Microflares now, major flares soon

H.S. Hudson
Space Sciences Lab, UC Berkeley

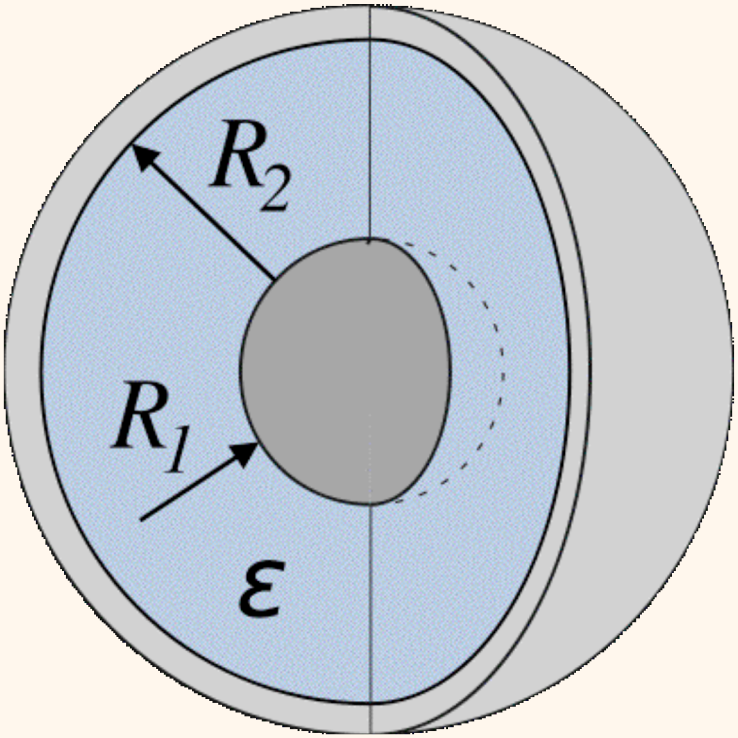
Microflares now, major flares soon

Our plasma experiment, the solar corona, begins its next run

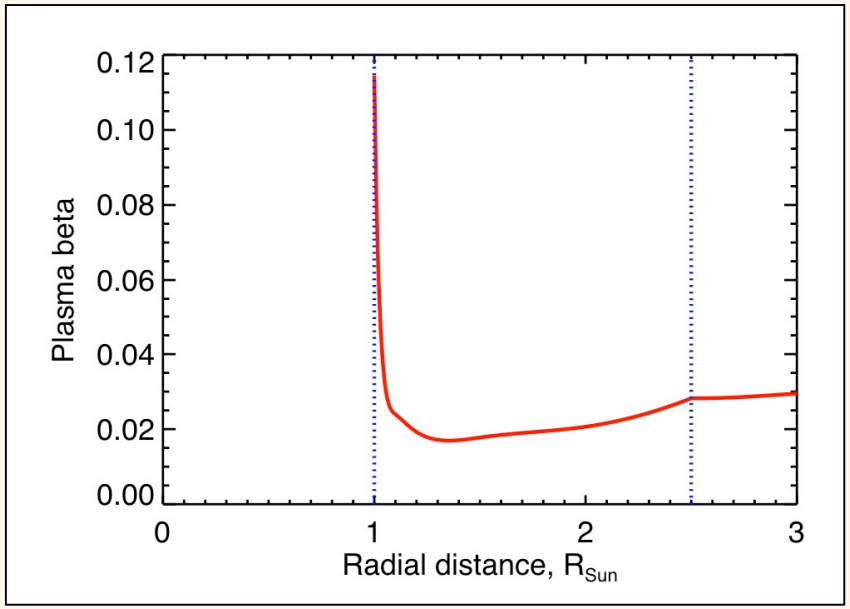
H.S. Hudson

