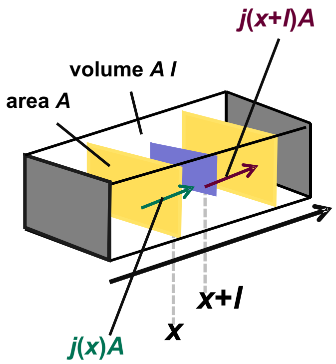
4.10 Continuity equation using divergency

In this section we discuss local changes of a concentration c induced by lateral current flow (and/or local sources or drains). This is illustrated in the following figure for the change of concentration c in a (tiny) volume Al induced by a difference of current flowing into and out of this volume in x direction, i.e. in a 1D model. The number of particles entering the volume at position x per time dt is



$$dn^{in} = j(x)Adt \quad .$$

Correspondingly the number of particles leaving the volume at position $x + l$ per time dt is

$$dn^{out} = j(x + l)Adt \quad .$$

Thus the change of concentration in the volume Al per time dt is

$$\frac{dc}{dt} = \frac{dn^{in} - dn^{out}}{Aldt} = \frac{j(x) - j(x+l)}{l} = \frac{j(x) - \left[j(x) + l\frac{dj}{dx}\right]}{l} = -\frac{dj}{dx} \quad .$$

In 3D and adding local sources and drains we find

$$\frac{dc}{dt} = -\frac{dj_x}{dx} - \frac{dj_y}{dy} - \frac{dj_z}{dz} + sources(\vec{r}) - drains(\vec{r}) = -\vec{\nabla}\vec{j} + sources(\vec{r}) - drains(\vec{r}) \quad .$$