Contribution ID: **381** Type: **Poster**

Solar Coronal Loops as Magnetically Confined Tori with Gravity

Wednesday 19 October 2016 08:30 (4 hours)

A large amount of evidence suggests that the bright loops that are
regularly observed in the sun's corona are magnetic flux ropes that confine plasma,
tied at both ends to structures in the photosphere.
Due to the difficulties of observation,
their steady states have never been explained.
Coronal loops resemble partial magnetic tori and
ideas from the equilibrium and stability of toroidal magnetic fusion
plasmas lead, for the first time, to 3D ideal MHD solutions for coronal loop
steady states that take into account the complete
force balance and geometry. The apparently weak solar gravity, previously ignored,
is found to be the crucial factor that allows a loop steady state.
and provides a unified observational picture.
Gravity, combined with magnetic line-tying at the
loop footpoints, stabilizes the intrinsic radial (major radius)
expansion instability of a curved current-carrying loop,
replacing the external fields used in laboratory plasmas.
Normalized to the loop MHD parameters, the gravitational force parameter is
G-hat = G a / v_A^2, in terms of the acceleration due to gravity G=274.9 m/s^2,
the loop minor radius a, and the shear Alfven speed v_A.
Analytical steady states exist at two orders in the loop
inverse aspect ratio epsilon=a/R_o, G-hat = epsilon^2 and epsilon^3.
Comparison to observations shows good agreement. Short hot coronal loops
and the shorter warm loops fit the epsilon^3 ordering,
while long, lower density loops better fit epsilon^2.
Intermediate length loops fall in between.
Small G-hat loops have an axisymmetric tokamak-like core, while
large G-hat loops are strongly nonaxisymmetric and more
closely related to high beta stellarators, modified by gravity.
Sufficiently long loops will be metastable, since the gravitational force
begins to decrease with height as (R_o+R_s)^-2,
and may provide the seed state for large Coronal Mass Ejections.
The constraints imposed by the gravitational N=1 nonaxisymmetry
are related to fusion questions on the effects of
small magnetic nonaxisymmetries on tokamaks, such error fields and the
density pump-out by RMPs.
*Work partially supported by U.S. DOE OFES contract DE-SC0007883
and SCIDAC DE-FG02-04ER54802.

Paper Number

TH/P3-36

Country or International Organization

U.S.A.

Author: Ms SUGIYAMA, Linda (Laboratory for Nuclear Science, UsMIT)

Co-author: Ms ASGARI-TARGHI, Maboubeh (Harvard-Smithsonian Center for Astrophysics)

Presenter: Ms SUGIYAMA, Linda (Laboratory for Nuclear Science, UsMIT)

Session Classification: Poster 3

Track Classification: THC - Magnetic Confinement Theory and Modelling: Confinement