figure 9: Forth Figure with [p] Option

You may give a local appearance to a counter *ctr* for the *i*-th column (zero origin) by a command;

```
\definethecounter{ctr}{i}{def}
```

where *def* is to be the body of the local definition of `\thectr`. For example, the preamble of this document has the following to give non-default definitions to `\thefootnote` and `\thesubsection` for right columns.

```
\definethecounter{footnote}{1}{%
  \textit{\arabic{footnote}}}
\definethecounter{subsection}{1}{%
  \texttt{%
    \arabic{section}.\arabic{subsection}}}
```

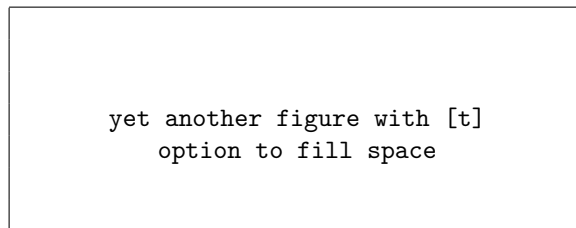


Figure 10: Yet Another Figure with [t] Option

6 Closing paracol Environment and Page Flushing

The final example shown here is this single-column text which the author put after the `paracol` environment above is closed. As you are seeing, a `paracol` environment can be finished at any vertical position in a page and can be followed by ordinary single column texts.

The environment may also be restarted anywhere you like as shown here.

The last issue is to flush a page. The ordinary `\newpage` command works as you expect. If you say `\newpage` in the left column in a page, the contents following it will appear in the left column in the next page. Note that this does not affect the layout of the right column.

To flush all columns in a page, a command `\flushpage` is available. This command in *i*-th column is almost equivalent to;

```
\switchcolumn[i]*[\newpage]
```

but more robust⁷. The ordinary page breaking command `\clearpage` may also be used to flush all columns and to start a fresh page, but it has a side effect to put all figures and tables which are not yet output.

Now the author will do `\flushpage` shortly to start a real binlingual example from the next page, after showing another example of closing `paracol` environments in this sentence and of restarting in the next one, in which *unbalanced column width* is demonstrated using `\columnratio` command shown in Section 7.3.

O.K., we have restarted `paracol` environment and we will see the effect of `\flushpage` now!!

```
\begin{paracol}{2}
\begin{leftcolumn}
The environment may also be restarted
anywhere you like as shown here. ...
\end{leftcolumn}
\begin{rightcolumn}
source
\end{rightcolumn}
\end{paracol}
Now the aurthor will do ...
```

```
\columnratio{0.6}
\begin{paracol}{2}
\begin{leftcolumn}
O.K., ...
\end{leftcolumn}
\begin{rightcolumn} source
\end{rightcolumn}
```

⁷For example `\switchcolumn*` may flush a page for the synchronization and thus `\newpage` may leave an empty page.

An Die Freude/To Joy Friedrich Schiller

The following is the libretto of the fourth movement of Beethoven's Ninth Symphony, his adaptation of Schiller's ode "An Die Freude" (or "To Joy" in English). Beethoven's additions and revisions are indicated in italics.

*O Freunde, nicht diese Töne!
Sondern laßt uns angenehmere anstimmen und freudenvollere*⁸.

*Oh friends, no more of these sad tones!
Let us rather raise our voices together
In more pleasant and joyful tones*⁴.

Freude!
Freude, schöner Götterfunken Tochter aus Elysium,
Wir betreten feuertrunken, Himmlische, dein Heiligtum!
Deine Zauber binden wieder, *Was die Mode streng geteilt;*
*Alle Menschen werden Brüder*⁹, Wo dein sanfter Flügel weilt

Joy!
Joy, thou shining spark of God,
Daughter of Elysium,
With fiery rapture, goddess,
We approach thy shrine.
Your magic reunites
That which stern custom has parted;
*All humans will become brothers*⁵
Under your protective wing.

Wem der große Wurf gelungen, eines Freundes Freund zu sein;
Wer ein holdes Weib errungen, mische seinen Jubel ein!
Ja, wer auch nur eine Seele sein nennt auf dem Erdenrund!
Und wer's nie gekonnt, der stehle weinend sich aus diesem
Bund!

Let the man who has had the fortune
To be a helper to his friend,
And the man who has won a noble woman,
Join in our chorus of jubilation!
Yes, even if he holds but one soul
As his own in all the world!
But let the man who knows nothing of this
Steal away alone and in sorrow.

Freude trinken alle Wesen an den Brüsten der Natur;
Alle Guten, alle Bösen folgen ihrer Rosenspur.
Küsse gab sie uns und Reben, einen Freund, geprüft im Tod;
Wollust ward dem Wurm gegeben, und der Cherub steht vor
Gott.

All the world's creatures drink
From the breasts of nature;
Both the good and the evil
Follow her trail of roses.
She gave us kisses and wine
And a friend loyal unto death;
She gave the joy of life to the lowliest,
And to the angels who dwell with God.

Froh, wie seine Sonnen fliegen durch des Himmels prächt'gen
Plan,
Laufet, Brüder, eure Bahn, freudig, wie ein Held zum Siegen.

Joyous, as his suns speed
Through the glorious order of Heaven,
Hasten, brothers, on your way,
Joyful as a hero to victory.

⁸If I had been a good student in my German class, I could find the German translation of the right column footnote ⁴ is "Dieser Teil wurde van Beethoven hinzugefügt" by myself without the kind help from a user.

⁹Original: Was der Mode Schwert geteilt;
Bettler werden Fürstenbrüder,

⁴This part was added by Beethoven.

⁵Original: What custom's sword has parted;
Beggars become princes' brothers

Seid umschlungen, Millionen! Diesen Kuß der ganzen Welt!
Brüder, über'm Sternenzelt muß ein lieber Vater wohnen.

Ihr stürzt nieder, Millionen? Ahnest du den Schöpfer, Welt?
Such'ihn überm Sternenzelt! Über Sternen muß er wohnen.

Be embraced, all ye millions!
With a kiss for all the world!
Brothers, beyond the stars
Surely dwells a loving Father.

Do you kneel before him, oh millions?
Do you sense the Creator's presence?
Seek him beyond the stars!
He must dwell beyond the stars.

7 Reference Manual

7.1 Environment `paracol`

`\begin{paracol}{num}[text] body \end{paracol}`

The environment `paracol` contains *body* typeset in *num* columns in parallel. The optional *text* is put spanning all columns prior to the multi-columned *body*.

- The environment may start from *any* vertical position in a page, i.e., not necessary at the top of a page. The single-column *pre-environment stuff* of the *starting page* in which `\begin{paracol}` lies are naturally connected to the beginning part of *body* in each column, unless the page has footnotes¹⁰ or bottom floats. If these kinds of bottom stuff exist, they are put above the multi-columned *body*, or the spanning *text* if provided, with a vertical skip of `\textfloatsep` separating them if bottom floats exist. The *deferred* floats which have not yet appeared in the starting page and thus will appear in the next or succeeding pages are considered as page-wise floats given in the environment.
- The environment can be enclosed in a *list-like environment* such as `enumerate`, `itemize` and `description`. If so, `\items` in each column are typeset using the parameters of the surrounding environment such as `\leftmargin` and `\rightmargin`. For example, the following short `paracol` environment is included in an `itemize` for this and other `\items` in this page.
- This is the first `\item` in the left column.
- This is the second `\item` in the left column followed by a `\switchcolumn`¹¹.
- This is the first `\item` in the right column.
- This is the second `\item` in the right column.
- This is the third and last `\item` in the right column.

You are now seeing the switching to/from multi-columned and `itemized` texts are naturally connected with the last and this single-columned sentences. You may feel the space between two columns above is too large but it simply results from the large total `\leftmargins` of the outer `description` and this `itemize`, which make the right column shifted right. A simple remedy for this large space is to make `\columnsep` narrower, for example 0pt as shown below.

- This `\item` is wider than the last `\item` above because `\columnsep` is 0pt.
- Therefore, this `\item` is shifted left a little bit to make inter-column space narrower.
- All local counters in all columns are initialized to have the values at `\begin{paracol}` on its first occurrence. On the second and succeeding occurrences of `\begin{paracol}`, the local counters in each column have the value at the last `\end{paracol}`, unless they are modified after the `\end{paracol}`. If a counter is modified (or declared by `\newcounter`) after the `\end{paracol}`, the local versions of the counter in all columns commonly have the value at `\begin{paracol}`.
- The environment may end at *any* vertical position in a page, i.e., the *post-environment stuff* being the single-column texts and others following `\end{paracol}` in the *last page* of the environment may not start from the top of a page. If any columns don't have deferred column-wise floats and the most advanced *leading column* at `\end{paracol}` has neither of footnotes¹² nor bottom floats, its bottom is naturally connected to the post-environment stuff. If the leading column has these kinds of bottom stuff, they are put above the post-environment stuff, with a vertical skip of `\textfloatsep` separating them if bottom floats exist. All deferred column-wise floats given in the environment are

¹⁰With merged footnote layout shown in Section 7.6, the footnotes in the single-column contents are merged with those in `paracol` environment and are put at the bottom of the starting page together as shown in this page.

¹¹This footnote is to show the footnotes in this page are merged.

¹²With merged footnote layout shown in Section 7.6, the footnotes in the closing `paracol` environment are merged with those in post-environment stuff and are put at the bottom of the page together as shown in this page.

flushed before the post-environment stuff appears, possibly creating *float columns* only with floats. On the other hand, deferred page-wise floats given in the environment are considered as deferred (single-) column-wise floats given just after `\end{paracol}`.

- The values of all local counters in the leftmost column are used as the initial values of them in the post-environment stuff.
- The `paracol` environment cannot be nested, or you will have an error message of illegal nesting.
- The commands `\switchcolumn`, `\synccounter`, `\syncallcounters` and `\flushpage`, and environments `column(*)`, `nthcolumn(*)`, `leftcolumn(*)` and `rightcolumn(*)` are *local* to `paracol` environment and thus undefined outside the environment¹³. The command `\clearpage` is of course usable outside and inside the environment but its function inside is a little bit different from outside.

```
\begin{paracol}[numleft]{num}[text]  body  \end{paracol}
\begin{paracol}[numleft]*{num}[text]  body  \end{paracol}
```

If a `\begin{paracol}` has the optional *numleft* argument to specify the number of leading columns n_l together with the total n given by *num*, columns in the environment are laid out across two adjacent pages. In this *parallel-page* typesetting, the first n_l columns are placed in the *left* page while remaining $n_r = n - n_l$ columns go to the next *right* page. The pair of left and right pages is considered as comprising a virtual *paired* page and thus shares a common page number, unless *non-paired* typesetting is specified by the optional ‘*’ following the optional *numleft* argument. In the non-paired parallel-paging, when the leading n_l columns are put in a page p , the trailing n_r columns are in the page $p + 1$.

- All *page-wise stuff*, i.e., pre-environment and post-environment stuff, page-wise floats, spanning text and (merged or non-merged) page-wise footnotes, are placed only in left parallel-pages leaving corresponding regions in right parallel-pages blank¹⁴.
- A non-paired left parallel-page is not necessary to be even-numbered, though the printing tradition requires so if you naturally want to have a parallel-page pair in a double spread. The page number given to the first left parallel-page is simply the number of the page p_1 in which `\begin{paracol}` reside, and that for the k -th left parallel-page is $p_1 + 2(k - 1)$ ¹⁵. Therefore, to make it sure p_1 is even, you might need to have an ordinary page of blank, a title, etc., or to let `page` counter have an even number by `\setcounter`, etc., before starting a `paracol` environment.
- Section 9 shows examples of parallel-paging together with related issues on two-sided typesetting.

7.2 Column-Switching Command and Environments

```
\switchcolumn[col]
\switchcolumn[col]*[text]
```

The command switches columns from i to j where i and j is the zero-origin ordinals of the columns from/to which we are leaving/visiting respectively. Without the optional *col*, $j = i + 1 \bmod n$ where n is the number of columns given to `\begin{paracol}`, while $j = col$ with the optional argument. If the command (or *col* if specified) is followed by a *, the column-switching takes place after synchronization and, if specified, the optional spanning *text* is put.

- Using `\switchcolumn` in a list-like environment *included* in a `paracol` environment causes an ugly result without any error/warning messages. This caution is effectual for all column-switching environments too.

¹³Unless you dare to define them.

¹⁴Someday the author could devise an advanced mechanism to exploit the space in right parallel-pages.

¹⁵Unless you make some change to `page` counter.

