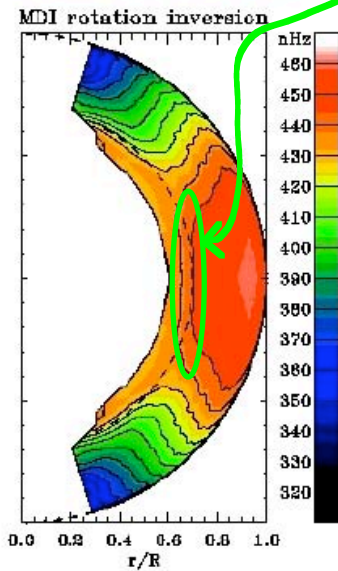
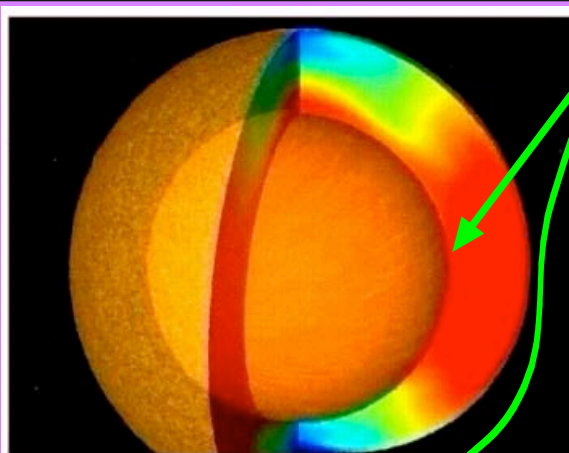


SMFs rise through the CZ via magnetic buoyancy...



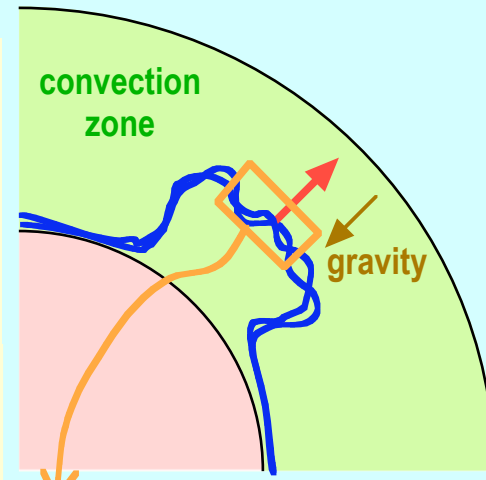
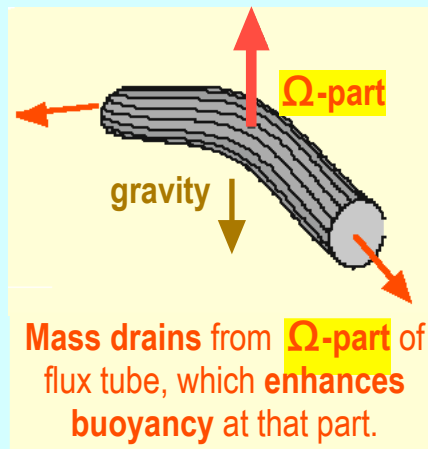
Distribution of angular velocity in the solar interior

Tachocline (bottom of the convection zone)

... sharp change of angular velocity => shear flow 

Magnetic fields could be amplified by the shear flow, producing a flux tube of intense magnetic flux. 

