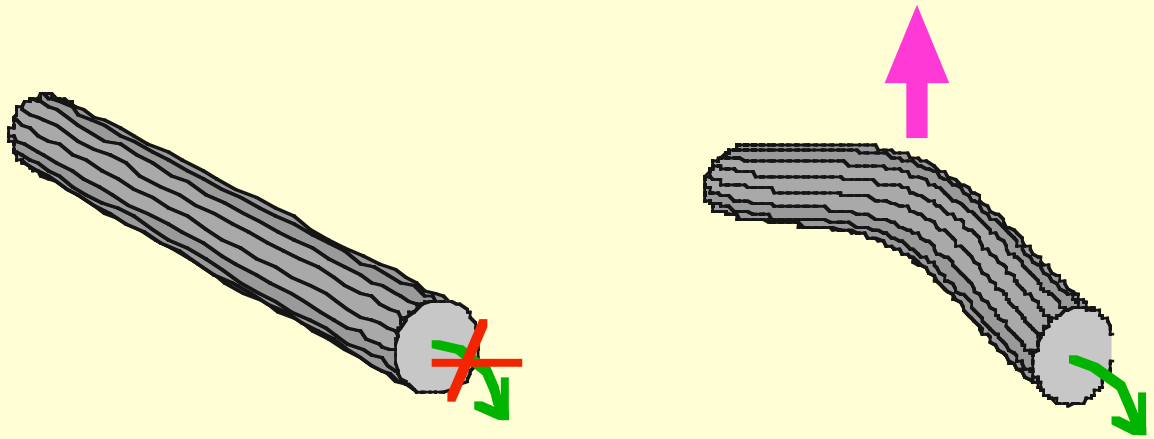
Three-dimensional effect



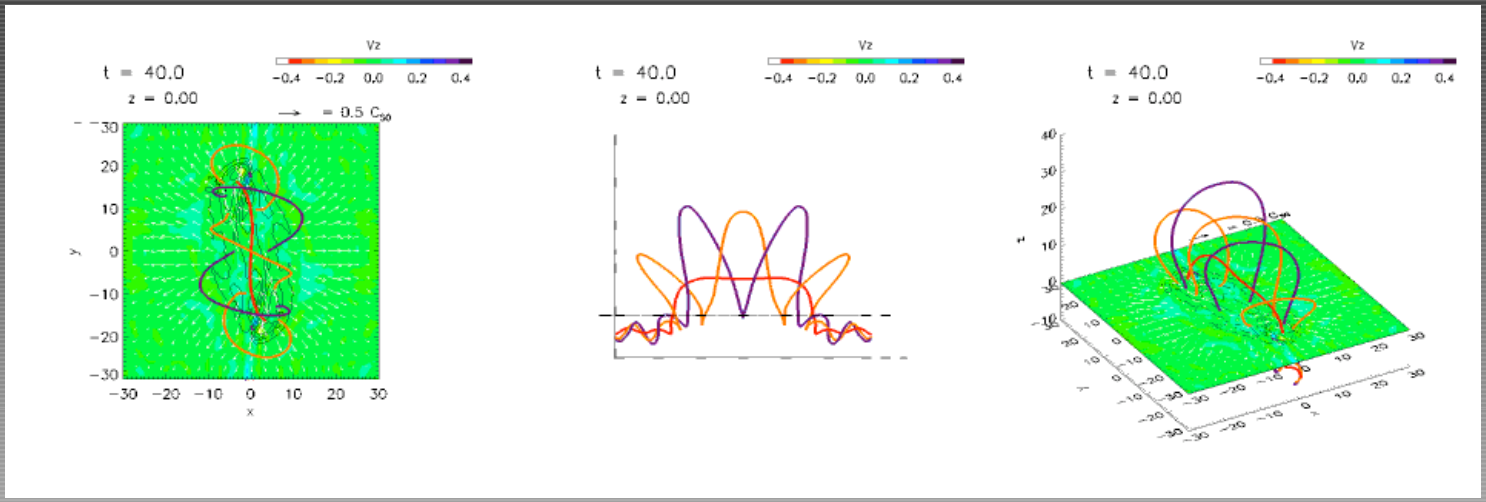
It enables a flux-tube plasma to drain along the axis of an emerging flux tube, thereby enhancing magnetic buoyancy.