- If $col \notin [0, n)$, an error is reported and, if you dare to continue, you will switch to the leftmost column 0.
- The synchronization point is set just below the last line of the leading column in a page p , partly taking deferred floats into account. That is, all deferred floats are put in the pages up to $p - 1$ and at the top of p if possible. Then, if a non-leading column has footnotes and/or bottom floats and they cannot be pushed down below the synchronization point, the point is moved to the next page top¹⁶.
- In a page having one or more synchronization points, stretch and shrink factors of all vertical spaces, such as those surrounding sectioning commands, are ignored. Therefore, even if you specify `\flushbottom`, the page is typeset as if `\raggedbottom` were specified.
- After a synchronization point is set, no top floats will be inserted in the page having the point, thus they will be deferred to the next page or further one.

```
\begin{column}  body  \end{column}
\begin{column*}[text]  body  \end{column*}
```

The environment `column` contains *body* for the column next to what we are in just before `\begin{column}`. The starred version `column*` does the same after synchronization and, if specified, the optional spanning *text* is put.

- The environments are almost equivalent to;

```
{\switchcolumn  body  \par}
{\switchcolumn*[text]  body  \par}
```

except for their first occurrences which don't switch to the column 1 (i.e., right column if two-columned) but stay in the leftmost column 0. More precisely, `\begin{column(*)}` does not make column-switching if it is not preceded by `\switchcolumn` nor other column-switching environments.

- The *body* of the environments cannot have `\switchcolumn` nor column-switching environments including `column(*)` themselves, or you will have an error message of illegal use of command/environment.
- Column-switching does not take place at `\end{column(*)}`. Therefore, texts following the environments are put in the column in which *body* resides until a column-switching command/environment is given.

```
\begin{nthcolumn}{col}  body  \end{nthcolumn}
\begin{nthcolumn*}{col}[text]  body  \end{nthcolumn*}
```

The environment `nthcolumn` contains *body* for the column *col*. The starred version `nthcolumn*` does the same after synchronization and, if specified, the optional spanning *text* is put.

- The environments are equivalent to;

```
{\switchcolumn[col]  body  \par}
{\switchcolumn[col]*[text]  body  \par}
```

- The *body* of the environments cannot have `\switchcolumn` nor column-switching environments including `nthcolumn(*)` themselves, or you will have an error message of illegal use of command/environment.
- Column-switching does not take place at `\end{nthcolumn(*)}`. Therefore, texts following the environments are put in the column in which *body* resides until a column-switching command/environment is given.

¹⁶Or below top floats deferred to the page.

```

\begin{leftcolumn} body \end{leftcolumn}
\begin{leftcolumn*}[text] body \end{leftcolumn*}
\begin{rightcolumn} body \end{rightcolumn}
\begin{rightcolumn*}[text] body \end{rightcolumn*}

```

The environment `leftcolumn` contains *body* for the leftmost column 0, while `rightcolumn` for the column 1 being the right column in two-column typesetting. The starred versions `leftcolumn*` and `rightcolumn*` do the same after synchronization and, if specified, the optional spanning *text* is put.

- The environments `leftcolumn(*)` are equivalent to;

```

\begin{nthcolumn}{0} body \end{nthcolumn}
\begin{nthcolumn*}{0}[text] body \end{nthcolumn*}

```

while `rightcolumn(*)` are equivalent to;

```

\begin{nthcolumn}{1} body \end{nthcolumn}
\begin{nthcolumn*}{1}[text] body \end{nthcolumn*}

```

`\thecolumn`

The command gives you the zero-origin ordinal of the column in which this command appears. Therefore, the following code snip;

```

\begin{paracol}{3}
Column-\thecolumn.\switchcolumn Column-\thecolumn.\switchcolumn Column-\thecolumn.
\end{paracol}

```

gives us the followings.

Column-0.

Column-1.

Column-2.

- The command is *neither* a L^AT_EX's counter nor `\count` register of native T_EX, and thus the value it keeps cannot be modified. However, it can be used wherever an integer number is required or appropriate. Therefore for example, `\setcounter{mycounter}{\thecolumn}` works well to give the column ordinal to the counter `mycounter`.

`\ensurevspace{len}`

The command tells the first synchronizing column-switching command (i.e., `\switchcolumn[col]*`) or environment (i.e., `column*`, etc.) following this command that the page must be broken before synchronization unless the synchronization point has the space of *len* or more below it in the page. If a synchronization does not have the command after the previous synchronization, it is assumed that `\ensurevspace{\baselineskip}` is given.

- This command is to be used when a synchronization point would be placed near the bottom of a page *p* and the space below it is not sufficient for a column *c* to put anything in the page, while another column *c'* can have a few lines in the page. If this happens, the first line after the synchronization should start at the top of the page *p* + 1 in the column *c*, while that of *c'* is still in the page *p*, giving you an impression that the synchronization fails to align the top of all columns below it. The fact is, however, the synchronization point is properly established near at the bottom of the page but the first line of *c* needs some large space due to, for example, the followings.
 - The line has unusually tall stuff including larger font letters.
 - The line has a footnote reference which is hardly apart from the footnote, and thus the line and the footnote go to the next page together.

- The parameter `\clubpenalty` is too large (e.g., 10000) to break the first and second lines into separate pages.
- The first line follows a vertical space.
- This manual itself has some instances of `\ensurevspace` command in the page 9 and 10 in which each German stanza is enclosed in `verse` and then `leftcolumn*` environments and has `\ensurevspace{2\baselineskip}` before the `\begining` of the outer `leftcolumn*` because the first line of the stanza is preceded by a vertical space inserted by `\begin{verse}`. In fact without `\ensurevspace`, the first two lines of the sixth English stanza would be in the page 9, while corresponding German stanza go to the next page 10 as a whole, due to the difference of the height of footnotes in each column, i.e., German ones are taller than English ones to narrow the space for the German column.
- As the author does in the “An die Freude/To Joy” example, it is a good tactics to have an `\ensurevspace` with some vertical space larger than the default `\baselineskip` if it is sure that a column has a feature shown above regardless of the position of the synchronization point in question, because the point goes up or down with revisions of your document and using an `\ensurevspace` for a synchronization far above the page bottom is perfectly harmless. Similarly, if you find a problem in a synchronization and add an `\ensurevspace` to solve it, keeping the command attached is recommended even when the synchronization point moves up or down to make the command unnecessary.

7.3 Commands for Column and Gap Width

`\columnratio{ r_0, r_1, \dots, r_k }[$r'_0, r'_1, \dots, r'_{k'}$]`

The command defines the width of each column by the fraction r_i to specify the portion which i -th ($i = 0$ for the leftmost) column occupies. More specifically, the width w_i of the i -th column is defined as follows, where W is `\textwidth`, S is `\columnsep`, and n is the number of columns given to `\begin{paracol}`.

$$W' = W - (n - 1)S$$

$$w_i = \begin{cases} r_i W' & i \leq k \\ \frac{(1 - \sum_{j=0}^k r_j) W'}{n - (k + 1)} & i > k \end{cases}$$

For a `paracol` environment with parallel-paging, n is replaced with n_l for the columns in left parallel-pages, while n and w_i are replaced with n_r and w_{n_r+i} for those in right parallel-pages. Moreover, if the optional argument having $r'_0, r'_1, \dots, r'_{k'}$ is provided, w_{n_r+i} for a column in right parallel-pages is determined by r'_i and k' instead of r_i and k .

- The equations above imply that $k < n - 1$, $r_i > 0$ and $\sum_{j=0}^k r_j < 1$. If $k \geq n - 1$, k is assumed to be $n - 2$ and all r_i such that $i \geq n - 1$ are ignored. If r_i or its sum does not satisfy the conditions, you will have an ugly result with “Overfull” messages.
- The argument r_0, r_1, \dots, r_k can be empty to mean $k = -1$ to let all column widths be W'/n as default.
- The setting of column width by the command takes effect in the `paracol` environments following the command¹⁷. Therefore, though placing the command in the preamble is the most natural way¹⁸, you may place this command between two `paracol` environments to change the column layout for the second one even when they appear in a page as shown in Section 6.

¹⁷If the command is in a `paracol` environment, the command does not affect the column widths of the environment but does the next ones, though such usage is very unusual.

¹⁸Or second most to not using it at all, of course.

- In the i -th column, `\columnwidth` has w_i and, for outermost paragraphs in the column, `\hsize` has w_i as well. As for `\linewidth`, it has $w_i - (\text{\textwidth} - l)$ where l is what `\linewidth` had at `\begin{paracol}`, i.e., the `\linewidth` for the list-like environment surrounding `paracol` if any, or `\textwidth` otherwise.
- You can specify width of each column and that of each *gap* between two columns more detailedly by `\setcolumnwidth` shown below. If your document has both of `\columnratio` and `\setcolumnwidth` prior to a `paracol` environment, the command given later is effective for the environment.

`\setcolumnwidth`{ s_0, s_1, \dots, s_k }[$s'_0, s'_1, \dots, s'_{k'}$]

The command defines the width of each column and that of each *gap* between two columns by the column/gap specification s_i for the i -th column and the gap between it and the $(i+1)$ -th column. More specifically, s_i has the form of \hat{w}_i or \hat{w}_i / \hat{g}_i where each of \hat{w}_i and \hat{g}_i is a proper glue including a proper dimension, or an empty string to mean $\hat{w}_i = \text{\fill}$ and $\hat{g}_i = \text{\columnsep}$, to determine the width of i -th column w_i and that of i -th gap g_i as follows, where $\text{nat}(x)$ is the natural width of the glue x , $\text{str}(x)$ is the infinite stretch factor of x , W is `\textwidth`, and n is the number of columns given to `\begin{paracol}`.

$$\begin{aligned}
 W' &= \sum_{i=0}^{n-2} (\text{nat}(\hat{w}_i) + \text{nat}(\hat{g}_i)) + \text{nat}(\hat{w}_{n-1}) \\
 F &= \sum_{i=0}^{n-2} (\text{str}(\hat{g}_i) + \text{str}(\hat{g}_i)) + \text{str}(\hat{w}_{n-1}) \\
 x_i &= \begin{cases} (W/W')\text{nat}(\hat{x}_i) & W' \geq W \vee F \leq 0 \\ \text{nat}(\hat{x}_i) + (\text{str}(\hat{x}_i)/F)(W - W') & W' < W \wedge F > 0 \end{cases} \quad (x \in \{w, g\})
 \end{aligned}$$

That is, if the total of natural widths W' is larger than `\textwidth` W or there are no infinite stretch factors in the specification, given widths are scaled down or up so that the scaled total is equal to W . Otherwise, each width with an infinite stretch factor is extended according to its ratio in the total stretch so that the stretched total is equal to W .

For a `paracol` environment with parallel-paging, n is replaced with n_l for the columns in left parallel-pages, while n , w_i and g_i are replaced with n_r , w_{n_r+i} and g_{n_r+i} for those in right parallel-pages. Moreover, if the optional argument having $s'_0, s'_1, \dots, s'_{k'}$ is provided, w_{n_r+i} and g_{n_r+i} for a column in right parallel-pages are determined by s'_i instead of s_i .

- In `paracol` environments having n columns, s_i s.t. $i \geq n$ and \hat{g}_{n-1} are ignored. On the other hand if $k < n - 1$, it is assumed s_i is an empty string for all $i > k$.
- Finite stretch factors and finite or infinite shrink factors in \hat{w}_i and \hat{g}_i are ignored.
- Unlike `TeX`'s genuine glue addition, all infinite unit `fil`, `fill` and `filll` are not distinguished in the summation for F . Also unlike `TeX`'s genuine scaling of a glue primitive, `f\fill` means `0pt plus f fill` for convenience¹⁹.
- The division W/W' and $\text{str}(\hat{x}_i)/F$ can have some arithmetic errors and thus the total of w_i and g_i may not be equal to W exactly but can be a little bit less than W . This small error is, however, equally distributed to g_i in typesetting of a page to make the total width of columns and gaps is exactly W ²⁰.
- All the specifications shown in the table below give us same results for a `paracol` environment having three columns, providing `\textwidth = 360pt` and `\columnsep = S = 20pt`.

¹⁹In `TeX`'s grammar, `f\fill` means a dimension rather than a glue and is `0pt` because the natural component of `\fill` is 0.

