

Wick contractions in L^AT_EX with `simplewick.sty`

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This is a manual accompanying the style file `simplewick.sty` providing macros `\acontraction` and `\bcontraction` to draw Wick contractions above and below expressions, respectively. The functionality is best illustrated by an example,

$$\overbrace{a_i^\dagger(t_1) \overbrace{a_j^\dagger(t_1) a_j(t_1)} a_i(t_1) \overbrace{a_i^\dagger(t_2) \overbrace{a_j^\dagger(t_2) a_j(t_2)} a_i(t_2)}}.$$

1 Usage

The syntax will be explained on something simpler, however. The sequence

```
$$  
\contraction[] {A} {B} {C}  
\contraction[2ex] {A} {B} {C} {D}  
ABCD  
$$
```

renders as

$$\overbrace{ABCD}.$$

The parameters of the macro `\contraction[] {} {} {} {}` (which is a synonym for `\acontraction[] {} {} {} {}`) are as follows.

- ▷ The first (optional) argument is the height of the contraction. When omitted (as in the first contraction above) it defaults to `1ex`,
- ▷ the second argument contains the expression that lies before the contraction start,
- ▷ the third argument contains the expression, above which the start of the contraction is centered,
- ▷ the fourth argument is the part of the formula that is bridged by the contraction, and finally
- ▷ the contraction ends above the center of the last argument of the macro.

Note that the macro itself typesets only the contraction alone and rewinds back to allow for multiple contractions. Therefore, the expression to appear below the contraction(s) has to be repeated once more when you are finished with contractions themselves.

I guess now it is the right time to move to that “real life” example from the beginning of this manual. Its source is

```

$$$
\contraction{}{a}{\dagger}_i(t_1)a^{\dagger}_j(t_1)}{a}
%
\contraction[2ex]{a^{\dagger}_i(t_1)}{a}{\dagger}_j(t_1)a_j(t_1)a_i(t_1)}{a}
%
\contraction[3ex]{a^{\dagger}_i(t_1)}{a^{\dagger}_j(t_1)a_j(t_1)}{a}{\dagger}_i(t_1)}{a}
%
\contraction[3ex]{a^{\dagger}_i(t_1)}{a^{\dagger}_j(t_1)a_j(t_1)}{a}{\dagger}_i(t_1)}{a}
%
\bcontraction{a^{\dagger}_i(t_1)}{a^{\dagger}_j(t_1)a_j(t_1)a_i(t_1)}{a}{\dagger}_i(t_2)a^{\dagger}_j(t_2)}{a}
%
a^{\dagger}_i(t_1)a^{\dagger}_j(t_1)a_j(t_1)a_i(t_1)
a^{\dagger}_i(t_2)a^{\dagger}_j(t_2)a_j(t_2)a_i(t_2)\,.
$$$

```

2 Contractions inside the text — stretching and shrinking

The macro `\contraction` is prone to giving not entirely satisfactory results when the formula is under stress or tension, i.e., when \TeX shrinks or stretches “the glue” from its natural width. When we try to squeeze the line

```

Contraction under stress
$
\contraction{}{\bar G}{\dagger}_1(\mathbf{q}_1)\>\>{}{\bar G}
\bar G_1(\mathbf{q}_1)\>\>{}{\bar G}_2(\mathbf{q}_2)
=\bar{\chi}_{12}(\mathbf{q}_1-\mathbf{q}_2)
$
and with no stress
$
\contraction{}{\bar G}{\dagger}_1(\mathbf{q}_1)\>\>{}{\bar G}
\bar G_1(\mathbf{q}_1)\>\>{}{\bar G}_2(\mathbf{q}_2)
=\bar{\chi}_{12}(\mathbf{q}_1-\mathbf{q}_2)
$.

