UNIVERSITY OF HELSINKI
DEPARTMENT OF PHYSICS

MONTE CARLO SIMULATIONS IN PHYSICS

Exercise 1

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March 2016

Note. In order to run the exercise's source codes, use the command *make all* (see the Makefile for more compilation commands and details). The graphs and plots are available in the ./Figures/ folder.

Problem 1

The source code for this problem's program is named ex1p1.f90. You can compile and test it using the Makefile.

The relation between $< R^2(N) >$ and the number of steps (N) can be seen in the plot in figure 1. This relation seems to be linear.

The relation between $< R^2(N) >$ and the step length (l) can be seen in the plot in figure 2. This relation seems to be exponential or quadratic.

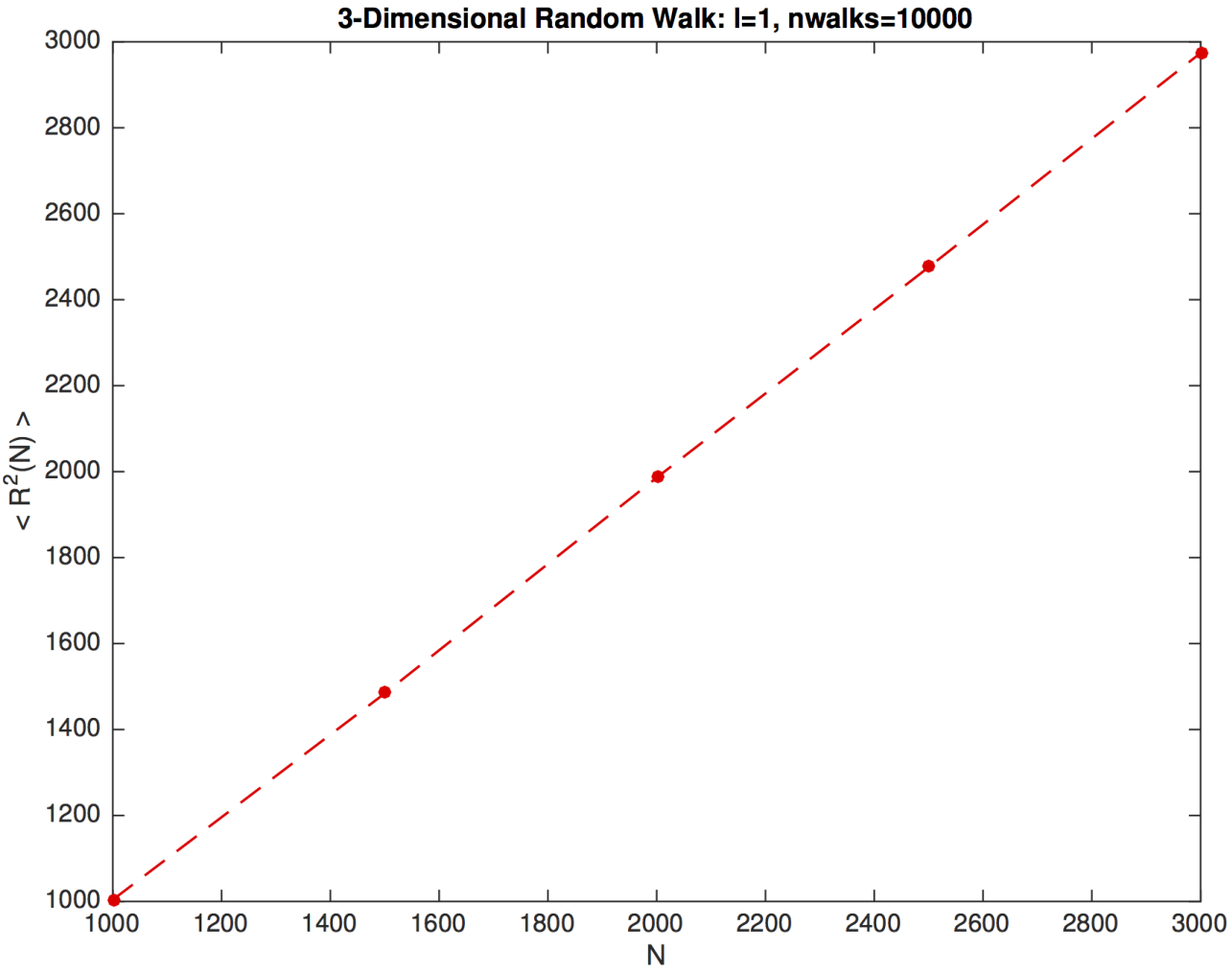

Figure 1: Relation between $< R^2(N) >$ and the number of steps (N).