²⁰If we may ignore the arithmetic error inherent in `TeX`.

| s_0, s_1, s_2 | w_0 | g_0 | w_1 | g_1 | w_2 (in pt) |
|---|-------------------|------------------|------------------------|------------------|------------------------|
| 50pt/20pt, 100pt/40pt, 150pt | 50 | 20 | 100 | 40 | 150 |
| 50pt, 100pt/2\columnsep, 150pt | 50 | S | 100 | $2S$ | 150 |
| 50pt/\fill, 100pt/2\fill, 150pt , 2\fill/2\columnsep, 3\fill | $(1/6) \cdot 300$ | $(1/3) \cdot 60$ | 100 | $(2/3) \cdot 60$ | 150 |
| 50pt/20, 50pt plus 1fil/40pt, 50pt plus 2fil | 50 | 20 | $50 + (1/3) \cdot 150$ | 40 | $50 + (2/3) \cdot 150$ |
| 5pt/2pt, 10pt/4pt, 15pt | $10 \cdot 5$ | $10 \cdot 2$ | $10 \cdot 10$ | $10 \cdot 4$ | $10 \cdot 15$ |
| 100pt/40pt, 200pt/80pt, 300pt | $0.5 \cdot 100$ | $0.5 \cdot 40$ | $0.5 \cdot 200$ | $0.5 \cdot 80$ | $0.5 \cdot 300$ |

- If your document has both of `\columnratio` and `\setcolumnwidth` prior to a `paracol` environment, the command given later is effective for the environment.

7.4 Commands for Two-Sided Typesetting and Marginal Note Placement

`\twosided[t1t2...tk]`

The command enables a set of two-sided typesetting features $\{t_i \mid t_i \in \{\mathbf{p}, \mathbf{c}, \mathbf{m}, \mathbf{b}\}, 1 \leq i \leq k\}$ explicitly by the optional argument, or all of the following four features as a whole without the argument, in even-numbered pages.

`p(age)` for ordinary two-sided paging, letting the left side margin be `\evensidemargin`, page headers be different from those in odd-numbered pages with `headings` or `myheadings` page style, and `\cleardoublepage` leave an even-numbered page blank if it is used in an odd-numbered page.

`c(olumn)` for *column-swapping* to *print* columns in even-numbered pages in reverse order. This feature is sometimes preferable in typesetting especially with unbalanced parallel columns to make, for example, a wider columns are always *inside* while narrower ones are *outside*.

`m(arginal text)` to place marginal notes in the side margin opposite to that specified by the command `\marginparthreshold` discussed shortly.

`b(ackground painting)` to make background painting, shown in Section 7.8, *mirrored* so that, for example, a color specified for the left margin is used to paint the right margin instead.

- The feature `p` is also enabled by the `twoside` option of `\documentclass` with almost all classes including `article`, `book`, `report`, etc. Though it is strongly recommended to make both settings by `\documentclass` and this command consistent, they can be inconsistent resulting in lack of some expected functions. For example, enabling `p` feature by `\twosided` without `twoside` option in `\documentclass` makes the format of headers and footers in all pages same even with `\pagestyle{headings}`.
- The column-swapping enabled by the feature `c` is ineffective in non-paired parallel-paging because it is meaningless²¹, and thus silently ignored.
- In ordinary single-column typesetting, marginal note swapping in even-numbered pages is enabled by the `twoside` option, while it never takes place in ordinary two-column typesetting. For marginal notes given in `paracol` environments, however, swapping of them in even-numbered pages is enabled by giving the feature `m` to `\twosided`.
- The command has to be outside of `paracol` environments to decide the action in the environments following them. If it appears in a `paracol` environment, you will have a warning message saying it is ignored.
- Here is an example of column swapping. Since this page 17 is odd, this wider column-0 with roman font is placed
- *This narrower, outside and italicized column-1 is at first in right*

²¹Unless somebody tells the author it is meaningful.

side but the page break has changed the position to the left.

in left side and thus inside at the beginning, but now we are in an even page in which this column is in right side.

- In old versions of `paracol`, namely 1.2 and its minor revisions 1.2x, column-swapping was controlled by lengthy commands `\swapcolumninevenpages` and `\noswapcolumninevenpages`. Though they are still available and will be so forever for backward compatibility, it is recommended to use `\twosided` with or without the feature `c`. The old versions also have a problem that spanning stuff crossing a page boundary is placed incorrectly after the page break in it, but this problem is solved by a fix incorporated in version 1.3.
- It must be $t_i \in \{\mathbf{p}, \mathbf{c}, \mathbf{m}, \mathbf{b}\}$, or you will have an error message of illegal two-siding feature.
- Section 9 shows examples of two-sided typesetting together with related issues on parallel-paging.

`\marginparthreshold{k}[k']`

The command specifies the minimum ordinal k of columns whose marginal notes are placed in right margin. That is, marginal notes given in a column- i go to left margin if $i < k$, while they go to right if $i \geq k$. The optional argument k' , if given, is for columns in right parallel-pages to decide the margin where their marginal notes are placed. In default, $k = 1$ is assumed to let marginal notes from the leftmost column-0 go to left margin while those from other columns go to right.

- You may specify $k = 0$ to let all marginal notes go to right margin, or may give the command a large number, say 100, to place all of them in left margin.
- The setting $k = 0$ or $k = 100$ above makes a side margin *shared* by marginal notes from different columns, and sharing is inevitable when a (parallel-) page has three or more columns. When a margin is shared by marginal notes from two or more columns, it can happen that two marginal notes from different columns conflict over the space to be occupied by each of them. This conflict is solved by `paracol` to push down the note given later in your source `.tex` until an available space for it is found. Note that the marginal note to be pushed down is determined by the position in the source rather than that in the printed result. Also note that `paracol` exploits space between two marginal notes having been already placed in the placement of other note coming later to place it at the natural position if possible or to minimize the amount of pushing down otherwise.
- In the decision of the real margin in which a marginal note is placed, other two factors are involved; `m` feature of `\twosided` command and the parity of the page; and \LaTeX 's genuine command `\reversemarginpar`. More specifically, after the first preliminary decision is made according to the threshold given to `\marginparthreshold`, we have the following two steps to modify the decision; if `m` feature has been specified in `\twosided` command and the marginal note belongs to an even-numbered page, the decision is reversed to have the second preliminary result; and then if `\reversemarginpar` has been specified, the second result is reversed (again) to have the final result.
- In old versions of `paracol`, namely older than 1.3, marginal note placement was not only uncontrollable but also gave ugly results when your document has three or more columns because the marginal notes from a column not being leftmost or rightmost were placed in the gap following the column rather than a margin. This miserable *gap note* placement does not happen any more, or in other words this is no more available because the author believes nobody loves it.
- Section 9 shows examples of marginal note placement together with related issues on parallel-paging and two-sided typesetting.

7.5 Commands for Counters

`\globalcounter{ctr}`

`\globalcounter*`

The command `\globalcounter{ctr}` declares that the counter *ctr* is global to all columns, while `\globalcounter*` does so for all counters. An update of a global counter in a column is seen by any other columns.

- All column-local values of a descendant local counter of a global counter are zero-cleared when the global counter is explicitly stepped by `\stepcounter` or `\refstepcounter`, or implicitly by a sectioning command and so on.
- The counter `page` is always global but an explicit update of it by e.g., `\setcounter` in a non-leftmost column is not seen by other columns and is canceled even for the column itself after a column-switching or a page break in the column. Therefore, if you want to make a *jump* of `page`, it must be done in the leftmost column 0. Note that a jump from a page *p* to *q* can be seen in other columns even if they have gone beyond *p* before the column 0 makes the jump, as far as `page` having *q* (or its successor) is referred to by `\pageref` or through *contents* files such as `.toc`²².
- All counters except for `page` are local by default. This feature may cause a problem with some packages including `marginnote` and (auto-)pst-pdf having their own counters which must be global. Since it is tough to find the name of such counters from package sources, if you have something wrong with these (or other) packages, try to put `\globalcounter*` in your preamble and use `\localcounter` shown below to localize specific counters which you need to be local.
- Globalizing a *ctr* being already global is just ignored without any complaints.

`\localcounter{ctr}`

The command declares that the counter *ctr* is local for each column.

- Though this command is intended for localizing a *ctr* which is once globalized, localizing a local counter does not causes any error but is just ignored. Localizing the permanently global `page` is also just ignored without any complaints.

`\definethecounter{ctr}{col}{rep}`

The command defines `\thectr` being *rep* for the local use in the column *col*. That is, `\thectr` in the column *col* acts as if it is defined by `\renewcommand{\thectr}{rep}`.

`\synccounter{ctr}`

The command *broadcasts* the value of the local counter *ctr* in the column in which the command appears to the values in all other columns.

`\syncallcounters`

The command broadcasts the values of all local counters in the column in which the command appears to the values in all other columns.

7.6 Page-Wise Footnotes

`\footnotelayout{layout}`

The command specifies the *layout* $\in \{c, p, m\}$ of footnotes in `paracol` environments as follows.

²²Direct reference to `page` may give an inconsistent result, as you might have in ordinary L^AT_EX documents.

`c(column)` makes footnotes *column-wise* (aka multi-columned) being default to place footnotes in each column at the bottom of the column and separating them from pre-environment and post-environment footnotes.

`p(age)` makes footnotes *page-wise* (aka single-columned) so that footnotes in all columns are gathered, typeset spanning all columns, and placed at the bottom of the page in which they appear or at the end of the `paracol` environment they belong to, so that they are separated from pre-environment and post-environment footnotes.

`m(erge)` makes page-wise footnotes *merged* with footnotes in outside of the environment but in the same page, i.e., those in pre-environment and post-environment stuff.

- An example of merged footnote is found in p. 11 while you will see many of them in Section 8²³.
- In any layouts, a footnote cannot have page breaks in it, i.e., a footnote is always put in a page as a whole. This makes it impossible to have a footnote taller than `\textheight` and thus you will see a warning message if you give a very long footnote which will be printed intruding into the area for page footer (or out of the paper bound).
- Choosing the layout page-wise or merged makes `footnote` counter global and `\fncounteradjustment` shown below performed inside `\footnotelayout`. Choosing column-wise let the command do the operations oppositely, i.e., localizes `footnote` and does `\nofncounteradjustment`. Though these settings are usually appropriate for each footnote layout but you can override them by explicitly using commands like `\localcounter{footnote}`.
- The command has to be outside of `paracol` environments to decide the action in the environments following them. If it appears in a `paracol` environment, you will have a warning message saying it is ignored.
- In old versions of `paracol`, namely 1.2 and its minor revisions 1.2x, footnote layout was controlled by a set of lengthy commands `\multicolumnfootnotes` for `c`, `\singlecolumnfootnotes` for `p`, and `\mergedfootnotes` for `m`. Though they are still available and will be so forever for backward compatibility, it is recommended to use `\footnotelayout`²⁴.
- It must be $layout \in \{c, p, m\}$, or you will have an error message of illegal layout specifier.

```
\footnote*[num]{text}
\footnotemark*[num]
\footnotetext*[num]{text}
```

The starred version of `\footnote`, `\footnotemark` and `\footnotetext` are for the adjustment of the footnote numbering, the order of footnote marks in main texts, and the stacking order of footnotes at page bottom. Their usages with various examples are given in Section 8.

```
\fncounteradjustment
\nofncounteradjustment
```

The maintenance of `footnote` with the starred footnote commands such as `\footnote*` shown above causes out-of-order progress of the counter to make it hard to have a consistent counter value at `\end{paracol}`. The command `\fncounteradjustment` is to let `\end{paracol}` adjust the value of the counter based on its value at `\begin{paracol}` and the number of footnote commands in the environment. The command `\nofncounteradjustment` is to tell `\end{paracol}` to do nothing as in default.

²³The left-column footnote 6 in p. 8 looks like a merged footnote because it is at the bottom of the page and the marked text is above the single-column text. However, it is an ordinary column-wise one produced by a trick with `\footnotemark` and `\footnotetext` in different `paracol` environments.

²⁴Not only for type saving but also for being familiar with this command which could have some advanced feature, for example to put gathered footnotes into a specific column, someday.

- Though `\footnotelayout` with `p`(age-wise) or `m`(erged) argument does `\fncounteradjustment` while that with `c`(olumn) does `\nofncounteradjustment` inside of it, you can override these settings by explicitly putting a counter adjustment command after `\footnotelayout`.
- The effect of `\fncounteradjustment` is shown in Section 8.

7.7 Commands for Coloring Texts and Column-Separating Rules

`\columncolor[mode]{color}[col]`
`\normalcolumncolor[col]`

The command `\columncolor` declares that the *default color* of a column is *color* or what it specifies by the combination with the optional *mode*. The command `\normalcolumncolor` declares the default color is what `\normalcolor` specifies, i.e., black usually. The target column of these commands is that in which the commands reside, or *col* if it specified.

