Diagrams and algebraic expressions at order 4 in MBPT

The ADG Dev Team

June 18, 2019

Valid diagrams: 39
Singles: 4
Doubles: 12
Triples: 16
Quadruples: 7
Quintuples and higher excitation levels: 0

Contents

1 Singles

Diagram 1:

$$\frac{1}{4}\sum \frac{v_{abij}v_{ijak}v_{kclm}v_{lmbc}}{\epsilon_{ab}^{ij}\ \epsilon_{b}^{k}\ \epsilon_{bc}^{lm}} \tag{1}$$
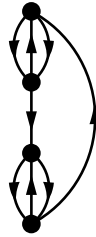

Diagram 2: Complex conjugate diagram: 3

$$-\frac{1}{4}\sum \frac{v_{abij}v_{ijak}v_{cdbl}v_{klcd}}{\epsilon_{ab}^{ij}\ \epsilon_{b}^{k}\ \epsilon_{cd}^{kl}} \tag{2}$$
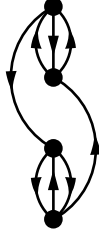
Diagram 3:   Complex conjugate diagram: 2

$$-\frac{1}{4}\sum \frac{v_{abij}v_{icab}v_{jdkl}v_{klcd}}{\epsilon^{ij}_{ab}\ \epsilon^{j}_{c}\ \epsilon^{kl}_{cd}} \tag{3}$$
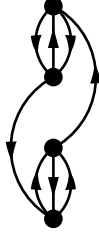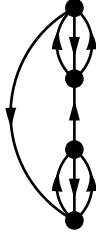

Diagram 4:

$$\frac{1}{4}\sum \frac{v_{abij}v_{icab}v_{deck}v_{jkde}}{\epsilon^{ij}_{ab}\ \epsilon^{j}_{c}\ \epsilon^{jk}_{de}} \tag{4}$$

2   Doubles

Diagram 5:

$$\frac{1}{16}\sum \frac{v_{abij}v_{ijkl}v_{klmn}v_{mnab}}{\epsilon^{ij}_{ab}\ \epsilon^{kl}_{ab}\ \epsilon^{mn}_{ab}} \tag{5}$$

Diagram 6:   Complex conjugate diagram: 8

$$\frac{1}{2}\sum \frac{v_{abij}v_{ijkl}v_{kcam}v_{lmbc}}{\epsilon^{ij}_{ab}\ \epsilon^{kl}_{ab}\ \epsilon^{lm}_{bc}} \tag{6}$$

2

Diagram 7: Complex conjugate diagram: 14

$$\frac{1}{16} \sum \frac{v_{abij} v_{ijkl} v_{cdab} v_{klcd}}{\epsilon_{ab}^{ij} \ \epsilon_{ab}^{kl} \ \epsilon_{cd}^{kl}} \tag{7}$$
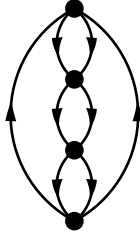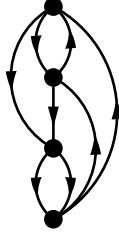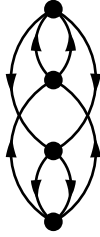

Diagram 8: Complex conjugate diagram: 6

$$\frac{1}{2} \sum \frac{v_{abij} v_{icak} v_{jklm} v_{lmbc}}{\epsilon_{ab}^{ij} \ \epsilon_{bc}^{jk} \ \epsilon_{bc}^{lm}} \tag{8}$$
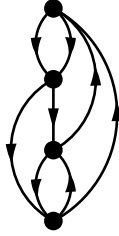

Diagram 9:

$$\sum \frac{v_{abik} v_{icaj} v_{jdcl} v_{klbd}}{\epsilon_{ab}^{ik} \ \epsilon_{cb}^{jk} \ \epsilon_{bd}^{kl}} \tag{9}$$
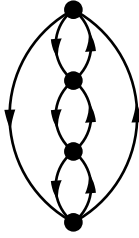