2.5D case (straight axis)... the axis does **not emerge** (Magara 2001)

3D case (curved axis)... the axis **does emerge** (Fan 2001; Magara & Longcope 2001)

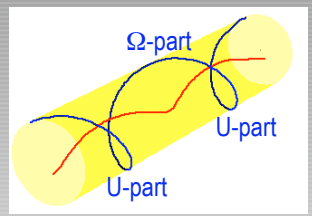
Three-dimensional evolution of emerging field lines

Magara & Longcope (2003)



red... **inner field line** (**axis** of flux tube)

purple, **orange**... **outer field lines**

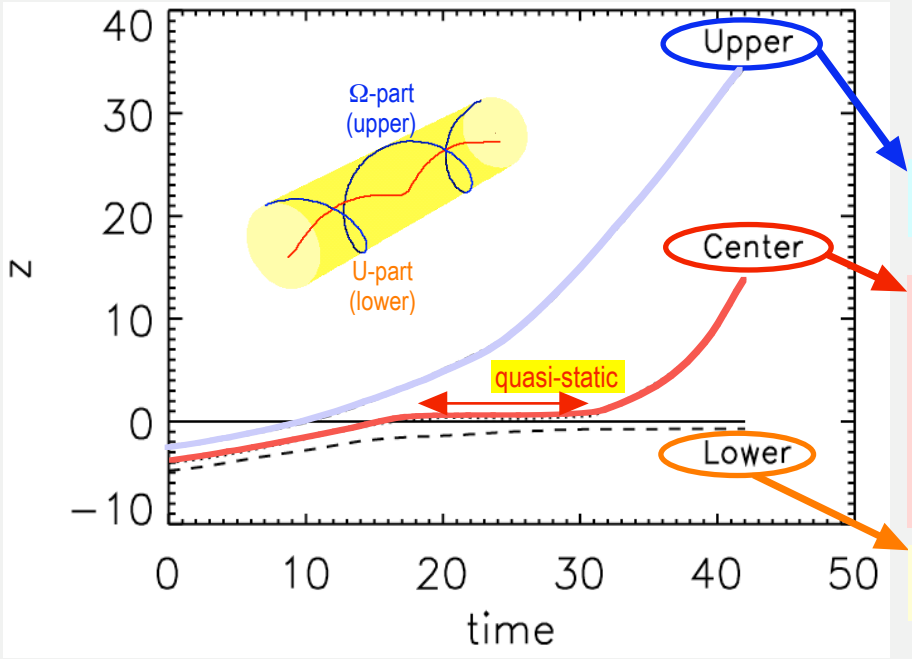


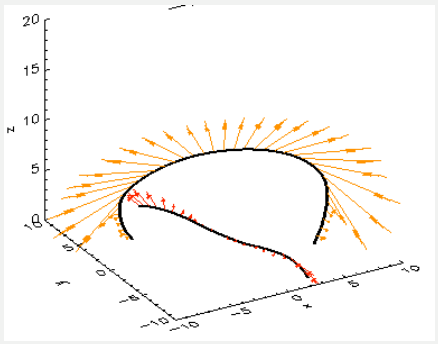
Flux-tube **axis does emerge** into a solar atmosphere (**3D effect**).

Ω-part of outer field lines **emerges**, whereas their **U-part** does **not emerge**.

Key features of emerging field lines (evolution)

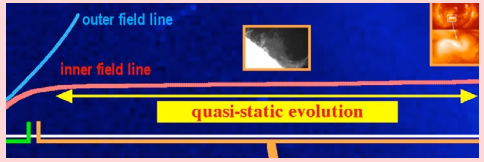
Height-time relation of outer & inner (axis) field lines:





Ω-part of outer field line **continuously expands**.

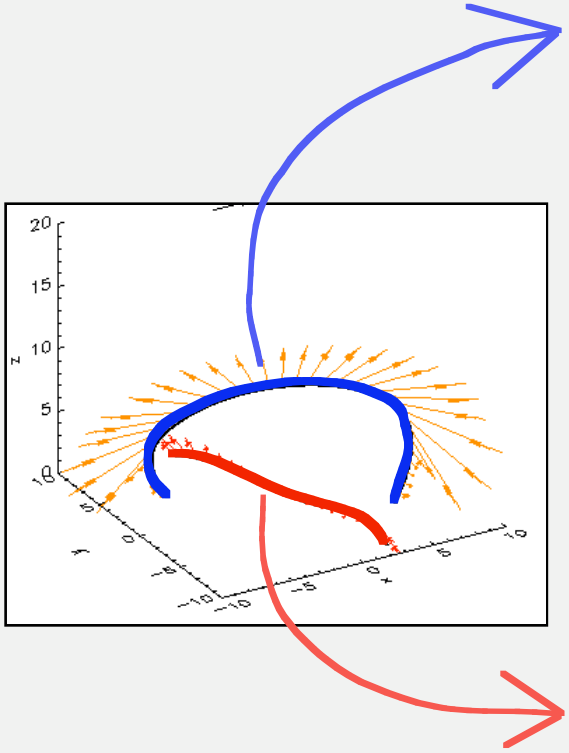
Inner field line shows **quasi-static evolution**.