Space Sciences Lab, UC Berkeley

The solar corona as a low-beta plasma laboratory



R_1 at photosphere
R_2 at top of corona



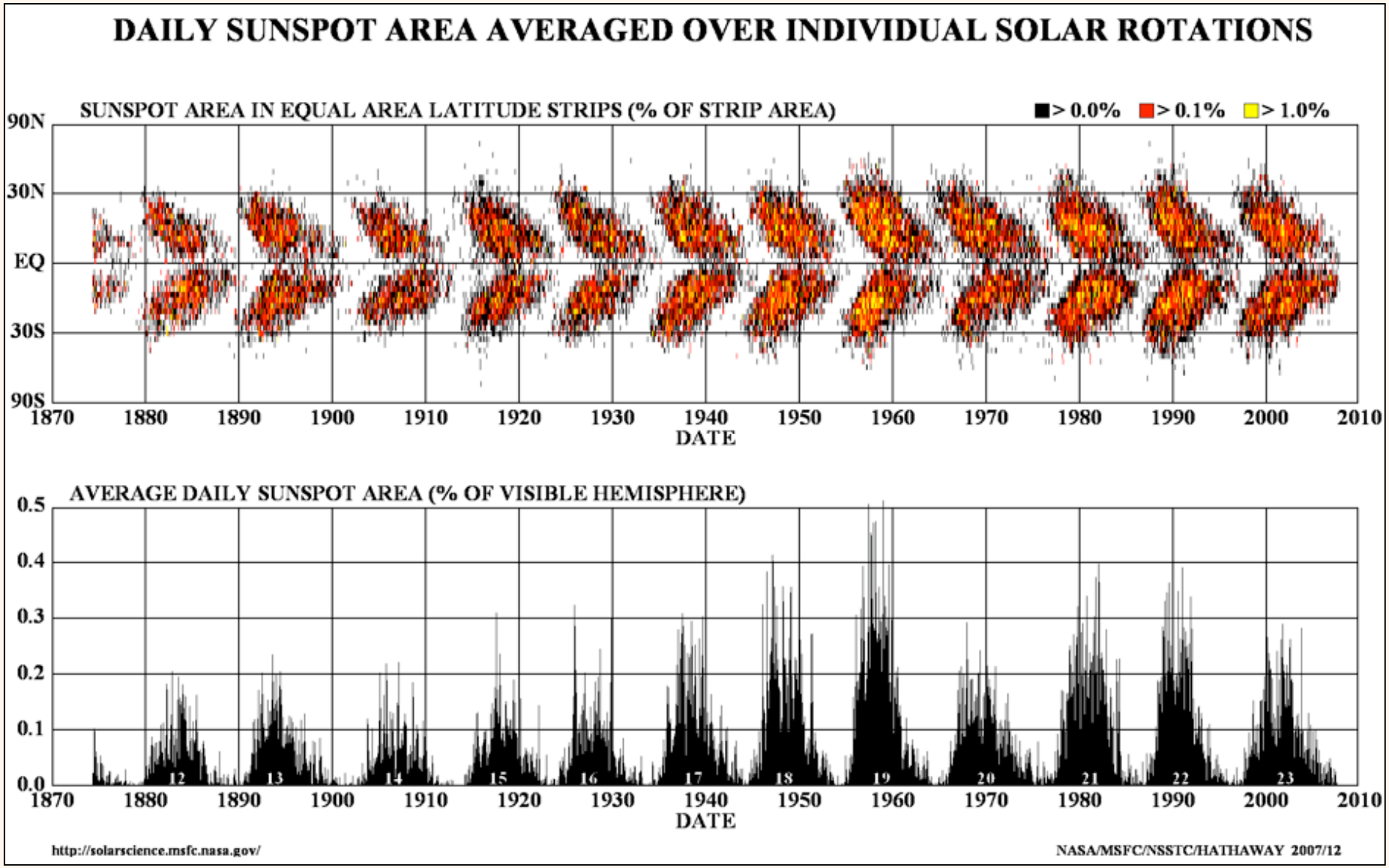
"plasma beta" = P_G/P_B

Every ~11 years, the plasma experiments begin anew with a fresh set of flares, each one a test of the system.

