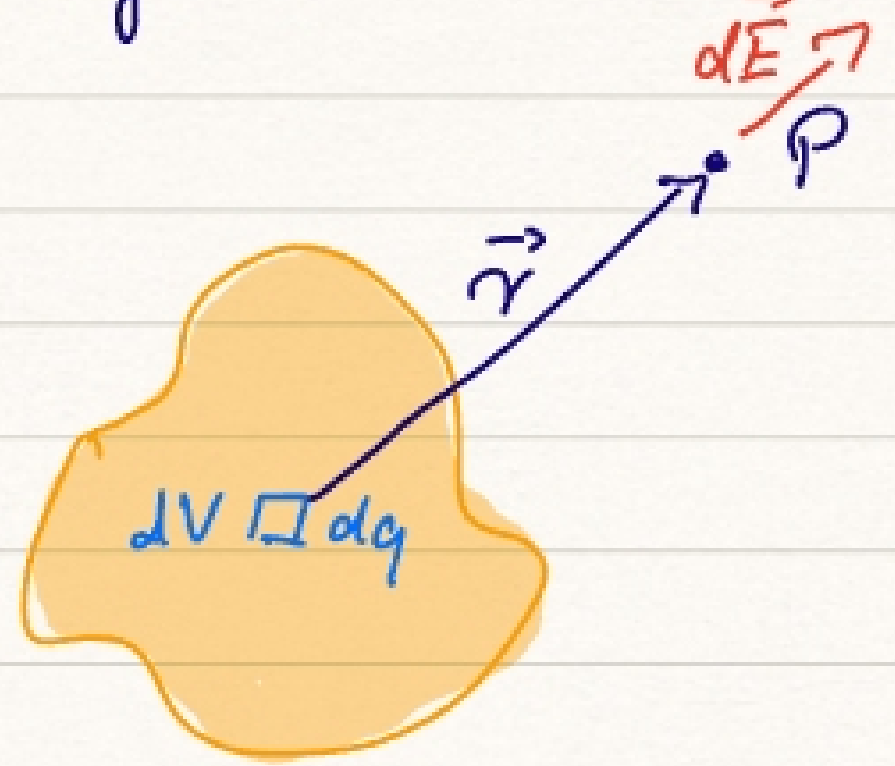
Electric field generated by a continuous charge distribution



Consider the continuous charge distribution shown on the left (potato). We assume that we know the volume density ρ of the electric charge.

$$\rho = \frac{dq}{dV} \quad \left[\frac{C}{m^3} \right]$$

Our goal is to determine the electric field $\vec{E}$ generated by the distribution at a given point P.

1. Devide the charge distribution into elements (cutting the potato). Each element has the charge $dq = \rho\, dV$. We assume that point P is at a distance r from dq
2. Determine the electric field $d\vec{E}$ generated by dq at point P

The magnitude dE of $d\vec{E}$ is given by

$$dE = \frac{dq}{4\pi\varepsilon_0 r^2}$$

3. Sum all the contributions

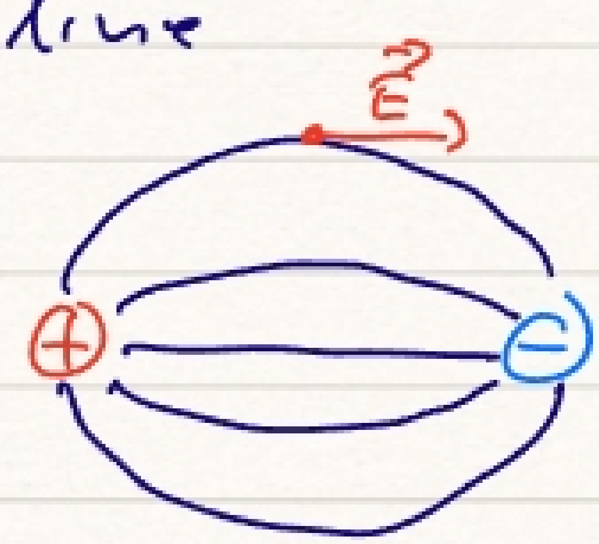
$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{\rho\, dV}{r^2}\,\hat{r}$$

Electric field lines

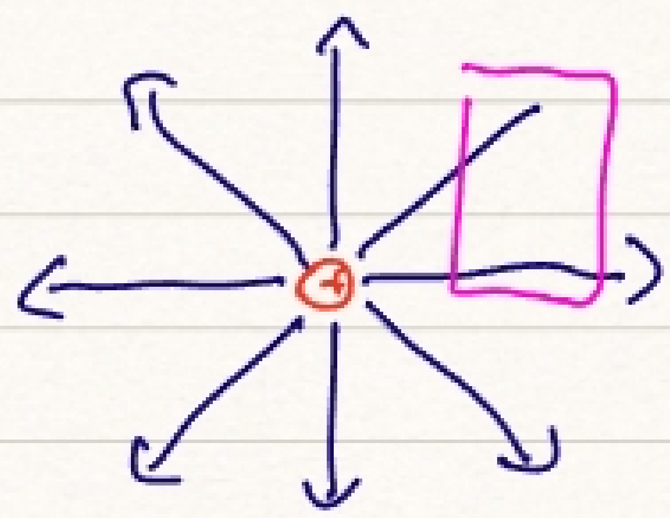
In the 19th century Michael Faraday introduced the concept of electric field lines which help to visualize the electric field vector $\vec{E}$

The relation between the electric field lines and $\vec{E}$ are:

1. At any point P the electric field vector $\vec{E}$ is tangent to the the electric field line



2. The magnitude of the electric field vector $\vec{E}$ is proportional to the density of the electric field lines



3. Electric field lines extend away from positive charge (where they originate) and towards negative charges (where they terminate)