Magnetic buoyancy

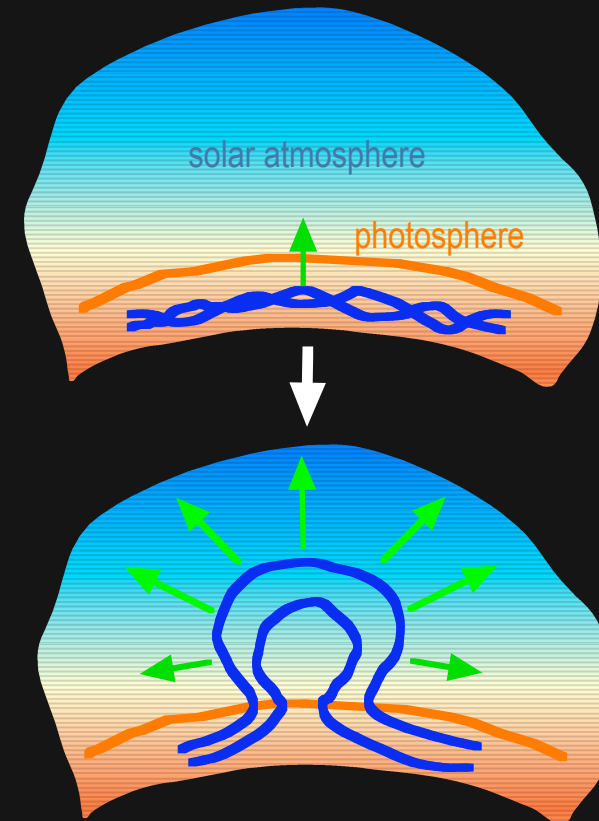
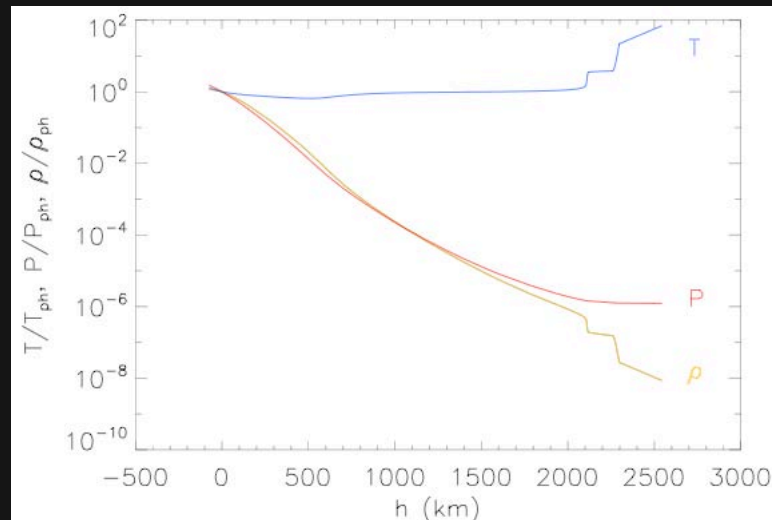


Twisted flux tube

Emergence of magnetic fields into the solar atmosphere

Flux emergence...

A magnetic flux tube emerging into solar atmosphere expands rapidly due to sharp decrease of gas pressure across solar surface (photosphere).



Photosphere

$P \sim 2 \times 10^5 \text{ dyn/cm}^2$

Chromosphere

$P \sim 1 \times 10^2 \text{ dyn/cm}^2$

Corona

$P \sim 2 \times 10^{-2} \text{ dyn/cm}^2$

840 km
($0.001 R_{\odot}$)