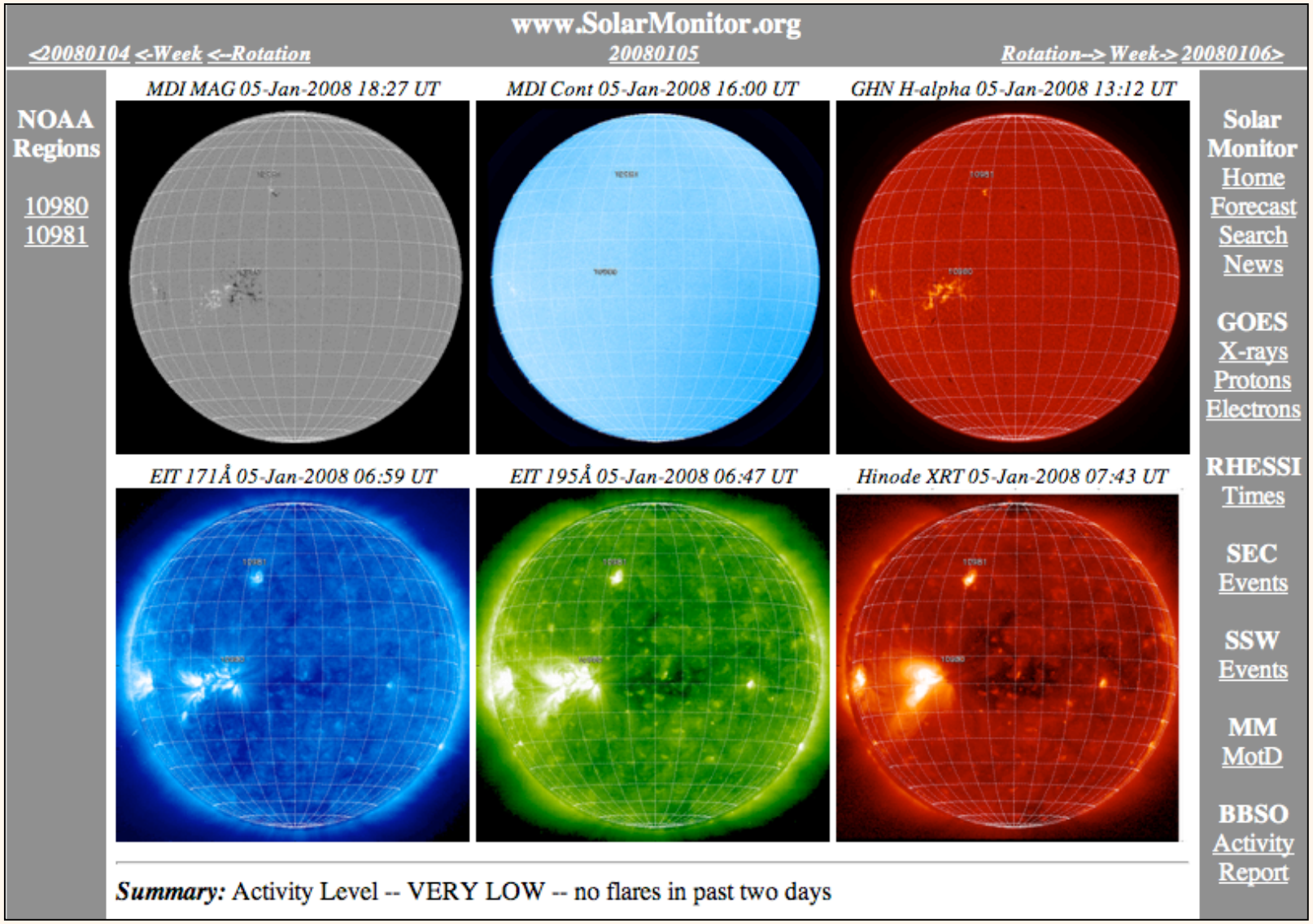
Every ~11 years, the plasma experiments begin anew with a fresh set of flares, each one a test of the system.

