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 microscopic description of this system? For a macroscopic description?

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 $r_1, r_2, \ldots r_N$ and $p_1, p_2, \ldots p_N$ — 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), $P$ (total momentum), and $L$ (total angular momentum). (For a box of gas molecules the external wall forces mean that $P$ and $L$ 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.