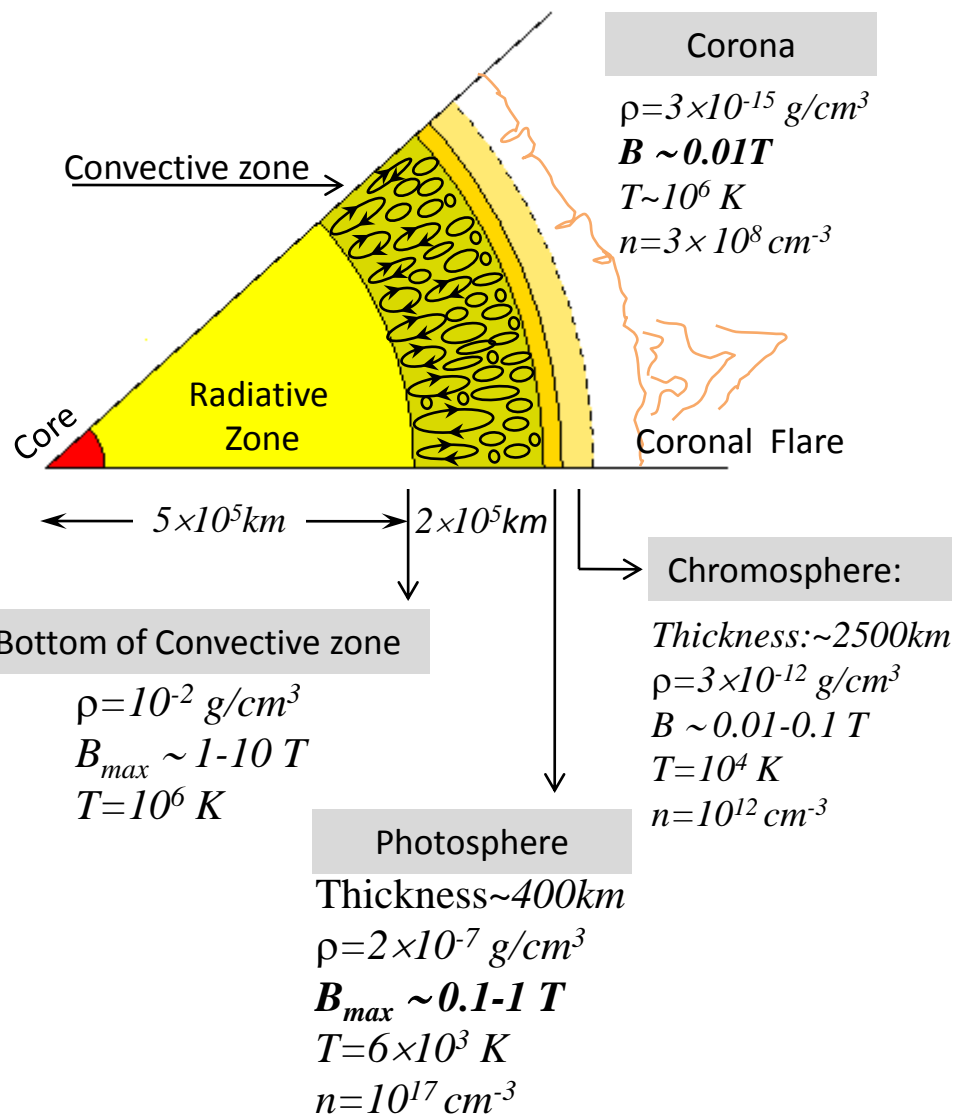# Hypothesis of IceCube SN trigger – Solar activity correlations

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Anatomy of the Sun

Corona

$\rho = 3 \times 10^{-15}$ g/cm^3
$B \sim 0.01T$
$T \sim 10^6$ K
$n = 3 \times 10^8$ cm^{-3}

Convective zone

Radiative Zone

Core

Coronal Flare

$\leftarrow$ $5 \times 10^5 km$ $\rightarrow$ $2 \times 10^5 km$

Bottom of Convective zone

$\rho = 10^{-2}$ g/cm^3
$B_{max} \sim 1\text{-}10$ T
$T = 10^6$ K

Chromosphere:

Thickness:~2500km
$\rho = 3 \times 10^{-12}$ g/cm^3
$B \sim 0.01\text{-}0.1$ T
$T = 10^4$ K
$n = 10^{12}$ cm^{-3}

Photosphere

Thickness~400km
$\rho = 2 \times 10^{-7}$ g/cm^3
$B_{max} \sim 0.1\text{-}1$ T
$T = 6 \times 10^3$ K
$n = 10^{17}$ cm^{-3}

High energy Solar neutrino production

1. Strongly turbulent upper layer of Convective zone and set of Unstable Current Sheets acting as nodes of acceleration can be very fast and efficient accelerator of protons and ions.
[Loukas Vlahos et al., Astrophys.J. 2004]
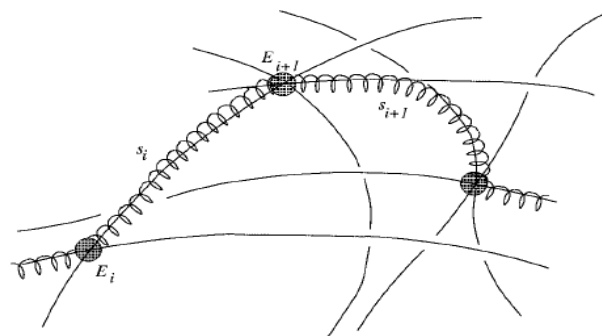
2. Maximal acceleration length is $\lambda_{in} = 3 \times 10^6 m$ for protons with energy $E_p = 2\text{-}20\ GeV$, $\sigma_{in}(pp) \approx 25mb$ and density of photosphere 2×10^{-7} g/cm^3.
3. Maximal electric field inside the **coronal** current sheets is about **E** $\approx 1kV/m$ and maximal energy gain for protons is $E_{max} = eEl_c \approx eE\lambda_{in} \approx$ **3-5 GeV**. *[D.Craig, Y.Litvinenko, Astrophys.J. 2002].* Current sheets in photosphere can provide $E_{max} \approx 30\ GeV$ due to at least ten-fold reconnecting magnetic field.

From Dieter Schmitt, "Theory of the Solar Dynamo":
Several processes, most notable magnetic buoyancy, transport magnetic flux from the bottom to the top of the convection zone in times of the order of month
[F. Moreno-Insertis et al., Astron. Astrophys., 1992].
 Observable IceCube SN trigger rate leads the sunspots number rate about 1-4 week!

Outlook: Topological changes in form of set of magnetic reconnections into photosphere or upper layer of convection zone can convert energy of magnetic field into acceleration of protons up to $30\ GeV$ energies and provide corresponding high energy neutrino productions.

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