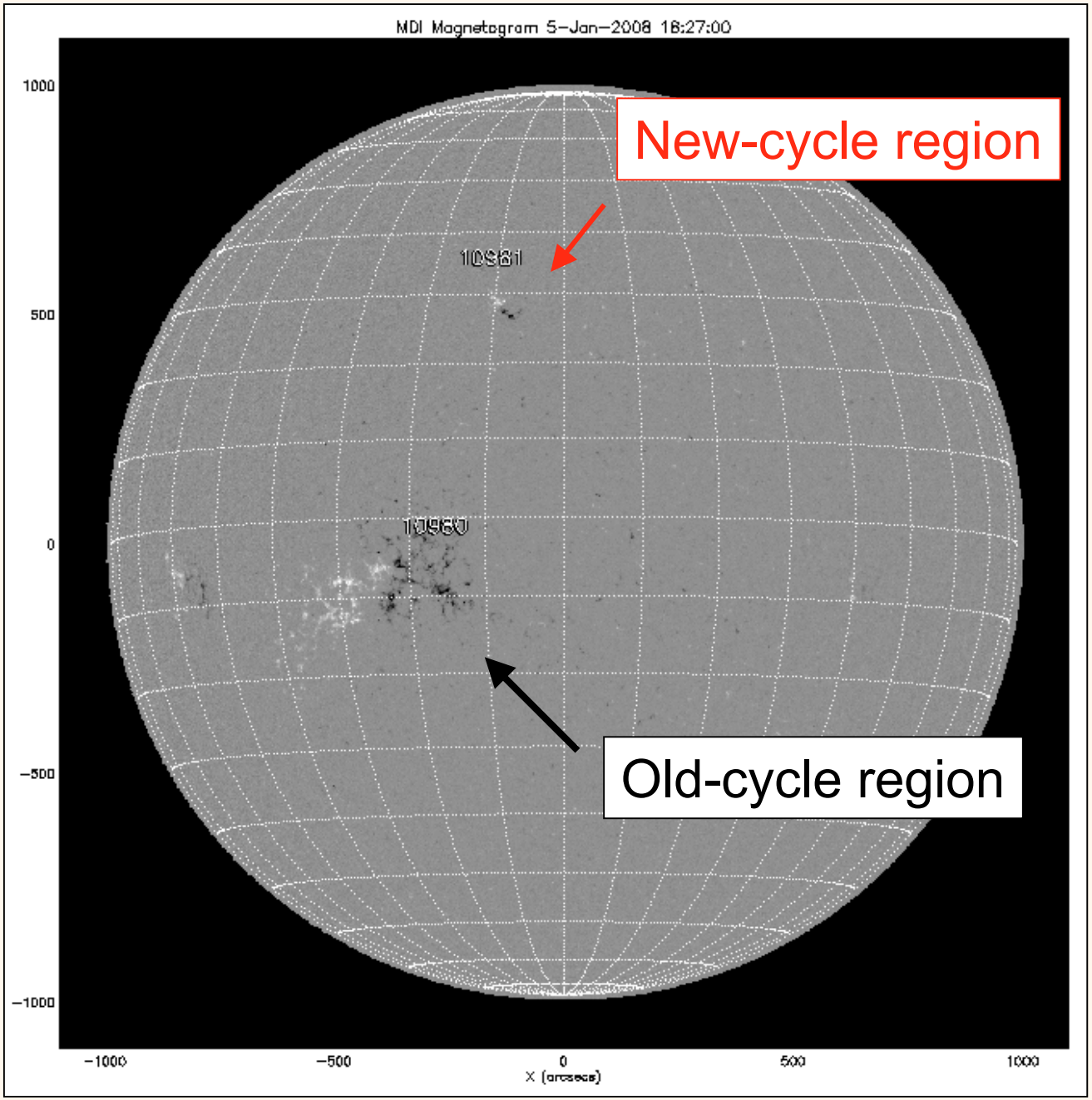
This gives us 11 years to get our act together!