- The command may be outside of `paracol` environment. If so and *col* is not provided, the target column is the leftmost 0.
- The default color declaration is *global*. Therefore, even if the command appears in a `paracol` environment (and even in some grouping structure in it), the declaration will be kept effective after `\end{paracol}` to determine the default color of the specified column in succeeding `paracol` environments.
- To give a color to texts (and maybe other stuff) in a column correctly, you need to load `color` package or its relative (e.g., `xcolor`) which the implementation of coloring in `paracol` relies on.
- Coloring with `\color[mode]{color}` and other coloring commands in `paracol` environments is of course allowed. One caution is that the `\color` decides the color for following texts until other specification is given or the group surrounding the command is closed. Therefore, `\switchcolumn` does not affect the coloring but a color given to the texts in a column is also applied to the texts in the column to be switched to. This irrelativeness of coloring and column-switching is shown in the example below.

This column is colored blue because
`\columncolor{blue}`
 is specified. Here we have a `\switchcolumn`.
 The color of this paragraph is green because
 we are still in the environment of green col-
 oring, which we are now closing.
 Since the coloring environment has been
 closed, the color of this paragraph is the de-
 fault blue. Now we have yet another and the
 last `\switchcolumn` to the right.

This column is colored red because
`\columncolor{red}`
 is specified.
 Now the color of the right column is changed
 to green because
`\begin{color}{green}`
 is given prior to this paragraph. Now we
 have another `\switchcolumn` to go back to
 the left.
 Since this paragraph is outside of the coloring
 environment, its color is the default red.

The default coloring of columns does not affect anything outside of `paracol` environment of course, and thus this sentence is not colored²⁵.

`\coloredwordhyphenated`
`\nocoloredwordhyphenated`

The command `\coloredwordhyphenated` allows the first word following a coloring command such as `\color` to be hyphenated, but at the same time make it possible that a line is broken before the word.

²⁵Or colored black as `\normalcolor` specifies.

The command `\nocoloredwordhyphenated` acts oppositely and thus line breaking before the first word and hyphenating it are inhibited. By default, `\coloredwordhyphenated` is effective.

- The implementation of `color` package and its relatives makes it impossible that *word* is hyphenated when it appears like `{\color{red}word ...}` or `\textcolor{word ...}`. This inhibition of the hyphenation is sometimes annoying especially when the document is multi-columned and thus a line is narrow and a column is written in a language having long words such as German. Therefore in `paracol` package, a trick is used to allow the *word* is hyphenated. However this trick being insertion of a null horizontal space has a side effect that the word can have a line break before it. Though this line break is usually unharmed, in a special occasion the break is undesirable and inappropriate by making it possible that the *half-colored* word ‘inappropriate’ is broken between ‘in’ and ‘appropriate’ without hyphenation. Therefore, if you find such an inappropriate break, use `\nocoloredwordhyphenated` as follows, for example.

```
{\nocoloredwordhyphenated in\textcolor{red}{appropriate}}
```

```
\colseprulecolor[mode]{color}[col]
\normalcolseprulecolor[col]
```

The command `\colseprulecolor` declares the color for *column-separating rules*, being the vertical rules drawn at the center of gaps between columns, is *color* or what it specifies by the combination with the optional *mode*. The command `\normalcolseprulecolor` declares the color of rules is what `\normalcolor` specifies, i.e., black usually. If the optional argument *col* is given, these commands specifies the color of the rule in the gap following the column whose ordinal is *col*, rather than all rules.

- The rules are drawn if L^AT_EX’s typesetting parameter `\columnseprule` for the rule width has non-zero value, e.g., `0.4pt` to obey the standard rule thickness. The rules are *not* drawn on page-wise stuff, i.e., pre-environment and post-environment stuff, page-wise floats or (merged or non-merged) page-wise footnotes of course but also spanning texts. Therefore, if a page has spanning texts, the rules are *broken* by them as shown in the red rule example below.

This is a left column paragraph preceding a spanning text. Of course the rule separating this and the next column starts from the top of this paragraph.

This is a right column paragraph preceding a spanning text given by the `\switchcolumn*` at its end.

An Example of Spanning Text Given by `\subsubsection*` Command

Since we have a spanning text above, the red rule separating this and the next column is broken by the text.

It is also natural that the rule separating this and the previous column is terminated at the end of this `paracol` environment.

- To give a color to rules correctly, you need to load `color` package or its relative (e.g., `xcolor`) which the implementation of coloring in `paracol` relies on.
- Once you give a color to rules in a specific gap with the optional *col*, another `\colseprulecolor` or `\normalcolseprulecolor` without *col* does *not* change the color of the rule in the gap.

7.8 Commands for Background Painting

```
\backgroundcolor{region}[mode]{color}
\backgroundcolor{region(x_0,y_0)}[mode]{color}
\backgroundcolor{region(x_0,y_0)(x_1,y_1)}[mode]{color}
```

The command declares that *background painting* of *region* is performed with *color* or what it specifies by the combination of the optional *mode*. The *region* whose background is painted is one of the following.

c(olumn) for all columns, or particular one if *region* is *c[col]* to specify its ordinal *col*.

g(ap) for all gaps between columns, or particular one if *region* is *g[col]* to specify the ordinal *col* of the column preceding the gap.

s(panning) for spanning texts.

f(loat) for page-wise floats.

n(ote) for (merged or non-merged) page-wise footnotes.

p(re/post) for pre-environment and post-environment stuff.

t(op) for top margin.

b(ottom) for bottom margin.

l(ef) for left margin.

r(ight) for right margin.

In addition, capitals of the keys above, i.e., **C**, **G**, . . . , **L**, are also legitimate for *under painting*. For example, you may specify to paint the background of a region, say top margin, by two `\backgroundcolor` with **t** and **T** and with different color arranging the size of the region of either **t** or **T** (or both of them) by the *extension* option shown below.

The optional (x_0, y_0) is to enlarge the region to be painted shifting its left-top and right-bottom corner outside by the dimension x_0 horizontally and y_0 vertically, or to shrink it with negative dimensions. This *extension* can be asymmetric giving another optional (x_1, y_1) so that it acts on the right-bottom corner while let (x_0, y_0) shift only the left-top corner. Moreover, you may make each extension *infinite* by giving 10000 pt (about 3.5 m) to x_0 , y_0 , x_1 and/or y_1 so that the corresponding region edge is shifted to the paper edge. Furthermore, this *infinite extension* can be terminated at the point α inside the corresponding paper edge by giving $10000 \text{ pt} - \alpha$ ($\alpha \leq 1000 \text{ pt}$) to an extension parameter x_0 , etc.

- A region whose color is not specified is not painted and thus left blank (or kept as painted by `\pagecolor` if you specify it).
- Under-painting of columns and gaps by **C** and **G** is made for regions different from those over-painting **c** and **g**. That is, under-painting is done ignoring all page-wise stuff and thus the height of the regions is always `\textheight + \maxdepth`. On the other hand, over-painting is only for chunks shrunk or separated by page-wise stuff.
- You may exploit the following painting order, where x_i is the i -th spanning text ($x \in \{\mathbf{s}, \mathbf{S}\}$) or i -th chunk followed by the i -th spanning text, m and n is the number of spanning texts and columns in a page respectively, to overlay a preceding region with a succeeding region, if your *printer* allows overlaid color painting.

$$\begin{aligned} \mathbf{T} &\rightarrow \mathbf{B} \rightarrow \mathbf{L} \rightarrow \mathbf{R} \rightarrow \mathbf{G}[0] \rightarrow \dots \rightarrow \mathbf{G}[n-1] \rightarrow \mathbf{C}[0] \rightarrow \dots \rightarrow \mathbf{C}[n-1] \\ &\rightarrow \mathbf{t} \rightarrow \mathbf{b} \rightarrow \mathbf{l} \rightarrow \mathbf{r} \rightarrow \mathbf{N} \rightarrow \mathbf{n} \rightarrow \{\mathbf{F}, \mathbf{P}\} \rightarrow \{\mathbf{f}, \mathbf{p}\} \rightarrow \mathbf{S}_1 \rightarrow \dots \rightarrow \mathbf{S}_m \\ &\rightarrow \mathbf{g}_1[0] \rightarrow \dots \mathbf{g}_1[n-2] \rightarrow \mathbf{c}_1[0] \rightarrow \dots \mathbf{c}_1[n-1] \rightarrow \mathbf{s}_1 \\ &\rightarrow \dots \end{aligned}$$

$$\begin{aligned} &\rightarrow \mathfrak{g}_m[0] \rightarrow \cdots \mathfrak{g}_m[n-2] \rightarrow \mathfrak{c}_m[0] \rightarrow \cdots \mathfrak{c}_m[n-1] \rightarrow \mathfrak{s}_m \\ &\rightarrow \mathfrak{g}_{m+1}[0] \rightarrow \cdots \mathfrak{g}_{m+1}[n-2] \rightarrow \mathfrak{c}_{m+1}[0] \rightarrow \cdots \mathfrak{c}_m[n-1] \end{aligned}$$

- If you specify `b` feature by `\twosided`, background painting is *mirrored* in even-numbered pages so that `l` and `L` mean right margin, `r` and `R` mean left margin, and asymmetric extensions are applied to right-top and left-bottom corners.
- To give a color for background painting correctly, you need to load `color` package or its relative (e.g., `xcolor`) which the implementation of coloring in `paracol` relies on.
- To paint margins and regions having infinite extension correctly, the parameters `\paperwidth` and `\paperheight` should be set properly by, for example, a paper selection option of `\documentclass`.
- Section 10 shows examples of background painting to give you more intuitive explanations of `\backgroundcolor` and its region specifications.

`\nbackgroundcolor{region}`
`\resetbackgroundcolor`

The command `\nbackgroundcolor` declares that the background of *region* is not painted, where *region* is one of legitimate region specifiers of `\backgroundcolor`. The command `\resetbackgroundcolor` declares no regions are painted and thus gives you the default state.

- If you specified the background painting of `c[col]` or `g[col]` by `\backgroundcolor`, the painting is *not* canceled by `\nbackgroundcolor` with `c` or `g` but without `[col]`. Similarly, once you made declarations of background painting of both `c` and `c[col]` (resp. `g` and `g[col]`), `\nbackgroundcolor` with `c[col]` (resp. `g[col]`) cancels the painting of `c[col]` (resp. `g[col]`) but the region will still be painted by the color you gave to `c` (resp. `g`).

`\pagemrim`

This is a (kind of) *length command*²⁶ to have the width of the *rim* area placed at each paper edge to inhibit background painting in the area. That is, the inner edges of the area are considered as virtual paper edges to block painting of all margins and regions having infinite extension to the edges, for example in order to avoid printing troubles caused by painting the rim area too close to the real paper edges. The default value of `\pagemrim` is 0 to allow paint anywhere in a paper.

7.9 Control of Contents Output

`\addcontentsonly{file}{col}`

The command inhibits the output of contents information to $file \in \{\text{toc}, \text{lof}, \text{lot}\}$ from columns other than *col*.

- For example, this manual has `\addcontentsonly{toc}{0}` to inhibit the contents information output from `\subsection` commands in the right column in Section 4 and 5, or the table should have duplicated entries of sub-sections.
- It must be $file \in \{\text{toc}, \text{lof}, \text{lot}\}$, or you will have an error message of illegal type of contents file.

7.10 Page Flushing Commands

`\flushpage`

The command flushes pages up to the *top page* in which the leading column resides. Deferred floats which can be put in the pages up to the top page are also flushed.

²⁶In reality, it is a `\dimen` register rather than a `\skip` register.

`\clearpage`

The command does what `\flushpage` does and then flushes all floats still deferred if any. The deferred float flushing beyond the top page takes place at first for column-wise ones creating float columns for them, and then for page-wise ones creating *float pages* only with page-wise floats, as L^AT_EX's `\clearpage` does outside `paracol` environment.

`\cleardoublepage`

The command does what L^AT_EX's `\cleardoublepage` does outside `paracol`. That is, it does `\clearpage` always and then leaves a blank page if it is even-numbered and two-sided `p(age)` feature is enabled by `twoside` option of `\documentclass` or `paracol`'s own `\twosided` command shown in Section 7.4.

- This command is equivalent to `\clearpage` in `paracol` environments for non-paired parallel-paging because `\clearpage` flushes *both* left and right parallel-pages.

8 Numbering and Placement of Page-Wise Footnotes

Here we have a simple example of page-wise but not-merged footnotes²⁷.