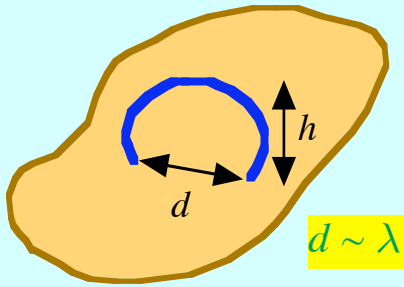
U-part of outer field line does **not emerge**.

Key features of emerging field lines

(**shape**)



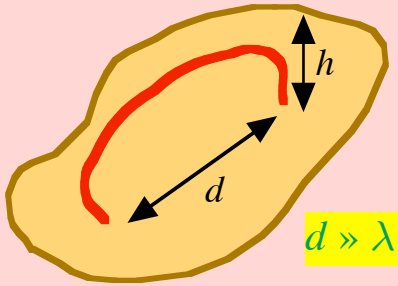
Outer field line... **short** **footpoint distance**



$d \sim \lambda_c$

aspect ratio *h/d:* **large**

Inner field line... **long** **footpoint distance**



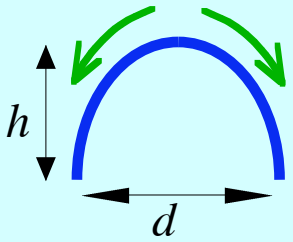
$d \gg \lambda_c$

aspect ratio *h/d:* **small**

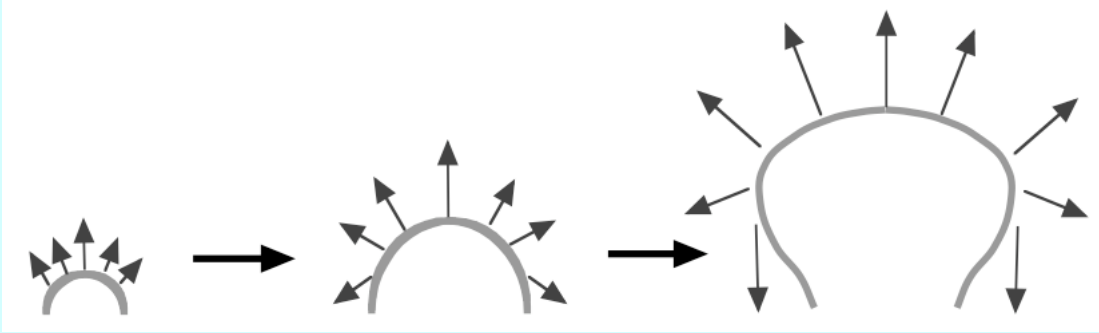
Relation between evolution and shape of emerging field line

Outer field line

plasma drains **fast**



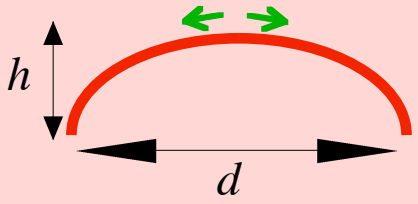
large *aspect ratio h/d*



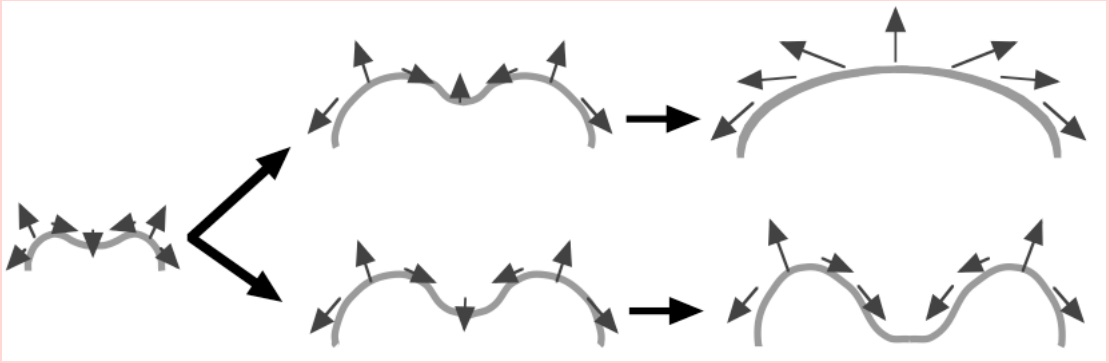
Continuous expansion

Inner field line

plasma drains **slowly**



small *aspect ratio h/d*



Slow evolution with **dip formation**