Maunder's (Carrington's?) "butterfly diagram"



Cycle 24: the next experiment begins

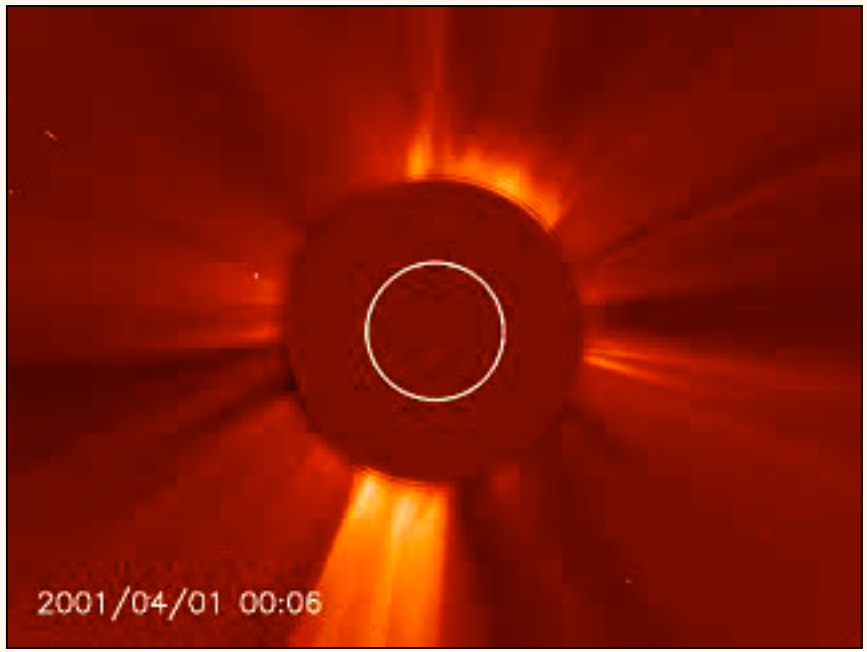


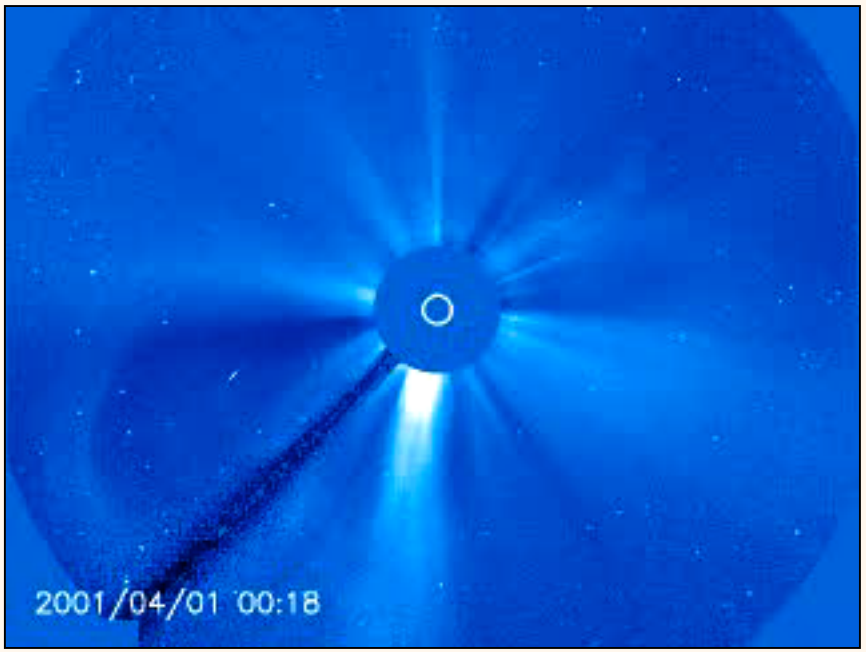

MDI Magnetogram 5-Jan-2008 18:27:00
New-cycle region
10961
10960
Old-cycle region
1000
500
0
-500
-1000
-1000
-500
0
500
1000
X (arcsec)

