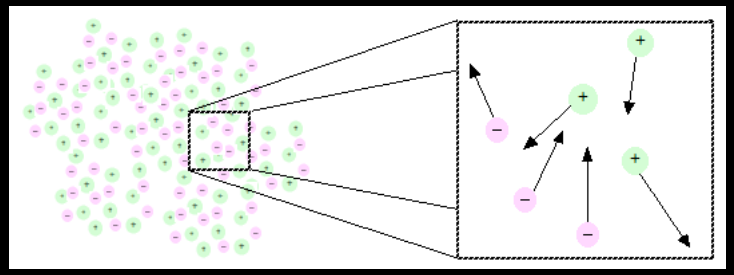
Basic properties of plasmas

1. Local charge neutrality

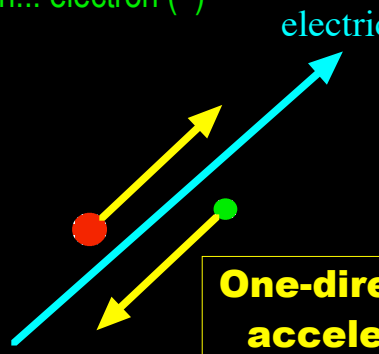


The numbers of positive charges and negative charges are almost the same in every local region.

2. Interaction with electric field (Coulomb force: $F_C = q\,E$)

magenta... particle's property

red... ion (+)
green... electron (–)



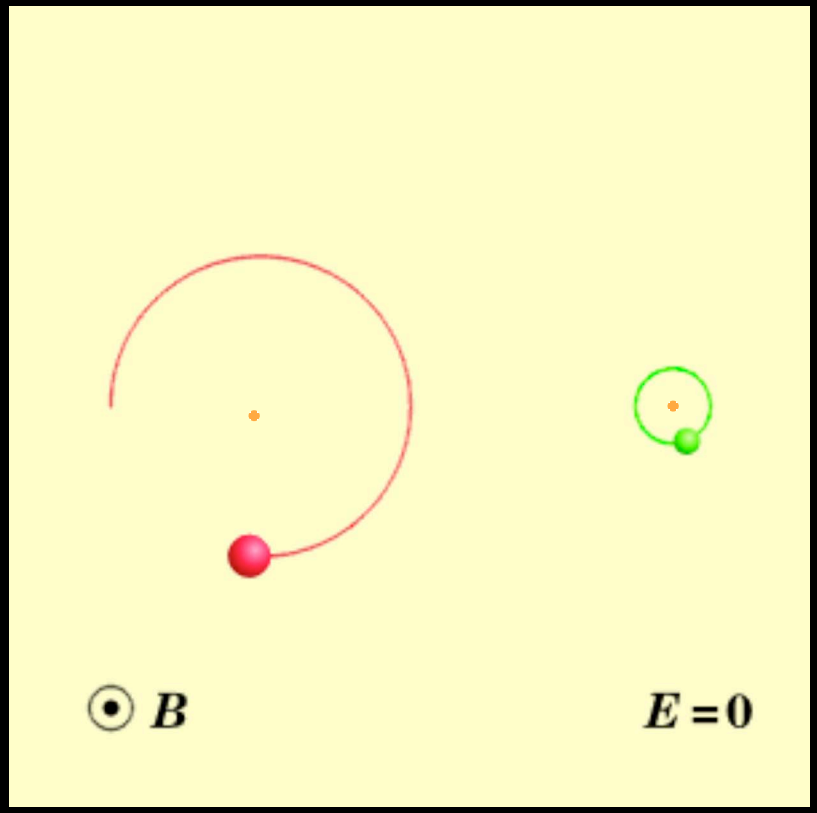
One-directional acceleration

Charged particles are accelerated along electric field.

$$\frac{d\boldsymbol{v}}{dt} = \frac{q}{m}\boldsymbol{E}$$

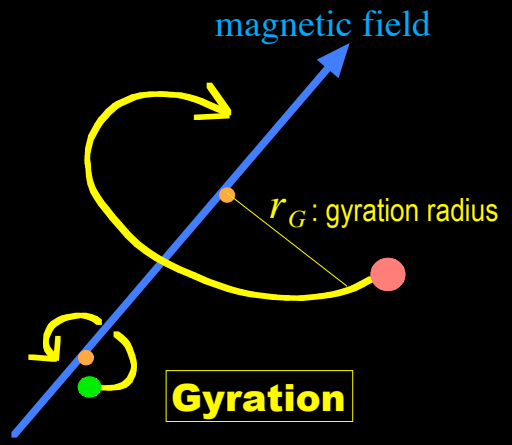
Magnitude of v is changed.

3. Interaction with magnetic field (Lorentz force: $F_L = q\, v \times B$)



$B_\perp$-plane

orange... gyration center



Charged particles gyrate around magnetic field.