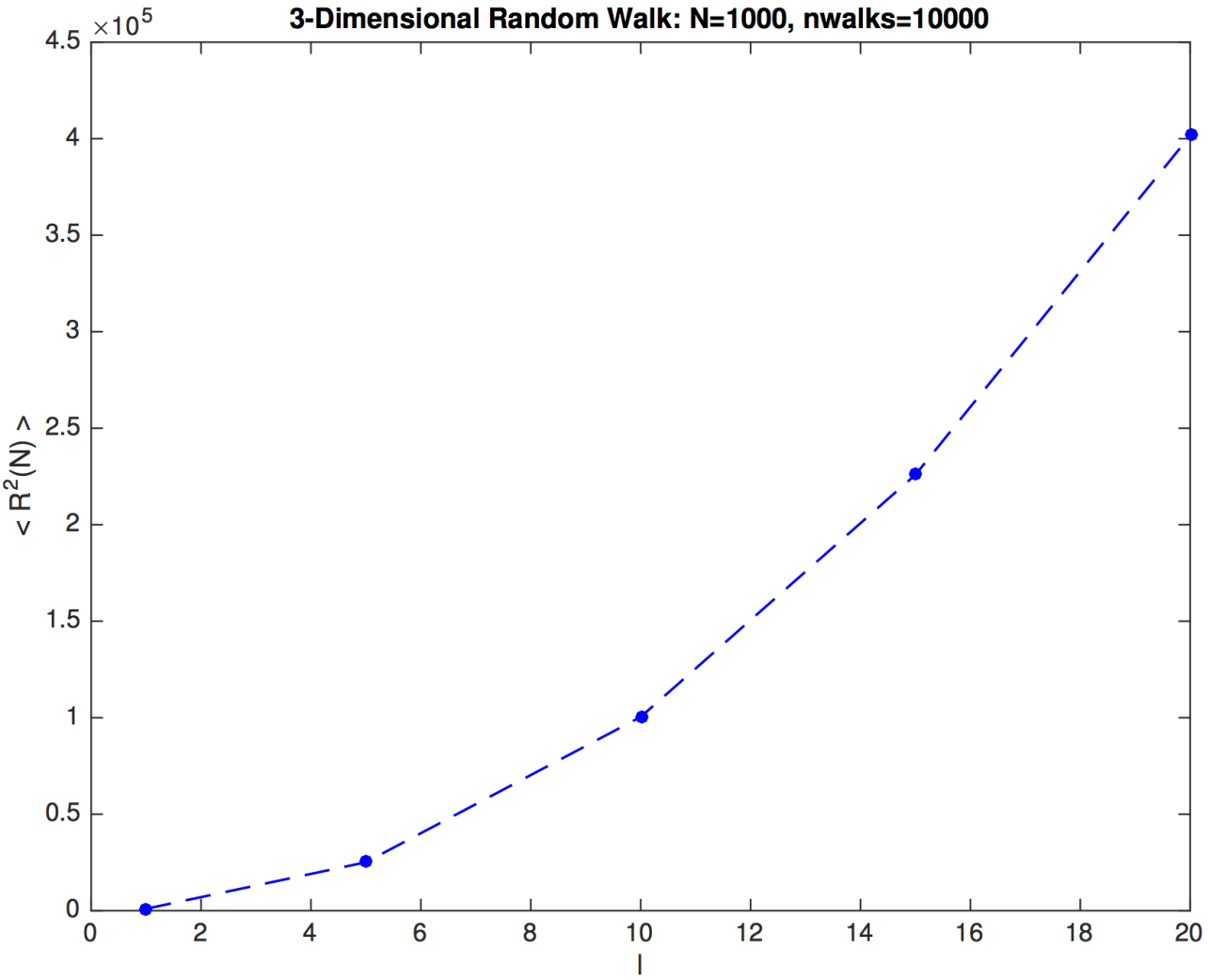

Figure 2: Relation between $< R^2(N) >$ and the step length (l).

Problem 2

The source code for this problem's program is named ex1p2.f90. You can compile and test it using the Makefile.

The relation between $< R^2(N) >$ and the step length 1 ($l1$) can be seen in the plot in figure 3. This relation seems to be exponential or quadratic. The relation between $< R^2(N) >$ and the step length 2 ($l2$) can be seen in the plot in figure 4. Just as expected, this relation seems to be exponential or quadratic as well.

The relation between $< R^2(N) >$ and the number of steps (N) can be seen in the plot in figure 5. This relation seems to be linear.