A flare/CME eruption represents a "test pulse" perturbation of the static large-scale structure of the low-beta corona.

A flare/CME eruption at the coronal base

Month-long time series (from SOHO, 2001)

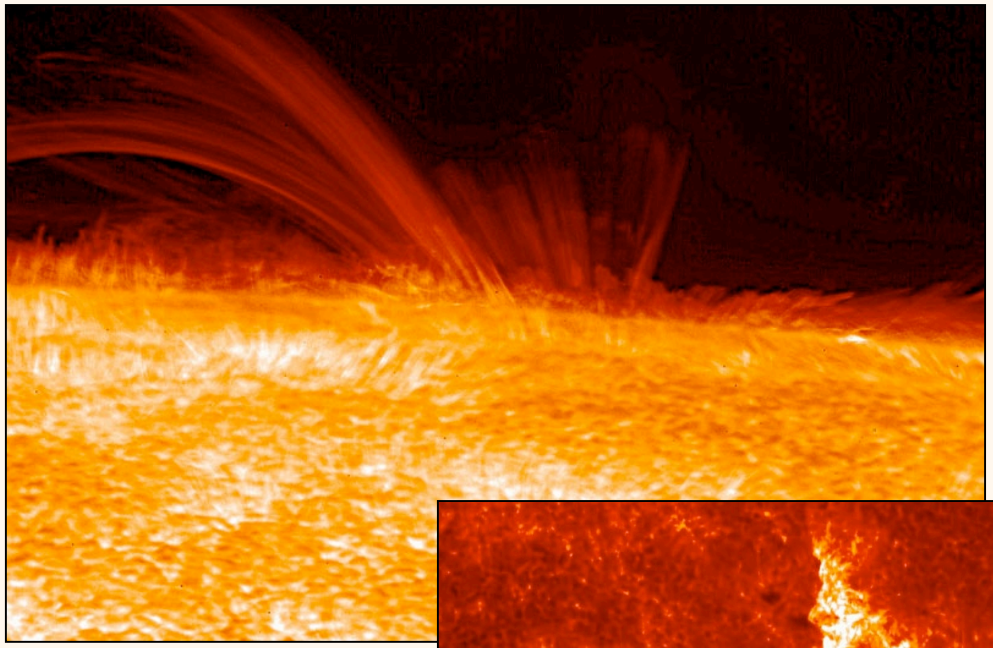


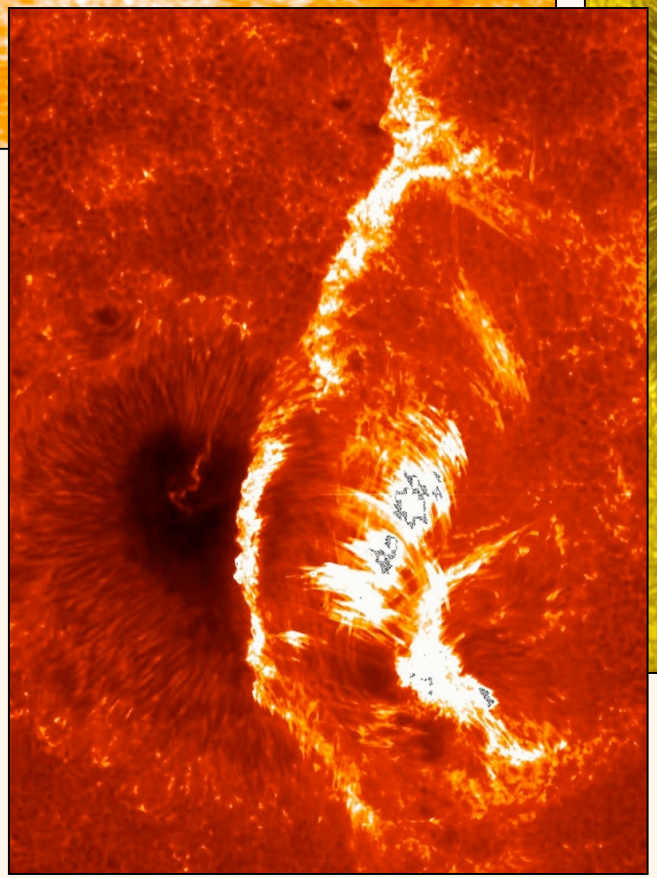


