Statistical Physics (MSc)
Homework 3.

Pál Balázs

2019. november 28.

QUESTION

(On the next page there is a table.) Next to your name you can find five numbers under the column $G(X, X')$. Give the contribution of those graphs to $G(X, X')$ in coordinate space. Choose appropriate coordinates at the vertices and write it on your figures in the solutions. Next to your name you can find another five numbers under the column $G(\boldsymbol{k}, i\omega_n)$. Give the contribution of those graphs to $G(\boldsymbol{k}, i\omega_n)$. Once again, use clear notations for your conventions together with a picture showing the newly introduced momenta and frequencies. Classify your graphs if they are reducible or irreducible.

The row of the table with my name:

No.	Name	$G(X, X')$					$G(\boldsymbol{k}, i\omega_n)$				
⋮	⋮	⋮					⋮				
17	Pál Balázs	8	5	6	10	3	7	2	4	1	9
⋮	⋮	⋮					⋮				

REDUCIBILITY

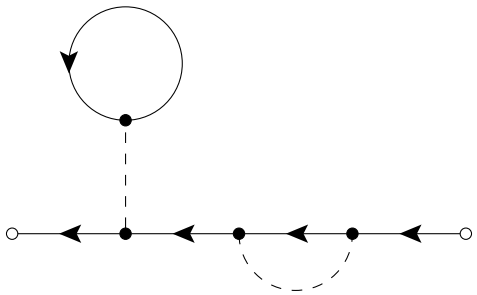
Def. An **internal vertex** is a node which is either part of a loop, or have more than one connections. Internal vertices are marked with filled dots (•) on the figures. Similarly, external vertices could be defined as the opposite of internal vertices, which are marked as empty dots (∘) on the diagrams.
Def. An **internal edge/line** is an edge which connects two internal vertices. In contrast, external edges/lines are always connected to at least one external vertex.
Def. We call a diagram **reducible** which fall into two disjunct pieces if we cut one internal propagator line.
Def. Similarly, we call a diagram **irreducible** which does not fall into two disjunct pieces if we cut one internal propagator line.

Using these definitions, we can easily identify the reducible and irreducible graphs:

Reducible graphs				Irreducible graphs					
1	3	7	8	2	4	5	6	9	10

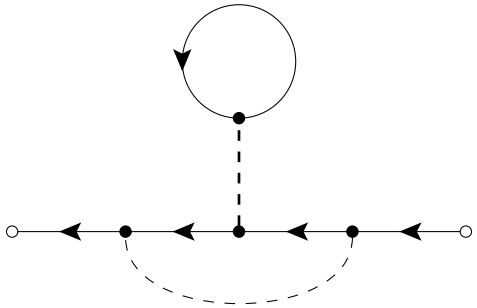
EXPRESSING THE GRAPHS

GRAPH 1. — MOMENTUM REPRESENTATION



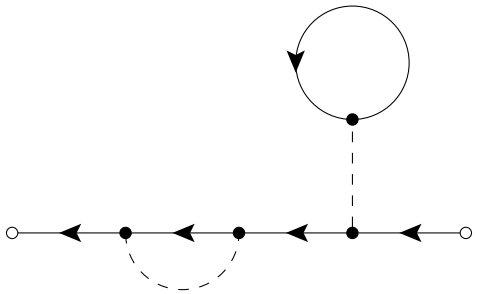
SOLUTION

GRAPH 2. — MOMENTUM REPRESENTATION



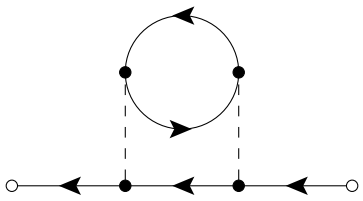
SOLUTION

GRAPH 3. — COORDINATE REPRESENTATION



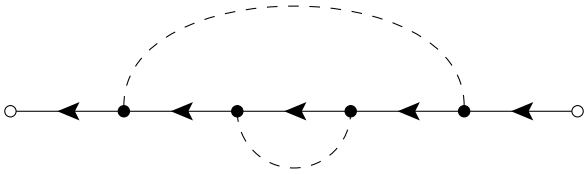
SOLUTION

GRAPH 4. — MOMENTUM REPRESENTATION



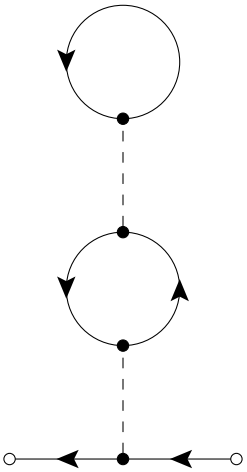
SOLUTION

GRAPH 5. — COORDINATE REPRESENTATION



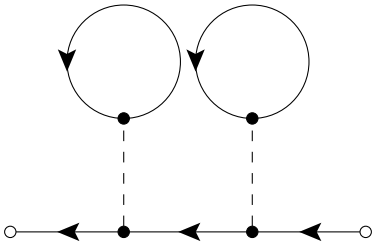
SOLUTION

GRAPH 6. — COORDINATE REPRESENTATION



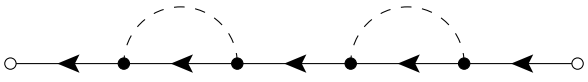
SOLUTION

GRAPH 7. — MOMENTUM REPRESENTATION



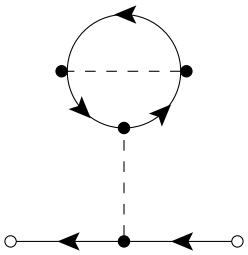
SOLUTION

GRAPH 8. — COORDINATE REPRESENTATION



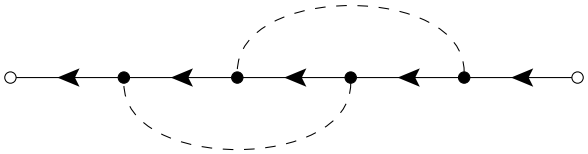
SOLUTION

GRAPH 9. — MOMENTUM REPRESENTATION



SOLUTION

GRAPH 10. — COORDINATE REPRESENTATION



SOLUTION