# USER MANUAL for GRAPE v1
# (Matlab version)

GRAPE is a code to compute the gravitational field of irregular shapes, described in terms of STL file. It has been realized for teaching purposes. It is sufficient to modify and save the "input.inp" file present in the folder and then type "data_probes = GRAPE_v1" in the Matlab command window. The speed of the algorithm depends on the number of spheres used to fill the STL file and the shape. The code is parallelized in the computation of the gravitational field at the probe points.

The input file is as follows:

```
rosetta2.stl    % stl_file_name (with stl extension)
100             % Number of spheres to use to fill the STL shape
5               % Number of iterations needed to place each single sphere
1e13            % Total mass of the object [kg]
4000   % Maximum size of the object [m]
40              % Number of probes per latus (i.e. NxNxN)
4000            % Maximum x coordinate for probes [m]
-4000                   % Minimum x coordinate for probes [m]
4000            % Maximum y coordinate for probes [m]
-4000                   % Minimum y coordinate for probes [m]
4000            % Maximum z coordinate for probes [m]
-4000                   % Minimum z coordinate for probes [m]
10              % x slice coordinate [m] for Fig. 4
10              % y slice coordinate [m] for Fig. 5
10              % z slice coordinate [m] for Fig. 6
10              % x slice coordinate [m] for Fig. 7
10              % y slice coordinate [m] for Fig. 8
10              % z slice coordinate [m] for Fig. 9
```

In detail:

- "*rosetta2.stl     % stl_file_name (with stl extension)*": here is where the STL file must be specified. It is important to have it in binary extension (otherwise it can create troubles with the memory space) and to specify the ".stl" extension. Some examples are reported in the folder.
- *"100     % Number of spheres to use to fill the STL shape"*: this is the number of spheres that are used to describe the irregular shape. We suggest to use a number within 50-1000 for computational time reasons. In case more computational time is permitted also numbers up to 10000 can be used.
- *"5     % Number of iterations needed to place each single sphere"*: this number specifies the number of iterations requested before placing a single sphere. If this number is higher, in general, the user will fill the STL file with sphere of larger radii. We suggest to set it up to 5.
- *"1e13     % Total mass of the object [kg]"*: this is the total mass of the actual body expressed in kilograms

- *"4000 % Maximum size of the object [m]"*: this number expresses the maximum length of the real body. It is needed to scale the STL file object to the actual size desired.
- *"40 % Number of probes per latus (i.e. NxNxN)"*: this number specifies the number of point around the object where the gravitational field vector is computed. The user should imagine a rectangular box around the body where NxNxN points are placed. This number depends on the resolution required. But since it grows polynomially we suggest to have it in the range 20-80.
- *"4000 % Maximum x coordinate for probes*
  *4000 % Minimum x coordinate for probes*
  *4000 % Maximum y coordinate for probes*
  *4000 % Minimum y coordinate for probes*
  *4000 % Maximum z coordinate for probes*
  *4000 % Minimum z coordinate for probes"*
  These six input lines define the size of the rectangular box around the body in which the probes will be located. The size is in meters. The size of the rectangular box depends on the object. We suggest to run several times the code to find the best desired configuration.
- *"10 % x slice coordinate [m] for Fig. 4*
  *10 % y slice coordinate [m] for Fig. 5*
  *10 % z slice coordinate [m] for Fig. 6*
  *10 % x slice coordinate [m] for Fig. 7*
  *10 % y slice coordinate [m] for Fig. 8*
  *10 % z slice coordinate [m] for Fig. 9"*
  These six input lines define the position of the slice for the 3D visualization.

## Output of the code

The output of the code are 9 figures – representing the original STL file, the one filled with spheres and the gravity field module or direction - and a Matlab structure (data_probes). In the structure is present all the information about g_x, g_y, g_z that can be later used by the user to calculate the orbital motion around the body. In this structure *"x_rand"*, *"y_rand"* and *"z_rand"* represent the 3D location of the probes in the rectangular box around the STL object. The x, y, and z component of the gravitational acceleration is reported in the field *"g_x_point"*, *"g_y_point"* and *"g_z_point"* respectively.