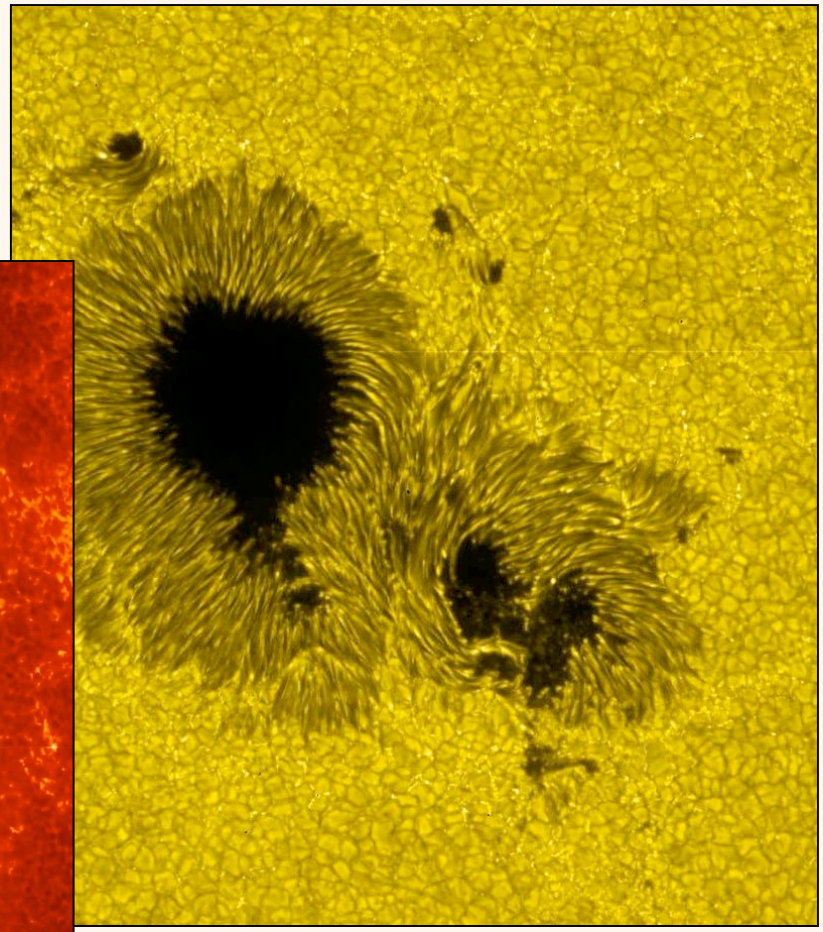
New observations in Cycle 24

- RHESSI (launch 2002): X-ray, hard X-ray, and the first γ-ray imaging
- Hinode (launch 2006): First high-resolution observations from space
- STEREO (launch 2006): First stereoscopic astronomical observations