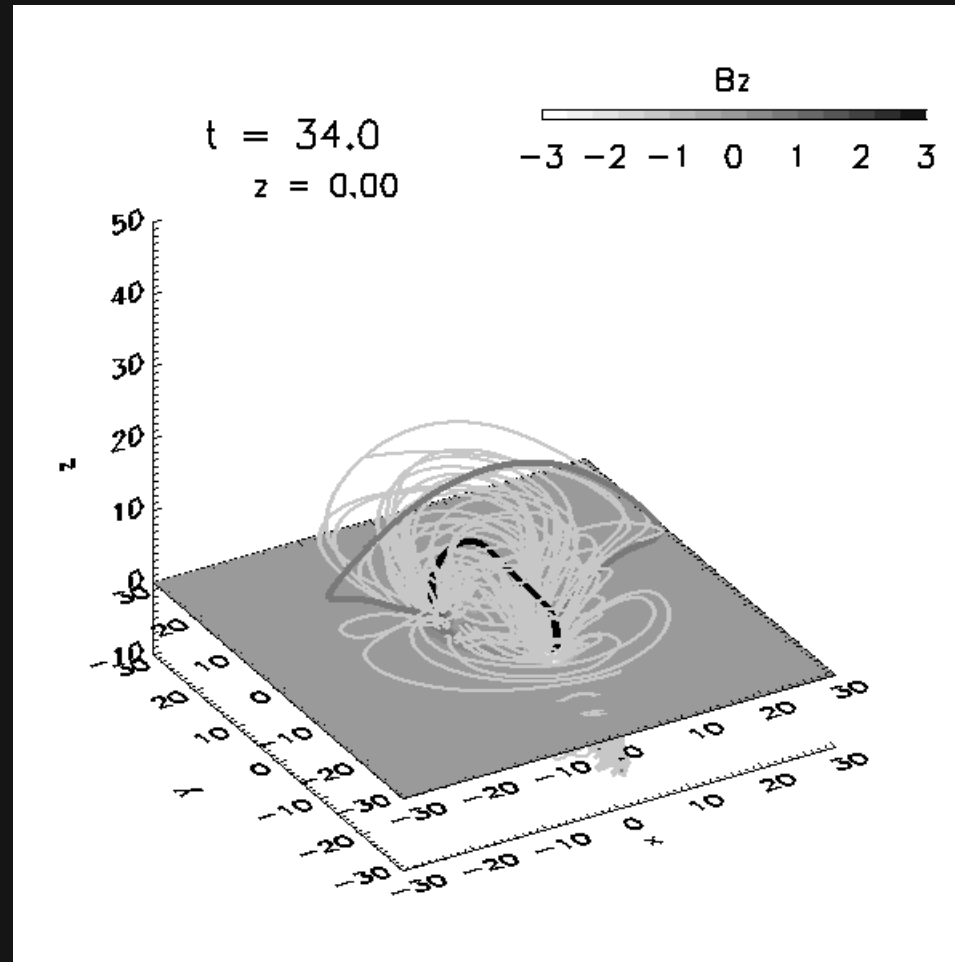
6000 km
($0.01 R_{\odot}$)

Flux emergence... a very dynamic process (observation)



Observed by *TRACE*

Flux emergence... a very dynamic process (simulation)



Magara (2004)

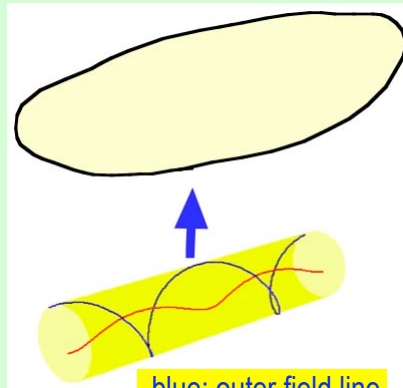
3D MHD simulation

Evolutionary phases of an emerging magnetic field



Emergence phase:

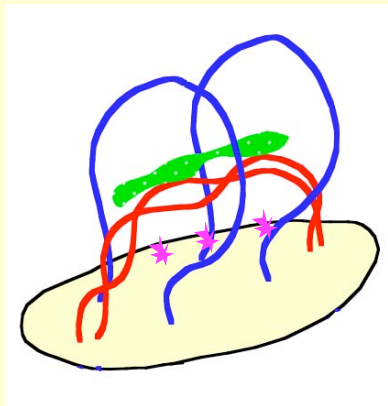
Emergence of subsurface magnetic field in **twisted flux-tube shape**



blue: outer field line
red: inner field line

Formation phase:

Formation of magnetic structure called **flux rope** in solar corona (**prominence / filament, sigmoid, small flare** are observed)



Eruption phase:

Eruption of flux rope toward interplanetary space (sometimes accompanied by **flare with plasmoid ejection**)