```

into a narrow box, we get

$\overbrace{\bar{G}_1(\mathbf{q}_1) \bar{G}_2(\mathbf{q}_2)} \quad = \bar{\chi}_{12}(\mathbf{q}_1 - \mathbf{q}_2)$ $\underbrace{\bar{G}_1(\mathbf{q}_1) \bar{G}_2(\mathbf{q}_2)} \quad = \bar{\chi}_{12}(\mathbf{q}_1 - \mathbf{q}_2).$

This is not quite right since the contraction drawn on the first line is slightly too long, although its length is precisely the same as the length of the contraction on the second line — they were entered via the same piece of code, after all. The style `simplewick.sty` offers a fix for this inconsistency in the form of the macro `\nomathglue{}` that prevents \TeX to shrink or stretch its argument. When used

```

Contraction under stress
$
\contraction{}{\bar G}{_1(\mathbf{q}_1)\>\>{}{\bar G}
  \nomathglue{%
    \bar G_1(\mathbf{q}_1)\>\>{} \bar G_2(\mathbf{q}_2)}
=\bar{\chi}_{12}(\mathbf{q}_1-\mathbf{q}_2)
$
and with no stress
$
\contraction{}{\bar G}{_1(\mathbf{q}_1)\>\>{}{\bar G}
  \bar G_1(\mathbf{q}_1)\>\>{} \bar G_2(\mathbf{q}_2)}
=\bar{\chi}_{12}(\mathbf{q}_1-\mathbf{q}_2)
$.

```

the outcome should look precisely as we wanted.

$\overbrace{\bar{G}_1(\mathbf{q}_1) \bar{G}_2(\mathbf{q}_2)} \quad = \bar{\chi}_{12}(\mathbf{q}_1 - \mathbf{q}_2)$ $\underbrace{\bar{G}_1(\mathbf{q}_1) \bar{G}_2(\mathbf{q}_2)} \quad = \bar{\chi}_{12}(\mathbf{q}_1 - \mathbf{q}_2).$

3 Alternatives

An alternative method for typesetting Wick contractions with \LaTeX is a `wick.sty` by Taichiro Kugo, available at

<http://www2.yukawa.kyoto-u.ac.jp/~kugo/index-e.html>

It is actually a more advanced solution than the one presented here (which is the reason why I call this package `simplewick`). Unfortunately, `wick.sty` seems to be somewhat conflicting with `amsmath` package. For example, I did not succeed to draw the `wick.sty` contractions above accented characters (such as those in the stretching examples above) when `amsmath` was loaded. Without `amsmath` it was just fine, however.

4 Credits

The package `simplewick.sty` is based on the code from `thophys.sty` by Thorsten Ohl that dates back to 1994. I only added the contractions below expressions (`\bcontraction`), the stretching/shrinking fix `\nomathglue` and this documentation. Contact information can be obtained by issuing a command `\simplewickcontact`.