²⁷Because of the non-merged typesetting, this footnote is put above the example.

| | |
|--|--|
| First left-column paragraph | First right-column paragraph..... |
| with a footnote ²⁸ in it. | with a footnote ³⁰ in it. |
| Second left-column paragraph..... | Second right-column paragraph..... |
| with a footnote ²⁹ in it. | with a footnote ³¹ in it. |

²⁸First left-column footnote.

²⁹Second left-column footnote.

³⁰First right-column footnote.

³¹Second right-column footnote. This and all other footnotes above are page-wise and, since footnote typesetting is non-merged, they are put above the post-environment stuff.

As shown above, it is easy to have a reasonable result of footnote numbering and placement as far as your `paracol` environment is completely included in a page and you accept the numbering in left-column-first manner constructing the environment as follows exploiting the fact `footnote` is made global, where b is the value of `footnote` counter at `\begin{paracol}`, i.e., the number given to the footnote just preceding the environment, and thus $b = 27$ in the example above.

```
\begin{paracol}{2}
left-column stuff having n footnotes numbered b + 1, b + 2, ..., b + n
\switchcolumn
right-column stuff having m footnotes numbered b + n + 1, b + n + 2, ..., b + n + m
\end{paracol}
```

The real life is, however, tougher than that, because the assumptions above are too optimistic as described in the following subsections.

8.1 Multiple `\switchcolumn` in a Page

Here we have an example with three `\switchcolumn` commands in a page having six footnotes. Hereafter, footnotes are typeset with `\footnotelayout{m}`³².

| | |
|--|---|
| First left-column paragraph | First right-column paragraph..... |
| with a footnote ³³ in it. | with a footnote ³⁵ in it. |
| Second left-column paragraph..... | It is followed by a <code>\switchcolumn*</code> . |
| with a footnote ³⁴ in it. | |
| It is followed by a <code>\switchcolumn</code> . | |
| Third and synchronized left-column paragraph . | Second and synchronized right-column paragraph |
| with a footnote ³⁶ in it. | with a footnote ³⁷ in it. |
| It is followed by a <code>\switchcolumn</code> . | Third right-column paragraph..... |
| | with a footnote ³⁸ in it. |

³²And thus this footnote is merged with those in the `paracol` environment.

³³First left-column footnote.

³⁴Second left-column footnote.

³⁵First right-column footnote but following the second left-column one.

³⁶Third left-column footnote but following the first right-column one.

³⁷Second right-column footnote but following the third left-column one.

³⁸Third right-column footnote.

The example in the previous page should look weird because the order of the third footnote in the left column 36 and the first in the right 35 are reversed in their numbers and in the stack at the page bottom. However, the result is *natural* because they are numbered and stacked in the order of occurrence in the source `.tex` as always done in any documents without `paracol` and with it but column-wise footnote typesetting. Since the `paracol` cannot maintain the order automatically³⁹, you have to maintain it by yourself.

The problem is partly solved by using `\footnote` with its optional argument `[num]` to number the first right-column and the third left-column footnotes explicitly, i.e., to give `num = 36` to the former and `num = 35` to the latter. One caution is that you have to remember that `\footnote` with the optional `num` does not update `footnote` counter and thus you have to do `\setcounter{footnote}{36}` or `\addtocounter{footnote}{2}` after the third left-column footnote.

This remedy, however, cannot change the stacking order of these two footnotes of course. Therefore, you need another trick with `\footnotemark` and `\footnotetext` to stack the third left-column footnote above the first right-column one. More specifically, you can solve the problem inserting

```
\footnotetext[35]{text for the third left footnote}
```

somewhere between `\footnote` commands for the second left-column and the first right-column ones, e.g., at the end of the second left-column paragraph, and attaching its mark to the appropriate word for the footnote by `\footnotemark[35]`, to have the following.

| | |
|--|--|
| <p>First left-column paragraph with a footnote⁴⁰ in it. Second left-column paragraph with a footnote⁴¹ in it. It is followed by <code>\footnotetext[42]{text}</code> and a <code>\switchcolumn</code>.</p> <p>Third and synchroized left-column paragraph... with a footnote whose mark here⁴² is given by <code>\footnotemark[42]</code> in it. It is followed by <code>\addtocounter{footnote}{2}</code> and a <code>\switchcolumn</code>.</p> | <p>First right-column paragraph..... with a footnote⁴³ in it. It is followed by a <code>\switchcolumn*</code>.</p> <p>Second and synchronized right-column paragraph with a footnote⁴⁴ in it. Third right-column paragraph..... with a footnote⁴⁵ in it.</p> |
|--|--|

Though this solution gives a good result, however, it has the following two problems. First, you have to explicitly specify the footnote number through the optional arguments `[num]` of `\footnote`, `\footnotetext` and `\footnotemark`. This problem is quite severe because, for example, if you add a footnote somewhere preceding the `paracol` environment in question, you have to modify all `[num]` arguments of footnote-related commands in the environment. This means that when the footnote addition is done in the first page of a 100-page document having `paracol` environments with explicitly numbered footnotes in every page, you have to make the corrections for environments in 99 pages. The other a little bit less severe problem is that you have to keep `footnote` counter having correct value by `\setcounter`, `\addtocounter` or `\stepcounter` for footnotes following those with explicit numbering so that their numbers are given by the default action of `\footnote`.

To cope with these two problems, `paracol` provides you with the *starred* versions of `\footnote` and its relatives as introduced in Section 7.6 and detailedly explained in the next Section 8.2.

³⁹So far, because the maintenance is extremely tough. But since it is not impossible, some day you could have an improved version of `paracol` with the automatic ordering.

⁴⁰First left-column footnote.

⁴¹Second left-column footnote.

⁴²Third left-column footnote given by `\footnotetext[42]{text}` placed at the end of the second left-column paragraph.

⁴³First right-column footnote whose number 43 is explicitly given by `\footnote[43]{text}`.

⁴⁴Second right-column footnote correctly following the first right-column one.

⁴⁵Third right-column footnote.

8.2 Commands `\footnote*` and Relatives

```
\footnote* $[+disp]$ {text}
\footnote* $[-disp]$ {text}
\footnote* $[disp]$ {text}
```

The command is similar to its non-starred counterpart but the explicit numbering with the optional argument is done in *self-relative* or *base-displacement* style. That is, if the optional argument has a leading ‘+’ or ‘-’, the number given to the footnote is $f + disp$ or $f - disp$ respectively where f is the value of `footnote` counter, or in other words the number given to the last footnote⁴⁶. Otherwise, i.e., the optional argument is a number without +/- sign, the number given to the footnote is $b + disp$ where b is the base value of `footnote` counter at `\begin{paracol}` for the environment in which the command appears, or in other words the number given to the last pre-environment footnote⁴⁷.

In addition, unlike the non-starred version, this command updates `footnote` counter with the number given to the footnote, i.e., $f \leftarrow f + disp$, $f \leftarrow f - disp$ or $f \leftarrow b + disp$ is performed, so that following `\footnote` without explicit numbering option have numbers $f + 1$, $f + 2$ and so on with new f .

- If the optional argument is not provided, it is assumed that `[+1]` is given and thus `\footnote*{text}` acts as `\footnote{text}`.

```
\footnotemark* $[+-]disp$ 
```

This command is a mixture of its non-starred counterpart and `\footnote*`. That is the number for the footnote mark is calculated in the way of `\footnote*` and `footnote` counter is updated.

```
\footnotetext* $[+-]disp$ {text}
```

Without the optional argument `[+-]disp`, this command does what `\footnotetext{text}` does but in addition increments `footnote` counter before that. With the optional argument, on the other hand, the number given to the footnote `text` is calculated as done in `\footnote`, but the `footnote` counter is not updated.

With these starred commands, you can produce the following using the base-displacement mechanism without worrying about the absolute value of `\footnote` counter and its change.

| | |
|---|--|
| <p>First left-column paragraph with a footnote⁴⁸ in it. Second left-column paragraph with a footnote⁴⁹ in it. It is followed by <code>\footnotetext*[3]{text}</code> and a <code>\switchcolumn</code>. Third and synchronized left-column paragraph with a footnote whose mark here⁵⁰ is given by <code>\footnotemark*[3]</code> because $50 = 47 + 3$. It is followed by a <code>\switchcolumn</code>.</p> | <p>First right-column paragraph with a footnote⁵¹ in it. It is followed by a <code>\switchcolumn*</code>. Second and synchronized right-column paragraph with a footnote⁵² in it. Third right-column paragraph with a footnote⁵³ in it.</p> |
|---|--|

⁴⁶If it is put by the ordinary `\footnote`.

⁴⁷Or the last footnote in the previous `paracol` environment, etc.

⁴⁸First left-column footnote.

⁴⁹Second left-column footnote.

⁵⁰Third left-column footnote given by `\footnotetext*[3]{text}` placed at the end of the second left-column paragraph to have $50 = 47 + 3$.

⁵¹First right-column footnote whose number 51 is given by `\footnotemark*[4]{text}` because $51 = 47 + 4$.

⁵²Second right-column footnote produced by `\footnote*[5]{text}` because $52 = 47 + 5$.

⁵³Third right-column footnote produced by `\footnote{text}` because $53 = 52 + 1$.

The other way to produce the same result except for the absolute footnote numbers is to use the self-relative mechanism and to exploit the progress of `footnote` counter as follows.

| | |
|--|--|
| <p>First left-column paragraph with a footnote⁵⁴ in it. Second left-column paragraph with a footnote⁵⁵ in it. It is followed by <code>\footnotetext*{text}</code> and a <code>\switchcolumn</code>.</p> <p>Third and synchronized left-column paragraph with a footnote whose mark here⁵⁶ is given by <code>\footnotemark*[-1]</code> because $56 = 57 - 1$. It is followed by a <code>\switchcolumn</code>.</p> | <p>First right-column paragraph with a footnote⁵⁷ in it. It is followed by a <code>\switchcolumn*</code>.</p> <p>Second and synchronized right-column paragraph with a footnote⁵⁸ in it. Third right-column paragraph with a footnote⁵⁹ in it.</p> |
|--|--|

It depends on the structure of your document which of the base-displacement and self-relative is better. If your document has frequent switching between single- and multi-column text typesetting and thus the contents of a `paracol` environment is relatively small, the base-displacement is a good choice because you may concentrate on one base value of `footnote` counter. Otherwise, especially when your document consists of one single and large `paracol` environment, the base-displacement is almost equivalent to maintaining absolute values and thus the self-relative should be preferred.

Note that if the last `\footnote` or `\footnotemark` in a `paracol` environment is starred, the command lets `footnote` counter have some value smaller than that for the last stacked footnote. For example, if the second and third right-column footnotes 58 and 59 are omitted from the example above, the last footnote-related command will be `\footnotemark*[-1]` which makes the counter at `\end{paracol}` 56 rather than 57. You may not worry about this problem, however, because `\end{paracol}` automatically maintains the counter letting it have $b + n$ where n is the number of `\footnote` and `\footnotemark` in the environment, if the maintenance is ordered by the command `\fncounteradjustment` which is automatically executed by `\footnotelayout` with the argument `p` or `m`.

8.3 Page Break

When a `paracol` environment with footnotes lays across a page boundary, you could have some weird result even if the environment have just one `\switchcolumn` as shown below.

| | |
|---|---|
| <p>First left-column paragraph with a footnote⁶⁰ in it.</p> | <p>First right-column paragraph with a footnote⁶² in it.</p> |
|---|---|

⁵⁴First left-column footnote.
⁵⁵Second left-column footnote.
⁵⁶Third left-column footnote given by `\footnotetext*{text}` placed at the end of the second left-column paragraph because it follows the second footnote 55.
⁵⁷First right-column footnote whose number 57 is given by `\footnote{text}` because $57 = 56 + 1$ and `\footnotetext*` for 56 lets `footnote` have the value.
⁵⁸Second right-column footnote produced by `\footnote*[+2]{text}` because $58 = 56 + 2$.
⁵⁹Third right-column footnote produced by `\footnote{text}` because $59 = 58 + 1$.
⁶⁰First left-column footnote.

Second left-column paragraph Second right-column paragraph
 with a footnote⁶⁸ in it. with a footnote⁶⁹ in it.
 It is also followed by a `\switchcolumn`.

Unfortunately, this tactics does not always solve the problem. If a left-column paragraph has a page break in it and a footnote before the break, doing `\switchcolumn` after the paragraph is too late to let right-column footnotes reside in the page just having been broken, while inserting `\switchcolumn` before the paragraph should cause incorrect stacking order.