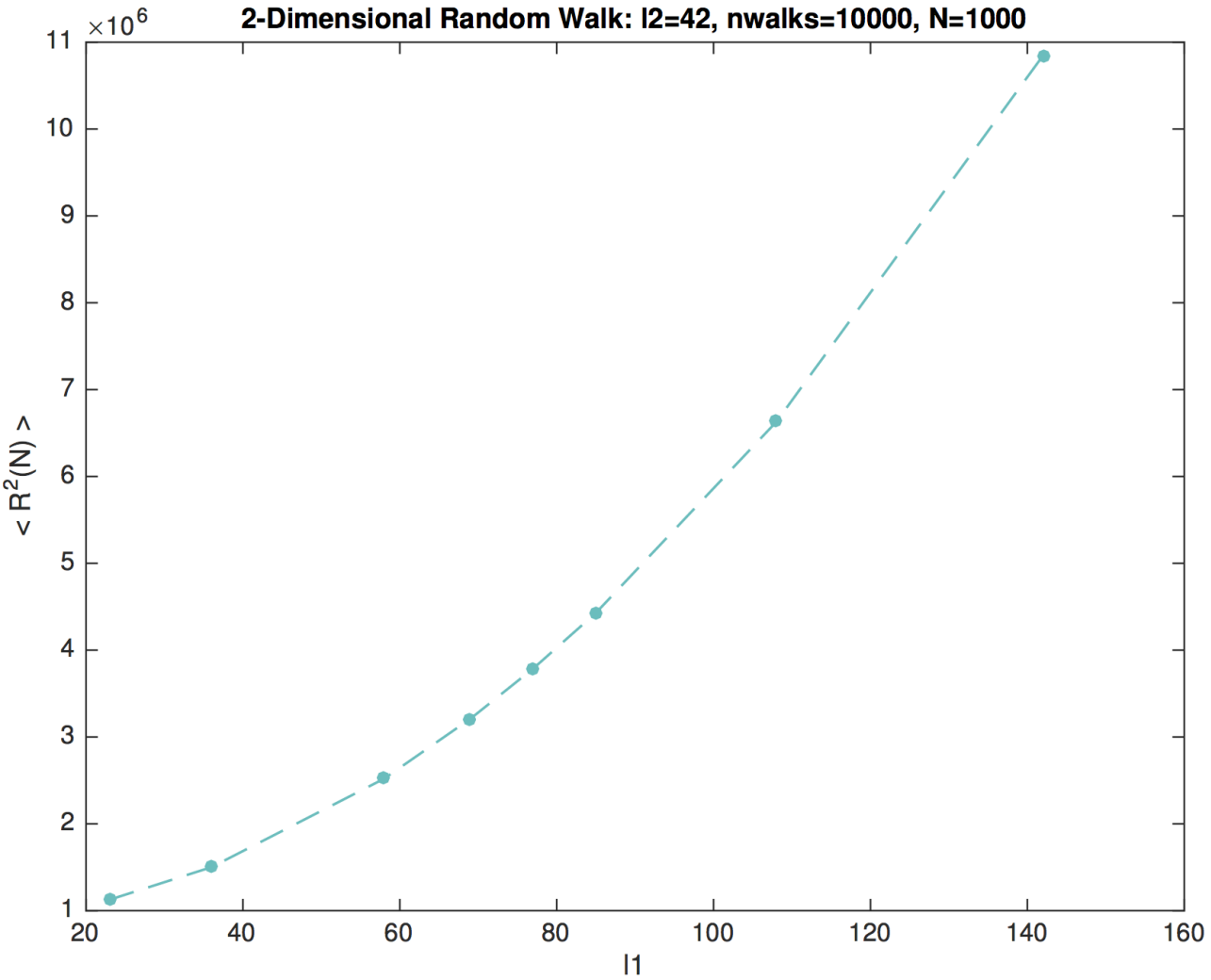

Figure 3: Relation between $< R^2(N) >$ and the step length 1 ($l1$).