Diagram 10:

$$-\sum \frac{v_{abij} v_{icak} v_{jdcl} v_{klbd}}{\epsilon_{ab}^{ij} \ \epsilon_{cb}^{jk} \ \epsilon_{bd}^{kl}} \tag{10}$$
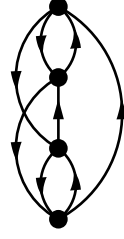
3

Diagram 11:

$$-\sum \frac{v_{abik}v_{icaj}v_{jdbl}v_{klcd}}{\epsilon_{ab}^{ik} \; \epsilon_{bc}^{jk} \; \epsilon_{cd}^{kl}} \tag{11}$$
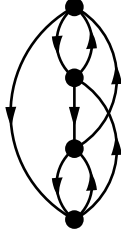

Diagram 12:

$$\sum \frac{v_{abij}v_{icak}v_{jdbl}v_{klcd}}{\epsilon_{ab}^{ij} \; \epsilon_{bc}^{jk} \; \epsilon_{cd}^{kl}} \tag{12}$$
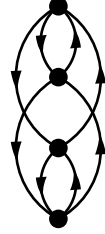

Diagram 13:   Complex conjugate diagram: 15

$$\frac{1}{2}\sum \frac{v_{abij}v_{icak}v_{debc}v_{jkde}}{\epsilon_{ab}^{ij} \; \epsilon_{bc}^{jk} \; \epsilon_{de}^{jk}} \tag{13}$$
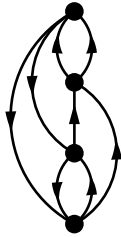

Diagram 14:   Complex conjugate diagram: 7

$$\frac{1}{16}\sum \frac{v_{abij}v_{cdab}v_{ijkl}v_{klcd}}{\epsilon_{ab}^{ij} \; \epsilon_{cd}^{ij} \; \epsilon_{cd}^{kl}} \tag{14}$$
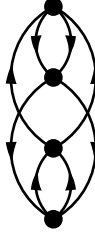
4

Diagram 15: Complex conjugate diagram: 13

$$\frac{1}{2} \sum \frac{v_{abij} v_{cdab} v_{ieck} v_{jkde}}{\epsilon_{ab}^{ij} \; \epsilon_{cd}^{ij} \; \epsilon_{de}^{jk}} \tag{15}$$
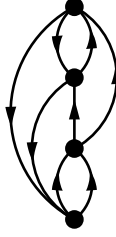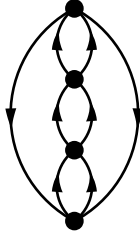

Diagram 16:

$$\frac{1}{16} \sum \frac{v_{abij} v_{cdab} v_{efcd} v_{ijef}}{\epsilon_{ab}^{ij} \; \epsilon_{cd}^{ij} \; \epsilon_{ef}^{ij}} \tag{16}$$

3   Triples

Diagram 17:

$$\frac{1}{4} \sum \frac{v_{abil} v_{icjk} v_{jkcm} v_{lmab}}{\epsilon_{ab}^{il} \; \epsilon_{cab}^{jkl} \; \epsilon_{ab}^{lm}} \tag{17}$$
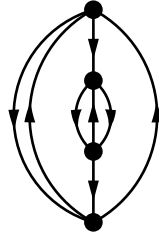

Diagram 18:

$$\frac{1}{2} \sum \frac{v_{abij} v_{ickl} v_{jkcm} v_{lmab}}{\epsilon_{ab}^{ij} \; \epsilon_{cab}^{jkl} \; \epsilon_{ab}^{lm}} \tag{18}$$
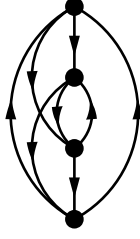
Diagram 19:

$$\frac{1}{2}\sum \frac{v_{abil}v_{icjk}v_{jkam}v_{lmbc}}{\epsilon_{ab}^{il}\ \epsilon_{abc}^{jkl}\ \epsilon_{bc}^{lm}} \tag{19}$$
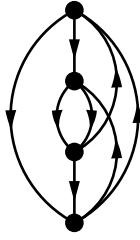

