The global distribution of magnetic helicity in the solar corona

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with thanks to
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To identify **where** magnetic helicity is stored in the corona.

**Magnetic helicity** is a volume integral that measures the average pairwise linking of magnetic field lines.

\[ H = \int_V A \cdot B \, dV \]
Aim

To identify **where** magnetic helicity is stored in the corona.

The concept extends to non-closed magnetic field lines if you specify relative connection of end-points (**relative helicity**).
The ideal tool

The magnetic flux through a closed magnetic field line is invariant in ideal magnetohydrodynamics.

\[ \mathcal{A}(L) = \int_{S(L)} B \cdot n \, dS = \oint_{L} A \cdot \, dl \]

We call \( \mathcal{A} \) the **field line helicity**.

\[ B = \nabla \times A \]
The ideal tool

If $L$ ends on the boundary, $A$ is still the flux through a suitable surface. This is invariant if the footpoints are fixed.

Choosing which curve $\gamma$ to complete the loop is equivalent to choosing the gauge of $A$ on the boundary, or to choosing the reference field in relative helicity.

\[ A(L) = \int_L A \cdot dl \]

Field line helicity reveals footpoints of the sheared arcade.
before the flare...
after the flare…
before the flare…
after the flare...

Significant *local* decrease in helicity during the flare.
Example: global magneto-frictional model

Field line helicity reveals the concentration of helicity above photospheric neutral lines.

Example: global magneto-frictional model

Field line helicity can identify flux ropes and eruptions…
Conclusions

- **Field line helicity** reveals the distribution of magnetic helicity within the corona.

- Useful tool both within active regions and globally, e.g. for identification of magnetic flux ropes [next talk!]

More details


http://www.maths.dur.ac.uk/~bmjg46/