The remedy for this problem is similar to that shown in Section 8.1 to cope with multiple `\switchcolumn` in a `paracol` environment. Here it is shown a little bit more formally. Suppose we have a page in a `paracol` environment in which a page break occurs in p_l -th and p_r -th paragraphs in the left and right columns respectively. Thus we have $p_l - 1$ and $p_r - 1$ completed paragraphs in each of both columns. Let n_l (resp. n_r) be the number of footnotes in the pre-break left-column (resp. right-column) paragraphs, and m_l (resp. m_r) be the number of pre-break footnotes in the p_l -th (resp. p_r -th) paragraph. Thus we have $n_l + m_l$ (resp. $n_r + m_r$) footnotes in the left (resp. right) column of the page before the break. The following construct assures that those footnotes are properly numbered and stacked at the bottom of the page.

```

First to  $(p_l - 1)$ -th paragraphs with  $n_l$  footnotes in total given by \footnote{text}.
\footnotetext*{1st footnote in  $p_l$ -th paragraph}
...
\footnotetext*{ $m_l$ -th footnote in  $p_l$ -th paragraph}
\switchcolumn
First to  $(p_r - 1)$ -th paragraphs with  $n_r$  footnotes in total given by \footnote{text}.
\footnotetext*{1st footnote in  $p_r$ -th paragraph}
...
\footnotetext*{ $m_r$ -th footnote in  $p_r$ -th paragraph}
\switchcolumn
 $p_l$ -th paragraph whose first footnote mark is given by \footnotemark*[-( $m_l+n_r+m_r-1$ )], while
second to  $m_l$ -th ones are given by \footnotemark without * nor optional [num]. The first
subsequent footnotes beyond the page break, if any, is given by \footnote*[( $n_r+m_r+1$ )]{text}
while further subsequent ones are given by \footnote{text}.
\switchcolumn
 $p_r$ -th paragraph whose first footnote mark is given by \footnotemark*[-( $m_r+k_l-1$ )] where  $k_l$  is
the number of left-column footnotes beyond the break, while second to  $m_r$ -th ones are given
by \footnotemark. The first subsequent footnotes beyond the page break, if any, is given by
\footnote*[( $k_l+1$ )]{text}, while further subsequent ones are given by \footnote{text}.

```

The example shown in the next two pages is for the case of $p_l = p_r = n_l = n_r = m_l = m_r = k_l = 2$.

⁶⁸Second left-column footnote whose number 68 follows the right-column footnote 67 in the last page.

⁶⁹Second right-column footnote whose number 69 follows the left-column footnote 68.

| | |
|---|---|
| ...and two post-break footnotes..... | ...and two post-break footnotes..... |
| ... here ⁷⁸ by <code>\footnote*{+5}{text}</code> | ... here ⁸⁰ by <code>\footnote*{+3}{text}</code> |
| ...and here ⁷⁹ by <code>\footnote{text}</code> | ...and here ⁸¹ by <code>\footnote{text}</code> |

followed by a `\switchcolumn`.

Note that though the remedy works well as shown above, it is not a good idea to do that when you are writing draft versions of your document because page break points go up and down by your modifications to the document. Therefore, it is recommended to put all footnotes by non-starred `\footnote` until your document becomes perfect except for footnote numbering and placement and then to adjust them by the technique described in this section.

⁷⁸Fifth left-column footnote given by `\footnote*{+5}` because $n_r + m_r + 1 = 2 + 2 + 1 = 5$ and thus $78 = 73 + 5$.

⁷⁹Sixth left-column footnote given by `\footnote{text}`.

⁸⁰Fifth right-column footnote given by `\footnote*{+3}` because $k_l + 1 = 3$ and thus $80 = 77 + 3$.

⁸¹Sixth right-column footnote given by `\footnote{text}`.

page 35 (now), this wider column is now right one keeping it inside, while the marginal note given in the first line of this page goes to left and outside. Now we will have a `\switchcolumn` below this paragraph to go to the column-1 and back to the previous page 34.

by the page break. The third marginal note is given in the first line of this page, but it is pushed down again due to the conflict with the note from the column-0.

Third
marginal
note from
column-0
Third
marginal
note from
column-1.
Marginal
note given
after
`paracol`
environ-
ment is
closed.

Note that the position of the last marginal note in the `paracol` environment which we just have closed affects the marginal note placement in post-environment stuff. For example, the marginal note given in the first line of this paragraph is pushed down.

From the next page, we will see a few examples of parallel-paging.

Marginal note from column-3. This is the first paragraph in the last rightmost column-3 whose width is equal to that of the column-2. The marginal note given in the first line goes to right and does not conflict with that from the column-2. We are now going back to the column-0 by a `\switchcolumn*` with a spanning text.

Marginal note from column-2.

As expected, this line is aligned to the first line of the paragraph in the column-2 as well as those in column-0 and 1. It is also consistent the first lines including that of this paragraph are not indented because the spanning text is given by `\subsection` which makes first paragraphs unindented.*

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After the page break we will have shortly, this column becomes the leftmost in the left parallel-page,

This is the first paragraph of the column-2 being the left column of the right parallel-page. Though we are in a page different from that column-0 and 1 reside in, this page is still numbered 36 because the left and right page is paired. Therefore, the left margin of this page is narrower than the right margin because the page number is odd.

You have to notice the first paragraph does not start from the page top but above it we have some space of exactly same size as the pre-environment stuff shown in the left parallel-page. Therefore, the top of the first paragraphs in all columns are aligned. The marginal note given in the first line of this paragraph goes to the right margin of this page because of the `\marginparthreshold` setting and the parity of this page. Now we have a `\switchcolumn` to the next column-3.

We have a few other materials not shown in right parallel-pages. The space above this paragraph is for the spanning text placed in the left parallel-page. The page-wise footnote given here⁸⁵ is also not in this page but in the left. Finally, the author has put a page-wise figure spanning columns just before `\switchcolumn` by which we left this column, but it will be in the right page 37 together with column-0 and 1.

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Though the footnote numbered 85 goes to the left page, its space and that of 84 make this and the next

page-wise figure given in column-2

Figure 11: A Page-Wise Figure

the break but in the right one. This is because the feature `c` is enabled to swap not only columns in a page but also the left and right paired parallel-pages when they are even-numbered. The other feature `p` makes the left outside margins of this right and the previous left pages wider than the right inside margins.

column-0 and is placed outside (left) in the page, as well as the marginal note in this right page but in the outside margin. Another marginal note from column-1.

Now you are seeing yet another material placed only in the page in which the `column-0` resides and thus being the right page now, i.e., this paragraph and the next one in the post-environment stuff. You might be disappointed by the fact the *outside* pages, i.e., left in this page 37 and right in the previous page 36, cannot have page-wise stuff but it is what the author can do now for the version 1.3 and thus you have to wait some future versions in which the author could devise a mechanism to exploit the corresponding space in the pages⁸⁶. In addition, you might think it is weird that the `c` feature of `\twosided` swaps columns *and* paired pages. However this swapping is a natural consequence of the combination of column-swapping and paired parallel-paging. Therefore, you can simply disable the `c` feature (maybe together with other features) to have more intuitive results.

In the next Section 9.2, you will see another kind of parallel-paging namely non-paired one. Before that, we need a blank page to let the non-paired parallel-paging start from an even-numbered page so that a left and right page pair comprises a double spread. A short remark on the blank next page is that it does not have a right counterpart parallel-page because the page is outside `paracol` environments and does not have any portion from the environments⁸⁷.

⁸⁶You might complain the immaturity of parallel-paging and might claim that it should be included in `paracol` after the author implements the mechanism. In fact the author himself is frustrated current features of parallel-paging but he dared to release the version 1.3 knowing that there are people who happily typeset their parallel-paged documents with the current limited features.

⁸⁷To illustrate this fact, the author dares to put a real blank page rather than stepping the `page` counter.

columns shorter in the previous page. Similarly, we have a space above for the page-wise figure shown in the right page.

as you are seeing now, but still outermost as well as the marginal note in the outside left margin. Another marginal note from column-3.

(intentionally blanked page)

9.2 Example of Non-Paired Parallel-Paging

This and following three pages are to show an example of non-paired parallel-paging, in which the author keeps the setting of `\twosided`, `\columnratio` and `\marginparthreshold` unchanged. The arguments of `\begin{paracol}` for column population are also unchanged to have 2 + 2 configuration, but the first argument is followed by `*` for non-paired typesetting. That is, the environment below starts by `\begin{paracol}[2]*{4}`. The contents of the environment is also almost same as the previous Section 9.1, while **bold-faced** words show the difference from the paired typesetting.

This is the first paragraph of the leftmost column-0, whose first line has a marginal note placed in the **left** margin because the setting of `\marginparthreshold` being 0 is still effective and we are in the **even**-numbered page **39**. Now we have a `\switchcolumn` to the next column-1.

This is the first paragraph of the second and right column-1 in the left parallel-page. We shortly give an italicized marginal note carefully, so that it does not conflict with the marginal note from the column-0. That is, now the author puts the note. Now we have a \switchcolumn to the next column-2.

Marginal note from column-0.
Marginal note from column-1.

A Spanning Text: though this is wider than the page width, this text does not span the boundary between the left and right parallel-pages.

We have come back to this column-0. The space above the spanning text is due to the synchronization because two paragraphs in the column-2 are significantly taller in total than the paragraphs in other columns. As the spanning text itself says, it cannot extend to the right parallel-page. The author puts dummy lines to go to the page bottom.

We have restarted this column-1. This paragraph has a footnote⁸⁸ as shown below.

.....

.....

Now we will have a page break shortly. You **will not** be surprised by seeing this column is still in the left parallel-

After the page break below, this column also stays in the left page together with

⁸⁸This footnote is put in the left parallel-page together with another footnote below given in the column-2 in the right parallel-page.

⁸⁹This footnote is *not* put in the right parallel-page though it is given in the column-2 in the right parallel-page and thus its reference is in the column, of course.

Marginal note from column-3.

This is the first paragraph of the column-2 being the left column of the right parallel-page. **Since we are in the page next to** that column-0 and 1 reside in, this page is numbered **40** because the left and right page is **non-paired**. Therefore, the left margin of this page is narrower than the right margin because the page number is odd.

Marginal note from column-2.

You have to notice the first paragraph does not start from the page top but above it we have some space of exactly same size as the pre-environment stuff shown in the left parallel-page. Therefore, the top of the first paragraphs in all columns are aligned. The marginal note given in the first line of this paragraph goes to the right margin of this page because of the `\marginparthreshold` setting and the parity of this page. Now we have a `\switchcolumn` to the next column-3.

We have a few other materials not shown in right parallel-pages. The space above this paragraph is for the spanning text placed in the left parallel-page. The page-wise footnote given here⁸⁹ is also not in this page but in the left. Finally, the author has put a page-wise figure spanning columns just before `\switchcolumn` by which we left this column, but it will be in the **left** page **41** together with column-0 and 1.

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.....

Though the footnote numbered **89** goes to the left page, its space and that of **88** make this and the next

This is the first paragraph in the last rightmost column-3 whose width is equal to that of the column-2. The marginal note given in the first line goes to right and does not conflict with that from the column-2. We are now going back to the column-0 by a `\switchcolumn` with a spanning text.*

As expected, this line is aligned to the first line of the paragraph in the column-2 as well as those in column-0 and 1. It is also consistent the first lines including that of this paragraph are not indented because the spanning text is given by `\subsection` which makes first paragraphs unindented.*

.....
.....
.....
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.....

After the page break we will have shortly, this column is kept being the rightmost in the right

page-wise figure given in column-2

Figure 12: A Page-Wise Figure

page after the break. This is because the feature `c` is **not effective in non-paired parallel-paging.** The other feature `p` consistently makes the left outside margins of this and the previous page in which this column resides wider than the right inside margins.

*the column-0 and is placed **inside (right)** Another in the page, as well as the marginal note in marginal this **left** page **still** in the outside margin. note from column-1.*

As the post-environment stuff in Section 9.1 is, this paragraph being the post-environment stuff of the non-paired parallel-pages appears only in the parallel-page in which the column-0 belongs to, and thus in the left parallel-page in this case.

Another marginal note from column-3. columns shorter in the previous page. Similarly, we have a space above for the page-wise figure shown in the **left** page.

parallel-page, as you are seeing now, **and** still outermost as well as the marginal note in the outside ***right*** margin.