Diagram 20:

$$\sum \frac{v_{abij}v_{ickl}v_{jkam}v_{lmbc}}{\epsilon_{ab}^{ij}\ \epsilon_{abc}^{jkl}\ \epsilon_{bc}^{lm}} \tag{20}$$
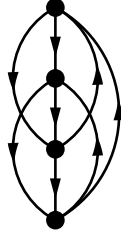

Diagram 21:   Complex conjugate diagram: 25

$$-\sum \frac{v_{abik}v_{icjl}v_{jdac}v_{klbd}}{\epsilon_{ab}^{ik}\ \epsilon_{acb}^{jkl}\ \epsilon_{bd}^{kl}} \tag{21}$$
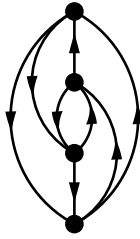

Diagram 22:   Complex conjugate diagram: 26

$$\frac{1}{2}\sum \frac{v_{abij}v_{ickl}v_{jdac}v_{klbd}}{\epsilon_{ab}^{ij}\ \epsilon_{acb}^{jkl}\ \epsilon_{bd}^{kl}} \tag{22}$$
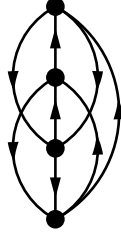
Diagram 23: Complex conjugate diagram: 29

$$\frac{1}{2} \sum \frac{v_{abik} v_{icjl} v_{jdab} v_{klcd}}{\epsilon_{ab}^{ik} \, \epsilon_{abc}^{jkl} \, \epsilon_{cd}^{kl}} \tag{23}$$
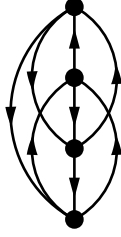

Diagram 24: Complex conjugate diagram: 30

$$-\frac{1}{4} \sum \frac{v_{abij} v_{ickl} v_{jdab} v_{klcd}}{\epsilon_{ab}^{ij} \, \epsilon_{abc}^{jkl} \, \epsilon_{cd}^{kl}} \tag{24}$$
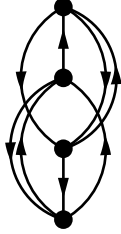

Diagram 25: Complex conjugate diagram: 21

$$-\sum \frac{v_{abik} v_{cdaj} v_{ijcl} v_{klbd}}{\epsilon_{ab}^{ik} \, \epsilon_{cbd}^{ijk} \, \epsilon_{bd}^{kl}} \tag{25}$$
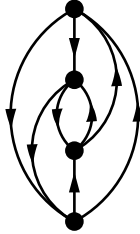

Diagram 26: Complex conjugate diagram: 22

$$\frac{1}{2} \sum \frac{v_{abij} v_{cdak} v_{ijcl} v_{klbd}}{\epsilon_{ab}^{ij} \, \epsilon_{cbd}^{ijk} \, \epsilon_{bd}^{kl}} \tag{26}$$
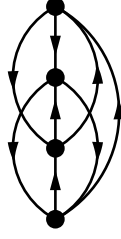
Diagram 27:

$$\frac{1}{4} \sum \frac{v_{abjk} v_{cdai} v_{iecd} v_{jkbe}}{\epsilon_{ab}^{jk} \ \epsilon_{cdb}^{ijk} \ \epsilon_{be}^{jk}} \tag{27}$$
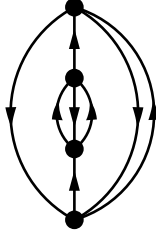

Diagram 28:

$$\frac{1}{2} \sum \frac{v_{abij} v_{cdak} v_{iecd} v_{jkbe}}{\epsilon_{ab}^{ij} \ \epsilon_{cdb}^{ijk} \ \epsilon_{be}^{jk}} \tag{28}$$
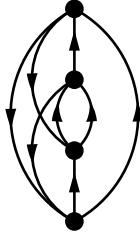

Diagram 29:   Complex conjugate diagram: 23

$$\frac{1}{2} \sum \frac{v_{abik} v_{cdaj} v_{ijbl} v_{klcd}}{\epsilon_{ab}^{ik} \ \epsilon_{bcd}^{ijk} \ \epsilon_{cd}^{kl}} \tag{29}$$
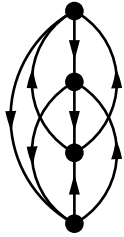