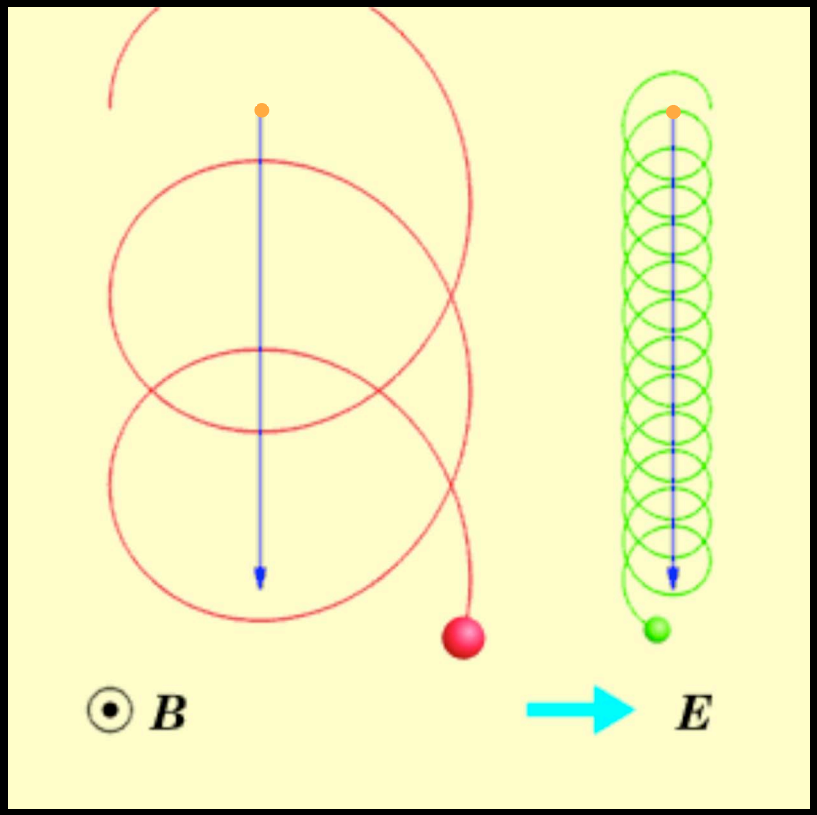
Direction of v is changed.

$$\frac{d\boldsymbol{v}_\perp}{dt} = \frac{q}{m}\,\boldsymbol{v}_\perp \times \boldsymbol{B}$$

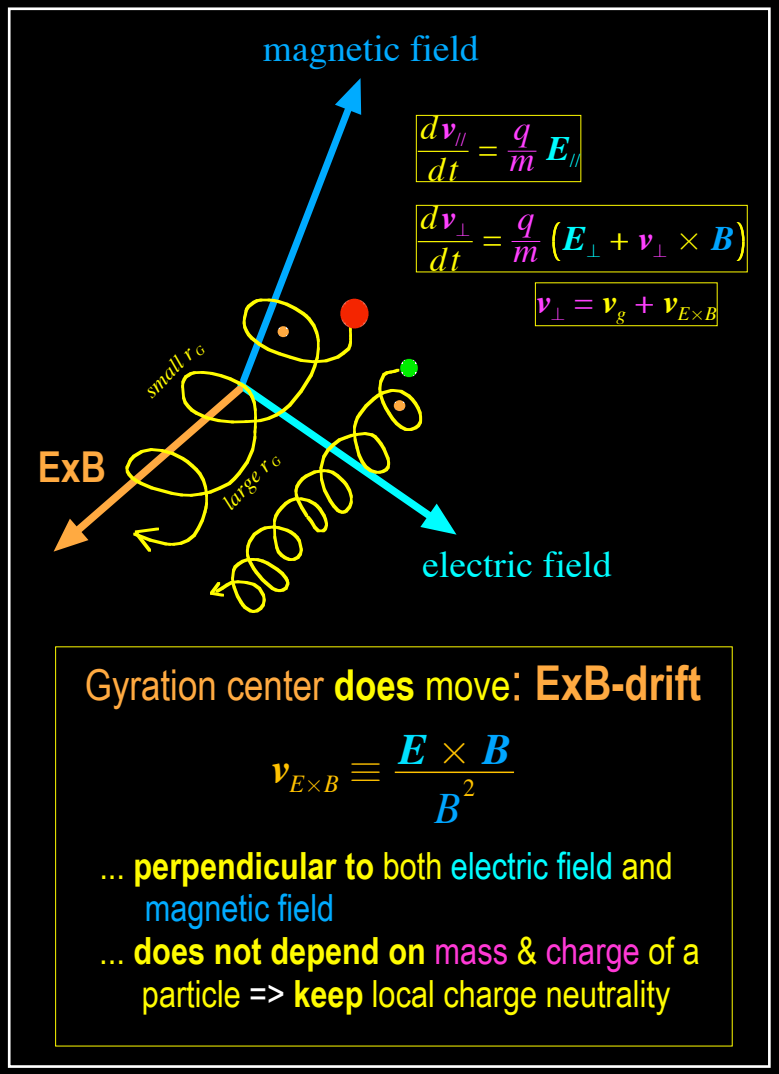
Gyration center does **not** move.

4. Interaction with electric field and magnetic field

blue... ExB drift



$B_\perp$-plane



Gyration center **does** move: **ExB-drift**

$$v_{E\times B} \equiv \frac{E \times B}{B^2}$$

... **perpendicular to** both electric field and magnetic field

... **does not depend on** mass & charge of a particle => **keep** local charge neutrality