10 Examples of Background Painting

10.1 Fundamental Painting

As you undoubtedly notice, this page and a few pages following it are colorfully painted. For this and the next three pages, the author declared the background color of each region as follows.

```
\backgroundcolor{t}[rgb]{0.7,0,0}      % dark red for top margin
\backgroundcolor{b}[rgb]{0.8,0.6,0}    % dark orange for bottom margin
\backgroundcolor{l}[rgb]{0,0,0.7}      % dark blue for left margin
\backgroundcolor{r}[rgb]{0,0.7,0}      % dark green for right margin
\backgroundcolor{c[0]}[rgb]{1,0.8,1}   % pink for column-0
\backgroundcolor{c[1]}[rgb]{1,1,0.8}   % cream yellow for column-1
\backgroundcolor{g}[rgb]{0.8,1,1}      % light blue for the gap
\backgroundcolor{f}[rgb]{0.8,0,1}      % purple for page-wise floats
\backgroundcolor{n}[rgb]{0.8,0.6,1}    % light purple for page-wise footnotes
\backgroundcolor{p}[rgb]{0.8,1,0.6}    % pale green for pre/post-environment
\backgroundcolor{s}[rgb]{0.8,0.8,0.8}   % light gray for spanning texts
```

Therefore, the background of this pre-environment paragraph and other stuff above is painted by pale green. Since the author set `\pagemargin` to be 5 pt, you will see unpainted strips of 5 pt wide at all paper edges surrounding painted regions. For this and the next three pages, `\twosided[pcm]` is declared to enable p, c and m features but to disable the b feature. Therefore, though this page 43 is even and thus the left outside margin is wider than the right inside one, the backgrounds of l(ef) and r(igh) margins are painted by dark blue and dark green respectively.

This column-0 is now right and inside because of the c feature of `\twosided` is enabled. On the other hand, the background of this column is painted by pink because `\backgroundcolor` for c[0] specifies so. That is, the column ordinals optionally given to c(olumn) (and g(ap)) regions are logical ones not always corresponding to their physical positions in a page.

As explained in the right column-0, the background of this left and outside column-1 is painted by cream yellow as `\backgroundcolor{c[1]}` specifies. Now we have a `\switchcolumn` with a spanning text to show the background painting for it⁹⁰.*

The background of this s(panning text) region is painted by light gray

This paragraph is to show how the first line of a paragraph just below a spanning text is placed in the painted region.

See the right column for the reason why this paragraph is here.

Now we have a `\flushpage` to see the background painting for a material not shown in the page, i.e., a page-wise float.

See the right column for what we are now doing.

⁹⁰Since the footnotes in this `paracol` environment are page-wise and merged, and `\backgroundcolor{n}` specifies light purple, the background of this (foot)n(ote) region is painted by the color.

`f(loat)` region for this page-wise figure is painted by purple

Figure 13: A Page-Wise Figure

As expected, the background of this column-1 is still painted by cream yellow.

Since we are now in an odd-numbered page 44, this column-0 is now a left one and is still painted by pink of course.

See the comment in the left column.

This paragraph is to show how the last line of a page without page-wise footnotes is placed in the painted region.

This page is to show how the page without any page-wise stuff looks like.

See the right column for the reason why we have this almost blank page.

Shortly we will close this paracol environment in the next page.

See the right column for what will happen shortly.

See the left column for the reason why we are now closing the environment.

Now we are closing this `paracol` environment to show how its post-environment stuff is painted.

The background of this paragraph in `p`(ost-environment) region is also painted by pale green, because post-environment stuff can be pre-environment stuff at the same time as we see shortly.

Therefore, the author does not have much to say in this column, except for giving a footnote here⁹¹.

This short `paracol` environment illustrates how the pre-environment stuff of this environment, or the post-environment stuff of the last environment in other words, is painted.

Before moving to the next example, one caution is given for background painting of merged footnotes. As the footnote 91 itself says, merged footnotes given in the last page of a `paracol` environment are considered as belonging to post-environment stuff. Therefore, the footnote 91 is painted by pale green as well as another footnote given now⁹².

⁹¹Since this footnote is merged with that in the post-environment stuff, it is considered as a part of post-environment stuff and thus painted by pale green rather than light purple.

⁹²Since this footnote really belongs to post-environment stuff, its background is painted by pale green naturally.

10.2 Mirrored Painting and Enlarging/Shrinking/Shifting Regions

At a glance, this and the next three pages look painted similarly to previous four pages, but by a careful examination you should notice two important differences. The first one is found in the colors of left and right margins. As the author enabled all features of `\twosided` including `b` for mirroring and we are now in an even-numbered page 47, the left and outside margin is painted by dark green for the region `r`(ight margin), while the right and inside one is painted by dark blue for `l`(eft margin).

The other is that regions are enlarged, shrunk or shifted by `4pt` by the following `\backgroundcolor` commands with extensions.

```
\backgroundcolor{t(0pt,0pt)(0pt,-4pt)}[rgb]{0.7,0,0} % B up
\backgroundcolor{b(0pt,-4pt)(0pt,0pt)}[rgb]{0.8,0.6,0} % T down
\backgroundcolor{l(0pt,4pt)(-4pt,4pt)}[rgb]{0,0,0.7} % R left T/B outside
\backgroundcolor{r(-4pt,4pt)(0pt,4pt)}[rgb]{0,0.7,0} % L right T/B outside
\backgroundcolor{c[0](4pt,4pt)}[rgb]{1,0.8,1} % all edges outside
\backgroundcolor{c[1](4pt,4pt)}[rgb]{1,1,0.8} % all edges outside
\backgroundcolor{g(-4pt,4pt)}[rgb]{0.8,1,1} % L/R inside & T/B outside
\backgroundcolor{f(4pt,4pt)(4pt,-4pt)}[rgb]{0.8,0,1} % L/R outside & T/B up
\backgroundcolor{n(4pt,-4pt)(4pt,4pt)}[rgb]{0.8,0.6,1} % L/R outside & T/B down
\backgroundcolor{p(4pt,4pt)}[rgb]{0.8,1,0.6} % all edges outside
\backgroundcolor{s(4pt,-4pt)}[rgb]{0.8,0.8,0.8} % L/R outside & T/B inside
```

In the comments above, L(eft), R(ight), T(op) and B(ottom) mean edges moved by a given extension. Therefore, for example, “L/R outside & T/B up” for `f`(loat) region means it is enlarged horizontally and shifted up vertically by the asymmetric extension `(4pt,4pt)(4pt,-4pt)`. These a little bit complicated setting of extensions are to solve the problems in the fundamental example shown in previous four pages, namely too strict definition of the regions to be painted. That is, both vertical edges of regions having texts, e.g., `c`(olumn) regions, should look too close to the first and last letters. Similarly both horizontal edges of those regions seem too close especially when the first line is tall (e.g., the section title in p. 43 and the page-wise figure in p. 44) and the last line of a column is followed by spanning text or post-environment stuff. Therefore, the author made fine tuning moving inside edges of margins outside, and so on. We will come back this issue after exemplifying the effect of the tuning.

By the tuning to enlarge this `c`(olumn) region, this paragraph has comfortable spaces above and below it, as well as at the both side edges.

This paragraph is surrounded by spaces of a small but comfortable amount as well.⁹³

The background of this `s`(panning text) region is painted by light gray and enlarged horizontally but shrunk vertically

This paragraph is to show how well the first line of a paragraph just below a spanning text is separated from the boundary of two painted regions.

See the right column for the reason why this paragraph is here.

By enlarging this `c`(olumn) region and shift the `(foot)n`(ote) region down, this paragraph has a comfortable amount of space below it.

See the right column for what we are now doing.

⁹³Shifting this `(foot)n`(ote) region down a little bit, the space below this footnote and above the top edge of the `b`(ottom margin) region is enlarged.

shifting up this $f(\text{loat})$ region gives us a small space above the top edge of the rectangle

Figure 14: A Page-Wise Figure

See the comment in the left column for the intention of placing this paragraph here.

Similarly to other paragraphs below page-wise stuff, this paragraph is well separated from the bottom edge of the $f(\text{loat})$ region above.

See the comment in the left column, too.

As in the case of the line above page-wise footnotes, the last line of this paragraph has a sufficient space separating it from the top edge of the $b(\text{ottom margin})$ region.

This page is to show how the page without any page-wise stuff looks like. As you are seeing, the space above this paragraph is sufficient and comfortable.

See the right column for the reason why we have this almost blank page.

Shortly we will close this paracol environment in the next page.

See the right column for what will happen shortly.

See the left column for the reason why we are now closing the environment.

Now we are closing this `paracol` environment to show how this paragraph is separated from the boundary of `c(olumn)` and `p(ost-environment)` regions.

The background of this paragraph in `p(ost-environment)` region is painted by pale green as done in p. 46, but its top and bottom edges *look* shifted down and up to give spaces below and above the last and first paragraphs in `paracol` environments, respectively.

Therefore, the author does not have much to say in this column, except for giving a footnote here⁹⁴.

This short `paracol` environment illustrates how the pre-environment stuff of this environment, or the post-environment stuff of the last environment in other words, is painted.

In the setting with `\backgroundcolor` commands in p. 47, the author carefully moved contacting edges of regions. For example, to enlarge `c(olumn)` regions, the inside edges of `l(eft margin)` and `r(ight margin)` regions are moved outside, and both vertical edges of the `g(ap)` region shifted toward its inside. As for the horizontal edges, the bottom edges of `t(op margin)` and `f(loat)` regions are moved up, the top edges of `b(ottom margin)` and `(foot)n(ote)` regions are moved down, and both top and bottom edges of the `s(panning text)` region are shifted toward its inside.

These edge shifting could make a region too narrow or too much shifted resulting in a material in it overreaching its boundary, especially in vertical shifting of horizontal edges. However we can exploit some large space automatically or manually inserted above and/or below the material to avoid overreaching. That is the author exploited the following spaces; `\headsep` below the page head (though it is empty in this document); `\dbltextfloatsep` below the bottom-most page-wise float; spaces that `\subsection*` inserts above and below it together with manually inserted `\medskip` below it; `\skip\footins`⁹⁵ above the first footnote which the author enlarged by `4pt` temporarily for this and the next subsections; and `\footskip` from the bottom edge of text area to that of the page number.

Now you might notice that the explanation above does not mention the `p` region for pre-environment and post-environment stuff. As you should find in the settings, this region is enlarged horizontally *and vertically* so that its top and bottom edges are moved up and down when the region is at the top or bottom of a page, as you are seeing now and find in p. 47. However, this enlargement of course has a side effect that the region collides against `c(olumn)` and `g(ap)` regions also enlarged vertically making them overlapped. This overlap will be invisible with most of *printers* because, as shown in Section 7.8, `p` region is painted *before* `c` and `g` regions are painted. In addition, since relatively large spaces of `\bigskip` are manually inserted before each `\begin{paracol}` and after each `\end{paracol}`, texts in pre-environment and post-environment stuff are well separated from region boundaries.

This overlay painting `c` and `g` over `p`, however, might produce an unexpected result with some printer with which, for example, two colors are *blended* in the thin overlapped strip⁹⁶. Unfortunately, this overlay painting is inevitable in the current version 1.3, but in a future version, hopefully 1.4, more sophisticated *position-dependent* region definition, for example, to shift the top edge of `p` region only when the region is at the top of page, could be introduced.

Another remark is that the mirroring specified by the `b` feature of `\twosided` works not only on the colors of side margins but also on their asymmetric shrinkage. That is, the asymmetric shifts of vertical edges of `l` and `r` regions correctly performed irrespective of their physical positions, i.e., even when the `l` (resp. `r`) region is at the right (resp. left) margin and the edge to be shift is the left (resp. right) one rather than right (resp. left).

⁹⁴As the footnote 91 in p. 46, this merged footnote is a part of post-environment stuff and thus painted by pale green rather than light purple.

⁹⁵This is a kind of “length command” maybe not widely known.

⁹⁶For example, a dvi previewer `dviout` produces such a blended result with the default setting of coloring.

10.3 Regions with Infinite Extensions

You are now seeing another background painting much different from previous two examples. That is, after disabling painting of `t`, `b`, `l`, `r` and `g` regions by `\nolbackgroundcolor`, the author gave the followings for painting this and the next pages.

```
\backgroundcolor{c[0](4pt,4pt)(0.5\columnsep,4pt)}[rgb]{1,0.8,1}
\backgroundcolor{c[1](0.5\columnsep,4pt)(4pt,4pt)}[rgb]{1,1,0.8}
\backgroundcolor{C[0](10000pt,10000pt)(0.5\columnsep,10000pt)}[rgb]{1,0.8,1}
\backgroundcolor{C[1](0.5\columnsep,10000pt)(10000pt,10000pt)}[rgb]{1,1,0.8}
```

The first two lines above is different from the previous declaration because inside edges of `c[0]` and `c[1]` regions are shifted toward outside of them and thus inside of unpainted `g` region so that the edges are contacted. On the other hand, the last two lines are for *under-painting* of columns and has *infinite extension* to make top, bottom and outside edges of `C` regions reaching to the corresponding paper edges. Since this under-painting is done with colors same as those of over-painting of `c` regions, you will have an impression that the paper is two-toned and page-wise stuff are pasted on the paper⁹⁷.