Diagram 30:   Complex conjugate diagram: 24

$$-\frac{1}{4} \sum \frac{v_{abij} v_{cdak} v_{ijbl} v_{klcd}}{\epsilon_{ab}^{ij} \ \epsilon_{bcd}^{ijk} \ \epsilon_{cd}^{kl}} \tag{30}$$
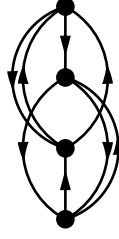
Diagram 31:

$$\frac{1}{2} \sum \frac{v_{abjk} v_{cdai} v_{iebc} v_{jkde}}{\epsilon_{ab}^{jk} \, \epsilon_{bcd}^{ijk} \, \epsilon_{de}^{jk}} \tag{31}$$
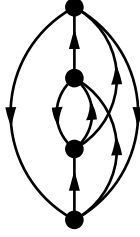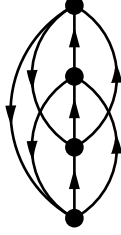

Diagram 32:

$$\sum \frac{v_{abij} v_{cdak} v_{iebc} v_{jkde}}{\epsilon_{ab}^{ij} \, \epsilon_{bcd}^{ijk} \, \epsilon_{de}^{jk}} \tag{32}$$

4 Quadruples

Diagram 33:

$$-\frac{1}{4} \sum \frac{v_{abik} v_{cdjl} v_{ijcd} v_{klab}}{\epsilon_{ab}^{ik} \, \epsilon_{cdab}^{ijkl} \, \epsilon_{ab}^{kl}} \tag{33}$$
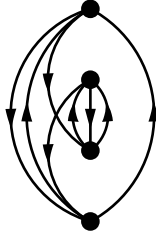

Diagram 34:

$$\frac{1}{16} \sum \frac{v_{abij} v_{cdkl} v_{ijcd} v_{klab}}{\epsilon_{ab}^{ij} \, \epsilon_{cdab}^{ijkl} \, \epsilon_{ab}^{kl}} \tag{34}$$
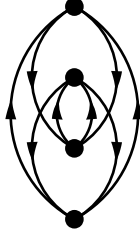
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Diagram 35:

$$-\frac{1}{4} \sum \frac{v_{abkl} v_{cdij} v_{ijac} v_{klbd}}{\epsilon_{ab}^{kl} \, \epsilon_{acbd}^{ijkl} \, \epsilon_{bd}^{kl}} \tag{35}$$
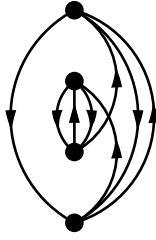

Diagram 36:

$$\sum \frac{v_{abik} v_{cdjl} v_{ijac} v_{klbd}}{\epsilon_{ab}^{ik} \, \epsilon_{acbd}^{ijkl} \, \epsilon_{bd}^{kl}} \tag{36}$$
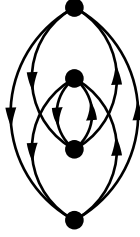

Diagram 37:

$$-\frac{1}{4} \sum \frac{v_{abij} v_{cdkl} v_{ijac} v_{klbd}}{\epsilon_{ab}^{ij} \, \epsilon_{acbd}^{ijkl} \, \epsilon_{bd}^{kl}} \tag{37}$$

Diagram 38:

$$\frac{1}{16} \sum \frac{v_{abkl} v_{cdij} v_{ijab} v_{klcd}}{\epsilon_{ab}^{kl} \, \epsilon_{abcd}^{ijkl} \, \epsilon_{cd}^{kl}} \tag{38}$$
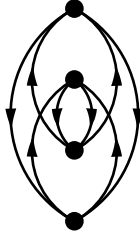
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Diagram 39:

$$-\frac{1}{4} \sum \frac{v_{abik} v_{cdjl} v_{ijab} v_{klcd}}{\epsilon_{ab}^{ik} \; \epsilon_{abcd}^{ijkl} \; \epsilon_{cd}^{kl}} \tag{39}$$