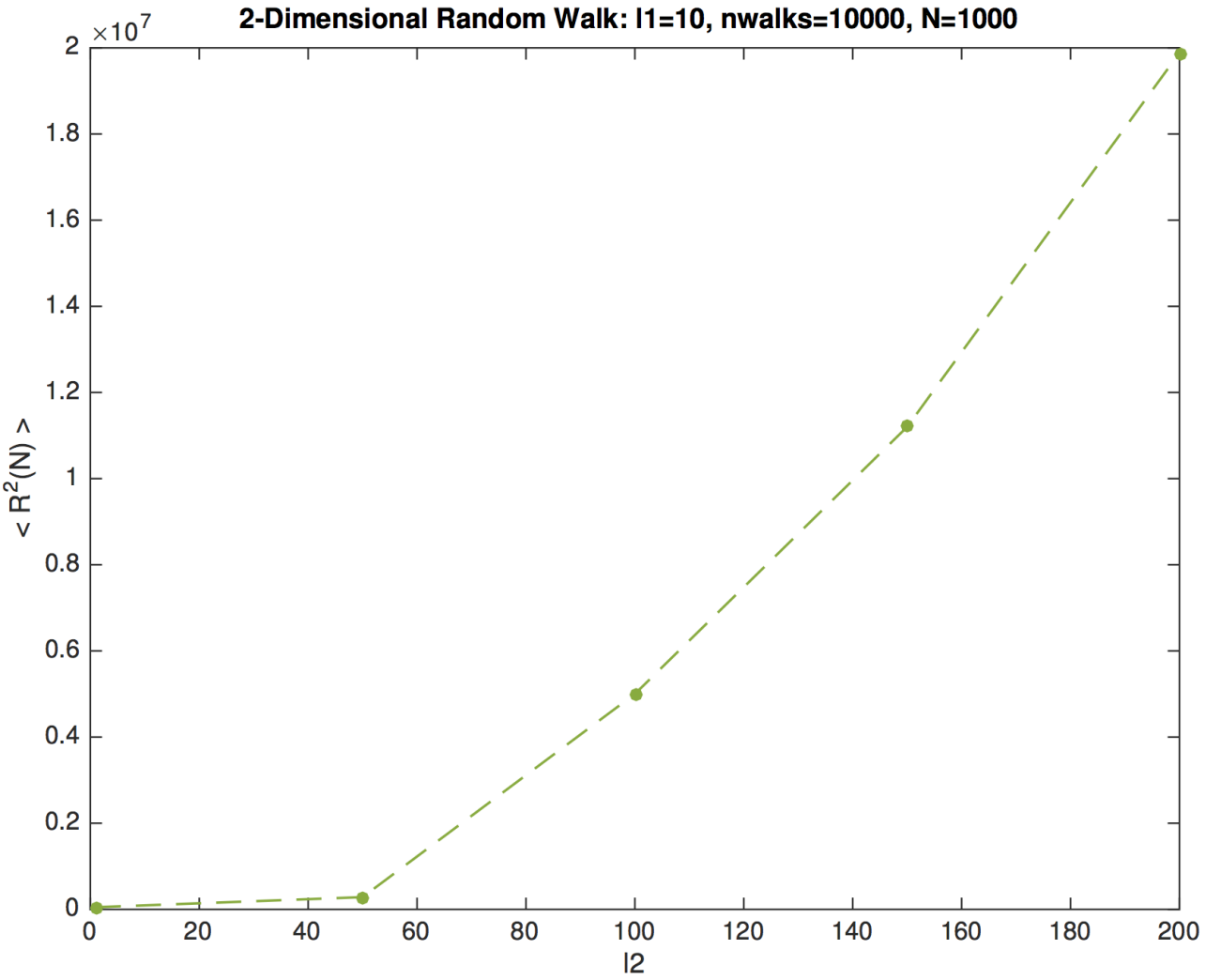

Figure 4: Relation between $< R^2(N) >$ and the step length 2 ($l2$).

