Lost in space

Question: A collection of N asteroids floats in space far from other gravitating bodies. Model each asteroid as a hard sphere of radius R and mass m. What quantities are required for a macroscopic description of this system?

A **microscopic** description consists of two pieces:

- The mechanical parameters N, m, R, plus Newton's law of gravity — these are the things we would need to know in order to write down the Hamiltonian.
- The dynamical variables $\mathbf{r}_1, \mathbf{r}_2, \ldots \mathbf{r}_N$ and $\mathbf{p}_1, \mathbf{p}_2, \ldots \mathbf{p}_N$ — these are the things we would solve for if this were a classical mechanics problem.

A **macroscopic** description also consists of two pieces:

- The same mechanical parameters as before.
- The conserved quantities E (energy), $\mathbf{P}$ (total momentum), and $\mathbf{L}$ (total angular momentum). (For a box of gas molecules the external wall forces mean that $\mathbf{P}$ and $\mathbf{L}$ are not conserved, so they don't become part of the macroscopic description. But for the asteroid case they *are* conserved and hence *are* part of the macroscopic description.)

In the microscopic description $6N$ dynamical variables are specified, whereas in the macroscopic description 7 conserved quantities are specified.