Though you cannot see, the right edge of this over-painted `c[0]` region is shifted right by `4pt` to hide the small patch at the right bottom corner of the `p` region above by overlaying.

As explained in the right column, this `c[1]` region also has an invisible left edge shifted left by `4pt`⁹⁸.

This `s(panning text)` region could be extended to both side edges of the paper if its extension were `(10000pt,-4pt)`.

The author does not have much to say now for this column chunk.

Little to say as well.

Still nothing to say particular to the page break we will have shortly.

Nothing to say as well.

⁹⁷This footnote is given outside `paracol` environment but its background is painted by light purple because it is merged with the footnote 98.

⁹⁸This `(foot)n(ote)` region could be extended to both side edges and the bottom edge of the paper if its extension were `(10000pt,-4pt)(10000pt,10000pt)`.

This f(loat) region could be extended to both side edges and the top edge of the paper if its extension were (10000pt,10000pt)(10000pt,-4pt).

Figure 15: A Page-Wise Figure *Imported* from Pre-Environment

This paragraph is not necessary for keeping alive the environment but is given for consistent view.

This paragraph is just for keeping the `paracol` environment alive in this page.

Note that overlay painting is inevitable for two-toned page painting, as far as you want to paint background of page-wise stuff.

The last issue of background painting is about painting materials given outside `paracol`. As you have seen, pre-environment and post-environment stuff are painted but it is done only when they reside in a page having a portion of a `paracol` environment (maybe) of course. Therefore, the next page is *not* painted because the page does not have any parallel-columned stuff. Therefore, even if you wish to paint the whole of your document including pages without `paracol` stuff, you cannot do it just with `paracol` package, at least so far.

On the other hand, some materials given outside `paracol` environments are painted as if they are given in the environment when they are *imported* into the environment. One category has footnotes given in pre-environment stuff when `\footnotelayout{m}` is specified for merging, as exemplified by the footnote 97 in the previous page. Note that such a footnote is painted by the color for `n` region rather than `p` region even when there are no footnotes in the `paracol` environment. The other category has ordinary floats given by `figure` and/or `table` (i.e., neither `figure*` nor `table*`) environments outside `paracol` and then *deferred* to a page having (a portion of) stuff produced by `paracol`. Since such a float, e.g., Figure 15 in this page, is considered as a page-wise float given in the `paracol` environment in this section, its background is painted by the color for the `f` region, rather than that for the `p` region which would be used if the float were placed in the previous page. Note that such a deferred float import could occur not only from the page having `\begin{paracol}` but also from pages preceding it. For example, if you have three `figure` environments in a page $p - 1$ just preceding the page p in which you start a `paracol` environment, it could happen that first one is placed in $p - 1$ without painting, the second is placed in p and painted by the color for `p`, and the third is placed in $p + 1$ and painted by the color for `f`.

Finally some materials *exported* from a `paracol` environment are painted as if they are in post-environment stuff. In previous two subsections, we saw merged footnotes (e.g., 91 in p. 46 and 94 in p. 50) are painted by the color of `p` rather than `n`. The other kind of exportation is of page-wise floats given in a `paracol` environment but deferred to the page next to the page having `\end{paracol}`, or further. For example, Figure 16 is given in the `paracol` environment above in this page, but its background is not painted because the next page in which the figure is placed does not have any parallel-columned stuff⁹⁹.

⁹⁹If it has, the background is painted by the color for `p`.

This figure is given in the `paracol` environment closed in the previous page but its background is not painted.

Figure 16: A Page-Wise Figure *Exported* to Post-Environment

(intentionally blanked page to show this page is *not* painted)

11 Known and Unknown Problems

Here a few problems you could face in the use of `paracol` are summarized.

- If your (e.g.,) left column goes ahead too much farther than the right column, \LaTeX could stop with the following error message.

```
! Package paracol Error: Too many unprocessed columns/floats.
```

This usually means that the internal space to keep materials in the left column is exhausted. More specifically, suppose at some point in your `.tex` the left column is in the page p while the right is in $q < p$. We need $(p - q)$ boxes to keep the left column contents in the pages $q, q + 1, \dots, p - 1$ because these pages cannot be printed yet until the right column fills them. In addition, we also need two boxes for the left column in p and the right column in q so that you make column-switching between them keeping unprinted contents in them. Therefore, at least we need to have $(p - q) + 2$ boxes, while the number of them provided by \LaTeX is only 18^{100} . Therefore, `paracol` cannot continue its work if $(p - q)$ reaches 17. Furthermore, other stuff also consumes the boxes as follows.

- If there are n pages in $q, q + 1, \dots, p$ having pre-environment stuff or page-wise floats, n boxes are consumed by them. Similarly, if m pages in them have page-wise footnotes, m boxes are given to them.
- If the left (resp. right) column has column-wise footnotes in p (resp. q), a box is used for them.
- If the left (resp. right) column has k floats to be placed in p (resp. q) or to be deferred to $p + 1$ (resp. $q + 1$) or a succeeding page, k boxes are reserved for them.

Therefore, it should be safe to keep $(p - q)$ from exceeding 10 or so placing `\switchcolumn` in both columns fairly frequently.

- As discussed in Section 7.2, setting a synchronization point in a page brings the following side effects.
 - Stretch and shrink factors of all vertical skips in the page are nullified. The nullification of stretch factors could make a sparse column in the page have a vertical space at its bottom as if `\raggedbottom` setting is in effect even with `\flushbottom` one, rather than distributing the amount of the space to the skips so that the bottom line is aligned at the page bottom. As for the nullification of shrink factors, it makes the page have lines a little bit less than that it would have without synchronization because lines above the (last) synchronization point cannot be compressed. The other effect is a little bit subtle because the shrink factors below the last synchronization point are taken care of by \TeX 's page builder when it examine the appropriateness of each breakable point, but they are nullified when the page is printed. That is, if \TeX finds a good break point which needs that the stuff between the synchronization and break points is compressed a little bit, the stuff is printed without compression making its bottom edge a little bit below the page bottom.
 - After a synchronization point is set, columns in the page cannot have top floats any more even if a column has space above the synchronization point and large enough to place the float. Therefore, if you like to exploit the space, you have to place the `figure` or `table` environment in question prior to the column-switching command or environment for the synchronization.
- As the author did for Section 1 to 5, sometimes you will make a section header spanning all columns by giving a sectioning command such as `\section`, `\subsection` and `\subsubsection` to the optional argument of `\switchcolumn*` or `\begin` of a synchronizing column-switching environment. These three commands work well and you will have what you intend to have, but you have to be careful with lower-level

¹⁰⁰Readers who are acquainted with \LaTeX implementation will understand that 18 is the cardinality of the set $\{\backslash\text{bx@A}, \dots, \backslash\text{bx@R}\}$ for floats acquired by `\newinsert`.

commands `\paragraph` and `\subparagraph`. Unlike higher-level relatives, these lower-level commands does *not* put the header *immediately* but keep it somewhere¹⁰¹ so that when the paragraph following the command starts it is put as the leading part of the paragraph. Therefore if the spanning text has (e.g.) `\paragraph` only, the header is not put as a spanning text but at the head of the first paragraph of the column to which you switch, leaving an empty spanning text with some large space as follows.

This left-column paragraph precedes a synchronized column-switching.

This right-column paragraph precedes a synchronized column-switching.

A Spanning Text Given by `\paragraph` This left-column paragraph follows the synchronization but is led by `\paragraph` given to the optional argument of `\switchcolumn*` for spanning text.

This right-column paragraph follows the synchronization with an empty spanning text.

Therefore, unless this is what you intend to do, you have to give some paragraph together with `\paragraph` to the optional argument for spanning text. For example, `\mbox{}` is a good candidate as the paragraph following `\paragraph` because it produces (almost) nothing. By using this technique the example above becomes the followings.

This left-column paragraph precedes a synchronized column-switching.

This right-column paragraph precedes a synchronized column-switching.

A Spanning Text Given by `\paragraph` Followed by `\mbox{}`

This left-column paragraph follows the spanning text above.

This right-column paragraph follows the spanning text above.

-
- As shown in Section 8, it is not easy to have good numbering and stacking order of page-wise footnotes even with the supports from `\footnote*` and its relatives. In addition, a footnote in a `paracol` environment cannot be broken into two (or more) pages.
 - As the author confessed in Section 9.1, right parallel-pages cannot have page-wise stuff but have blank spaces in the corresponding region for them. The author will try to remove this limitation from a future version of `paracol`, in the version 1.4 hopefully.
 - As discussed in Section 10.2, it is desirable that background painting region definition in `\backgroundcolor` has position dependent extensions. The author is fairly optimistic about the incorporation of this advanced feature in the version 1.4.
 - In the release on 2015/01/10, L^AT_EX changed its mechanism of the placement of double-column floats (or in our terminology, page-wise floats) to avoid *out-of-order* appearance of them. That is, until the release on 2014/05/01 a double-column float (e.g., `figure*`) can be overtaken by a single-column float of the same category (e.g., `figure`) when they cannot be put into the page in which texts around them are put. In order to cope with the problem, the new version merged two lists to keep *deferred* double- and single-column floats into one so that the appearance order of them is determined by their order in the single list. Though this change should have made people happy when they typeset *ordinary* two-column (or multiple-column) documents, the new feature might not be welcomed by `paracol` users because your parallel-columns have their own *stream* of floats to be put in the corresponding columns. Therefore, and for the sake of simplicity of `paracol`'s implementation, the author decided to nullify this new feature in

¹⁰¹For people familiar to T_EX's *dangerous bends*, the header is kept in `\everypar`.

`paracol` environments. That is, even with new releases of L^AT_EX, your page-wise floats given in a `paracol` environment can be overtaken by column-wise floats.

In addition to the problems above known to the author, there may be (or should be, honestly speaking) other unknown problems in `paracol` because it cannot be perfect though the author has made his best effort for testing and debugging it. Particularly, sometimes it is very tough, if not impossible, to make `paracol` compatible with other packages, especially with those having dark magic as `paracol` has in it¹⁰². Therefore, though reporting incompatibleness with a package you use is very welcome¹⁰³, you should kindly understand the toughness of the compatibility issue.

Furthermore, even without such problematic packages, `paracol` might produce weird results due to its bug. If your document has something to make unknown bugs visible, you might have one (or more) of the followings which the author encountered in his debugging work.

- A page, a column, a footnote and/or a float disappears¹⁰⁴.
- A page, a column, a footnote and/or a float is duplicated.
- A message like “Overfull \vbox (1.23456pt too high) has occurred while \output is active” is shown.
- A message “Underfull \vbox (badness 10000) has occurred while \output is active” is shown. This message, however, does not always mean a bug but may just be a complaint that a column or a page is too sparse to meet your request to align the bottom of all columns and pages by `\flushbottom` setting. Therefore, if you have this message and you cannot be sure whether it means a bug or not, try `\raggedbottom` setting to see if you still have the message, before sending a bug report to the author.

If you encounter anything like them (or whatever you cannot solve by yourself), don’t hesitate to report it to the author with minimum source file to produce the problem¹⁰⁵.

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¹⁰²For example, the author knows it is almost impossible to make `paracol` compatible with one of the author’s own package available in CTAN.

¹⁰³For example, `paracol` is now compatible with `color` package thanks to a report from a user.

¹⁰⁴In fact, a bug fixed in version 1.2 caused page losing though it happens very very rarely but an unlucky user encountered it.

¹⁰⁵And with patience because your problem might not be solved quickly.

would have the capability of rule drawing in the gaps separating columns and painting backgrounds of columns and so on; Michael Bolin who gave the author motivated examples showing the necessity of `\ensurevspace`. Tigran Aivazian who reported a memory leak problem fixed in version 1.32; and Marcus Zelezny and Touhami Mamouni who found an incompatibility with L^AT_EX itself (2015/01/10 or later) and enlighten the author on the cause of the problem.

For the implementation of the style file, the author referred to the base implementations of `\output`, `\newcounter` and related macros of L^AT_EX 2_ε written by Leslie Lamport, Johannes Braams and other authors.

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