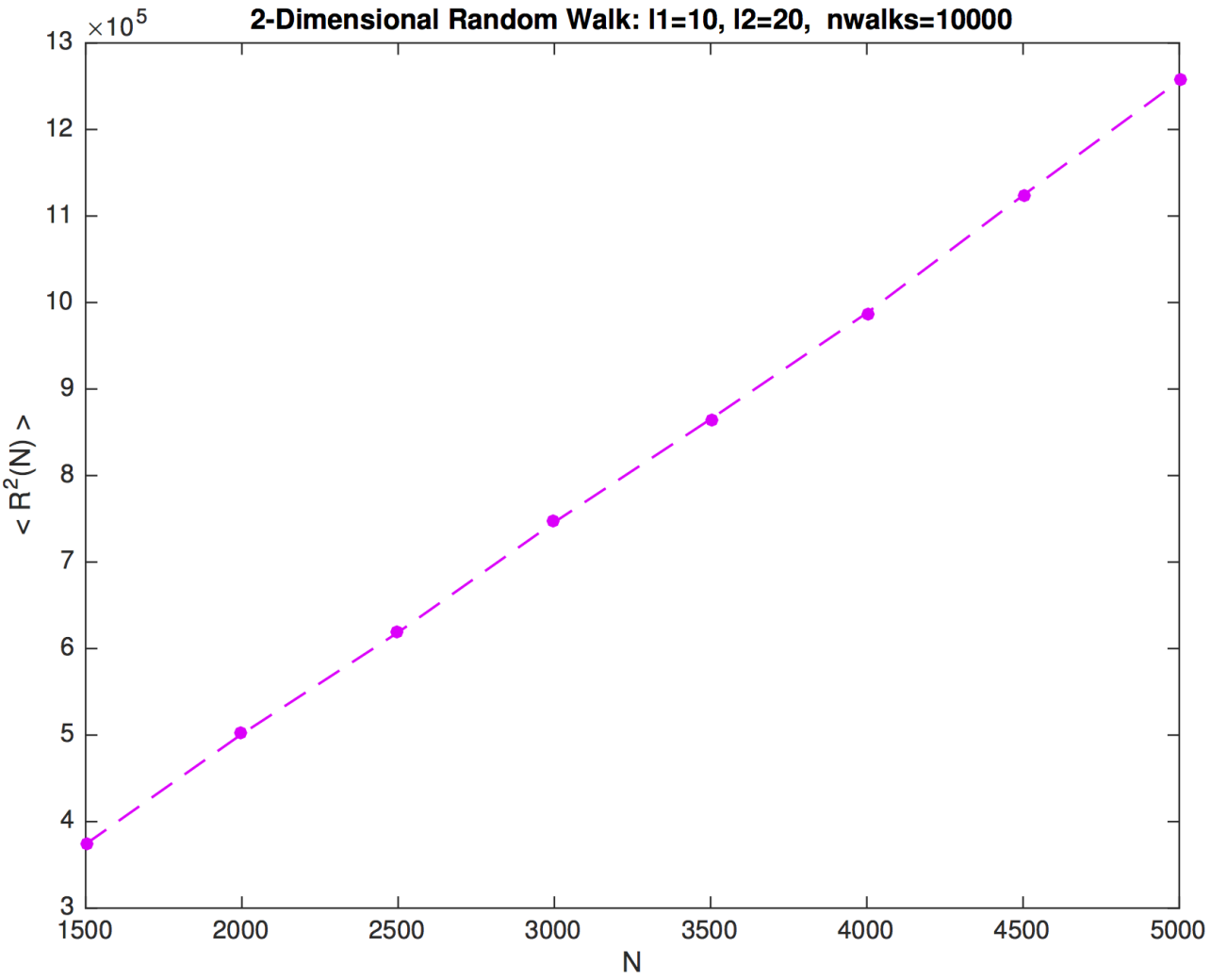

Figure 5: Relation between $< R^2(N) >$ and the number of steps (N).

Problem 3

COMMAND 1

```
$ ./ex1p3
 drunkensailor: 2-dimensional Random Walk
 Usage: drunkensailor N nwalks wind [seed]
 The argument [ARGUMENT] is optional.
 Note: wind can be 0 (no wind), 1 (west wind) or 2 (east wind).

$ ./ex1p3 1000000 1000 0

 drunkensailor: 2-dimensional Random Walk
 Doing random walk to      1000000 steps         1000   times
 Failures            18
 <t>    17200.0449      min
 median(t)    904.000000      min

$ ./ex1p3 1000000 1000 1

 drunkensailor: 2-dimensional Random Walk
 Doing random walk to      1000000 steps         1000   times
 Failures             0
 <t>    1719.85901      min
 median(t)    656.000000      min

$ ./ex1p3 1000000 1000 2

 drunkensailor: 2-dimensional Random Walk
 Doing random walk to      1000000 steps         1000   times
 Failures           457
 <t>    1412.45483      min
 median(t)    118.500000      min
```

We can notice that, with a strong wind coming from west, the drunken sailor reaches the quay much quicker and with no cases where the sailor doesn't reach the quay even after 10^6 minutes. If there is a strong wind coming from east, however, the number of cases where the sailor doesn't reach the quay even after 10^6 minutes is almost half of the number of tries (or simulations).

Problem 4

COMMAND 2

```
$ ./ex1p4
 saw3d: 3-dimensional Self-Avoiding Random Walk
 Simulating a polymer with           50 monomers         1000   times
 <R^2(N)>    97.7233429      N            50
 ni   0.585525692      +/-    1.86048448E-03
```

The value obtained by the simulation very close to the experimental value of $\nu = 0.592$.