5 The Code

```
1 (*simplewick.sty)
2
3 \def\fileversion{v1.2a}
4 \def\filedate{2007/11/23}
5 \ProvidesPackage{simplewick}[\filedate\space\fileversion]
6 \typeout{Package: simplewick \fileversion\space (\filedate)}
7
8 \makeatletter
9
10 % ----
11 % definition of several boxes we will use
12 % ----
13 \newbox\swb@xone
14 \newbox\swb@xtwo
15 \newbox\swb@xthree
16 \newbox\swb@xfour
17 \newdimen\swdimen@one
18 \newdimen\swdimentwo
19
20 % ----
21 % contraction above the expression
22 % ----
23 \newcommand{\acontraction}[5][1ex]{%
24   \mathchoice
25     {\acontraction@\displaystyle{#2}{#3}{#4}{#5}{#1}}%
26     {\acontraction@\textstyle{#2}{#3}{#4}{#5}{#1}}%
27     {\acontraction@\scriptstyle{#2}{#3}{#4}{#5}{#1}}%
28     {\acontraction@\scriptscriptstyle{#2}{#3}{#4}{#5}{#1}}}%
29 \newcommand{\acontraction@}[6]{%
30   \setbox\swb@xone=\hbox{${}\#1{}#2{}}$}%
31   \setbox\swb@xtwo=\hbox{${}\#1{}#3{}}$}%
32   \setbox\swb@xthree=\hbox{${}\#1{}#4{}}$}%
33   \setbox\swb@xfour=\hbox{${}\#1{}#5{}}$}%
34   \swdimen@one=\wd\swb@xtwo%
35   \advance\swdimen@one by \wd\swb@xfour%
36   \divide\swdimen@one by 2%
37   \advance\swdimen@one by \wd\swb@xthree%
38   \vbox{%
```

```

39   \hbox to Opt{%
40     \kern \wd\swb@xone%
41     \kern 0.5\wd\swb@xtwo%
42     \acontraction@@{\swdimen@ne}{#6}%
43     \hss}%
44   \vskip 0.5ex%  how far above the line starts
45   \vskip\ht\swb@xtwo}}
46 \newcommand{\acontracted}[5][1ex]{%
47   \acontraction[#1]{#2}{#3}{#4}{#5}\ensuremath{#2#3#4#5}}
48 \newcommand{\acontraction@@}[3][0.05em]{%
49 % the 1st parameter (explicitly inserted) is the width
50 % of the contraction line
51   \hbox{%
52     \vrule width #1 height Opt depth #3%
53     \vrule width #2 height Opt depth #1%
54     \vrule width #1 height Opt depth #3%
55     \relax}}
56 % compatibility with the previous version
57 \let\contraction\acontraction
58
59 % ----
60 % contraction below the expression
61 % ----
62 \newcommand{\bcontraction}[5][1ex]{%
63   \mathchoice
64     {\bcontraction@\displaystyle{#2}{#3}{#4}{#5}{#1}}%
65     {\bcontraction@\textstyle{#2}{#3}{#4}{#5}{#1}}%
66     {\bcontraction@\scriptstyle{#2}{#3}{#4}{#5}{#1}}%
67     {\bcontraction@\scriptscriptstyle{#2}{#3}{#4}{#5}{#1}}}%
68 \newcommand{\bcontraction@}[6]{%
69   \setbox\swb@xone=\hbox{${}\#1{}#2{}}$}%
70   \setbox\swb@xtwo=\hbox{${}\#1{}#3{}}$}%
71   \setbox\swb@xthree=\hbox{${}\#1{}#4{}}$}%
72   \setbox\swb@xfour=\hbox{${}\#1{}#5{}}$}%
73   \swdimen@ne=\wd\swb@xtwo%
74   \advance\swdimen@ne by \wd\swb@xfour%
75   \divide\swdimen@ne by 2%
76   \advance\swdimen@ne by \wd\swb@xthree%
77   \lower 0.5ex \vbox{%
78     \hbox to Opt{%
79       \kern \wd\swb@xone%
80       \kern 0.5\wd\swb@xtwo%
81       \bcontraction@@{\swdimen@ne}{#6}%
82       \hss}%
83     }}
84 \newcommand{\bcontracted}[5][1ex]{%
85   \bcontraction[#1]{#2}{#3}{#4}{#5}\ensuremath{#2#3#4#5}}
86 \newcommand{\bcontraction@@}[3][0.05em]{%
87 % the 1st parameter (explicitly inserted) is the width

```

```

88 % of the contraction line
89 \hbox{%
90   \swdimentw@=#3
91   \advance\swdimentw@ by -#1
92   \vrule width #1 height Opt depth #3%
93   \lower\swdimentw@\hbox{\vrule width #2 height Opt depth #1}%
94   \vrule width #1 height Opt depth #3%
95   \relax}}
96
97 \makeatother
98
99 % ----
100 % macro to switch off shrinking/stretching in mathmode
101 % (consult TeXbook, page 168, to see where the numbers came from)
102 % ----
103 \newcommand\nomathglue[1]{
104 \begingroup
105 \thinmuskip=3mu \medmuskip=4mu \thickmuskip=5mu
106 #1
107 \endgroup
108 }
109
110 % ----
111 % obfuscated contact info
112 % ----
113 \newcommand\simplewickcontact{%
114 {\tt {k}{o}{l}{o}{r}{e}{n}{c}{\tt @}{f}{z}{u}{.}{c}{z}}%
115 }
116
117 </simplewick.sty>

```