

Pensieve header: Fixing the δ_{aa} relations.

? Precedes

Precedes[x, y, ...] displays as $x < y < \dots >$

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DQ[is___] := (Sort[{is}] === Union[{is}]);
OQ[is___] := OrderedQ[{is}]; (*Also T if {is}={i,i}*)
Kδ /: Kδis_ := KroneckerDelta[1, Length[Union[{is}]]];
Simp[expr_] := Expand[expr];
S[expr_] := expr /. (λβ | λa | λδβ | λδa | λδaa) => MapAt[Simp, λ, 1];
AutoCollecting[λ_] := (λ /: λ[0, ___] = 0;
  λ /: λ[f_, r___] + λ[g_, r___] := λ[Simp[f+g], r];
  λ /: g_ * λ[f_, r___] := λ[Simp[g f], r]);
AutoCollecting /@ {β, a, δβ, δa, δaa};
UU /: UU[x_] + UU[y_] := UU[x+y];
UU /: a_ * UU[x_] := UU[Expand[a x]];
bϕ = 1;
Υ[f_, j_, k_] := δa[f, j, k] - δa[ε0 bj f, ϕ, k];
Υa[f_, j_, k_, l_, m_] := δaa[f, j, k, l, m] - δaa[ε0 bj f, ϕ, k, l, m];
UU[expr_] // S := UU[S[expr] /. {
  δaa[f_, i_, j_, k_, l_] /: !OQ[j, l] ∧ DQ[i, k, ϕ] => δaa[f, k, l, i, j],
  δaa[f_, i_, j_, k_, l_] /: !OQ[i, k] ∧ DQ[j, l] ∧ OQ[j, l] ∧ DQ[i, k, ϕ] =>
  δaa[f, i, l, k, j] + δaa[ε1 bk f, ϕ, l, i, j] + δaa[-ε1 bi f, ϕ, l, k, j] +
  δaa[-ε1 bk f, ϕ, j, i, l] + δaa[ε1 bi f, ϕ, j, k, l],
  δaa[f_, i_, k_, j_, k_] /: !OQ[i, j] ∧ DQ[i, k, ϕ] =>
  δaa[f, j, k, i, k] + δa[-ε2 bi f, j, k] + δa[ε2 bj f, i, k]
}]];

```

Sort[{1, a, ϕ}]

{1, a, ϕ}

S@UU[δaa[f, 1, 3, 2, 4]] /. Thread[{1, 3, 2, 4} → {i, j, k, l}] /. {ε₁ → ε₁, ε₂ → ε₂}

UU[δaa[f, i, j, k, l]]

S@UU[δaa[f, 1, 3, 1, 4]] /. Thread[{1, 3, 2, 4} → {i, j, k, l}] /. {ε₁ → ε₁, ε₂ → ε₂}

UU[δaa[f, i, j, i, l]]

S@UU[δaa[f, 1, 3, 2, 3]] /. Thread[{1, 3, 2, 4} → {i, j, k, l}] /. {ε₁ → ε₁, ε₂ → ε₂}

UU[δaa[f, i, j, k, j]]

S@UU[δaa[f, 1, 3, 1, 3]] /. Thread[{1, 3, 2, 4} → {i, j, k, l}] /. {ε₁ → ε₁, ε₂ → ε₂}

UU[δaa[f, i, j, i, j]]

S@UU $[\delta_{aa}[f, 2, 3, 1, 4]]$ /. **Thread** $[\{2, 3, 1, 4\} \rightarrow \{i, j, k, l\}]$ /. $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$
 UU $[\delta_{aa}[f, k, j, i, l] + \delta_{aa}[-f b_i \epsilon_1, \zeta, l, k, j] +$
 $\delta_{aa}[f b_i \epsilon_1, \zeta, j, k, l] + \delta_{aa}[-f b_k \epsilon_1, \zeta, j, i, l] + \delta_{aa}[f b_k \epsilon_1, \zeta, l, i, j]]$
S@UU $[\delta_{aa}[f, 2, 3, 1, 3]]$ /. **Thread** $[\{2, 3, 1, 3\} \rightarrow \{i, j, k, l\}]$ /. $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$,
S@UU $[\delta_{aa}[f, 2, 3, 1, 4]]$ /. **Thread** $[\{2, 3, 1, 4\} \rightarrow \{i, j, k, l\}]$ /.
 $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$ /. **l** \rightarrow **j**
 {UU $[\delta_{aa}[-f b_i \epsilon_2, k, j] + \delta_{aa}[f b_k \epsilon_2, i, j] + \delta_{aa}[f, k, j, i, j]]$, UU $[\delta_{aa}[f, k, j, i, j]]$ }

S@UU $[\delta_{aa}[f, 1, 4, 2, 3]]$ /. **Thread** $[\{1, 4, 2, 3\} \rightarrow \{i, j, k, l\}]$ /. $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$
 UU $[\delta_{aa}[f, i, l, k, j] + \delta_{aa}[-f b_i \epsilon_1, \zeta, l, k, j] +$
 $\delta_{aa}[f b_i \epsilon_1, \zeta, j, k, l] + \delta_{aa}[-f b_k \epsilon_1, \zeta, j, i, l] + \delta_{aa}[f b_k \epsilon_1, \zeta, l, i, j]]$
S@UU $[\delta_{aa}[f, 1, 4, 1, 3]]$ /. **Thread** $[\{1, 4, 1, 3\} \rightarrow \{i, j, k, l\}]$ /. $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$,
S@UU $[\delta_{aa}[f, 1, 4, 2, 3]]$ /. **Thread** $[\{1, 4, 2, 3\} \rightarrow \{i, j, k, l\}]$ /.
 $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$ /. **k** \rightarrow **i**
 {UU $[\delta_{aa}[f, i, j, i, l]]$, UU $[\delta_{aa}[f, i, l, i, j]]$ }

S@UU $[\delta_{aa}[f, 2, 4, 1, 3]]$ /. **Thread** $[\{2, 4, 1, 3\} \rightarrow \{i, j, k, l\}]$ /. $\{\epsilon_1 \rightarrow \epsilon_1, \epsilon_2 \rightarrow \epsilon_2\}$
 UU $[\delta_{aa}[f, k, l, i, j]]$

UU $[\delta_{aa}[f, k, j, i, l] + \delta_{aa}[-f b_i \epsilon_1, \zeta, l, k, j] +$
 $\delta_{aa}[f b_i \epsilon_1, \zeta, j, k, l] + \delta_{aa}[-f b_k \epsilon_1, \zeta, j, i, l] + \delta_{aa}[f b_k \epsilon_1, \zeta, l, i, j]]$ -
 UU $[\delta_{aa}[f, i, l, k, j] + \delta_{aa}[-f b_i \epsilon_1, \zeta, l, k, j] + \delta_{aa}[f b_i \epsilon_1, \zeta, j, k, l] +$
 $\delta_{aa}[-f b_k \epsilon_1, \zeta, j, i, l] + \delta_{aa}[f b_k \epsilon_1, \zeta, l, i, j]]$
 UU $[\delta_{aa}[-f, i, l, k, j] + \delta_{aa}[f, k, j, i, l]]$