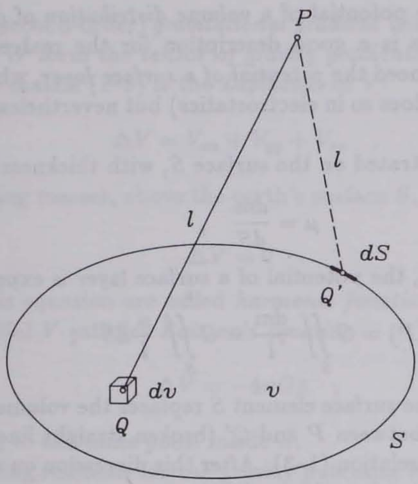

FIGURE 1.2: Illustrating eqs. (1–1) and (1–5)

point, variable within the earth's body, which forms the center of the mass element dm or the volume element dv, l is the distance between P and Q (solid straight line), and $\rho = \rho(Q) = dm/dv$ is the mass density at Q. G is the Newtonian gravitational constant

$$G = 6.673 \times 10^{-11}\,\mathrm{m^3 s^{-2} kg^{-1}} \quad . \tag{1–2}$$

The integral is to be extended over the whole earth's body v, which includes the solid and liquid parts. The (very small) effect of the atmosphere is usually disregarded; if necessary, it can be taken into account by corrections, which have the relative order of 10^{-6}. The same treatment may be applied to temporal variations of V (due to earth tides, etc.) which have the order of 10^{-7}. Atmospheric effects and temporal variations will consistently be disregarded here.

Even so, the representation (1–1) has only theoretical importance because its practical use would require the knowledge of the detailed density distribution within the earth, which obviously is not known.

For large distances

$$r = \sqrt{x^2 + y^2 + z^2} \quad ,$$

(1–1) may be expressed as

$$V = \frac{GM}{r} + O\left(\frac{1}{r^2}\right) \quad \text{as} \quad r \to \infty \quad , \tag{1–3}$$

M denoting the total mass of the body and $O(1/r^2)$ (read $O(\epsilon)$ as "term(s) of order ϵ") symbolizing a term that, for $r \to \infty$, tends to zero as $1/r^2$. The physical sense of this equation is that, at large distances and approximately, any body acts gravitationally as a point mass.