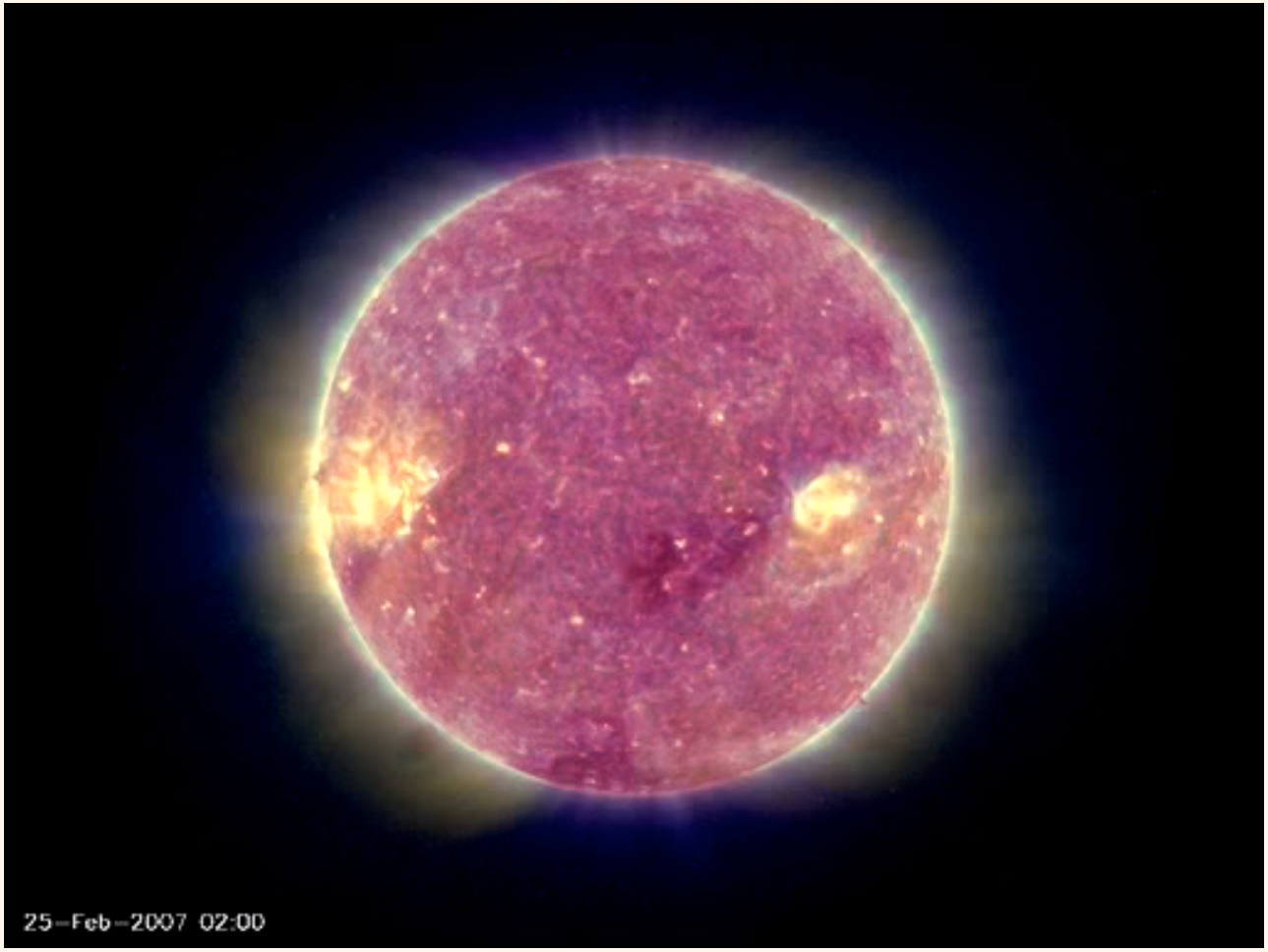
Hinode



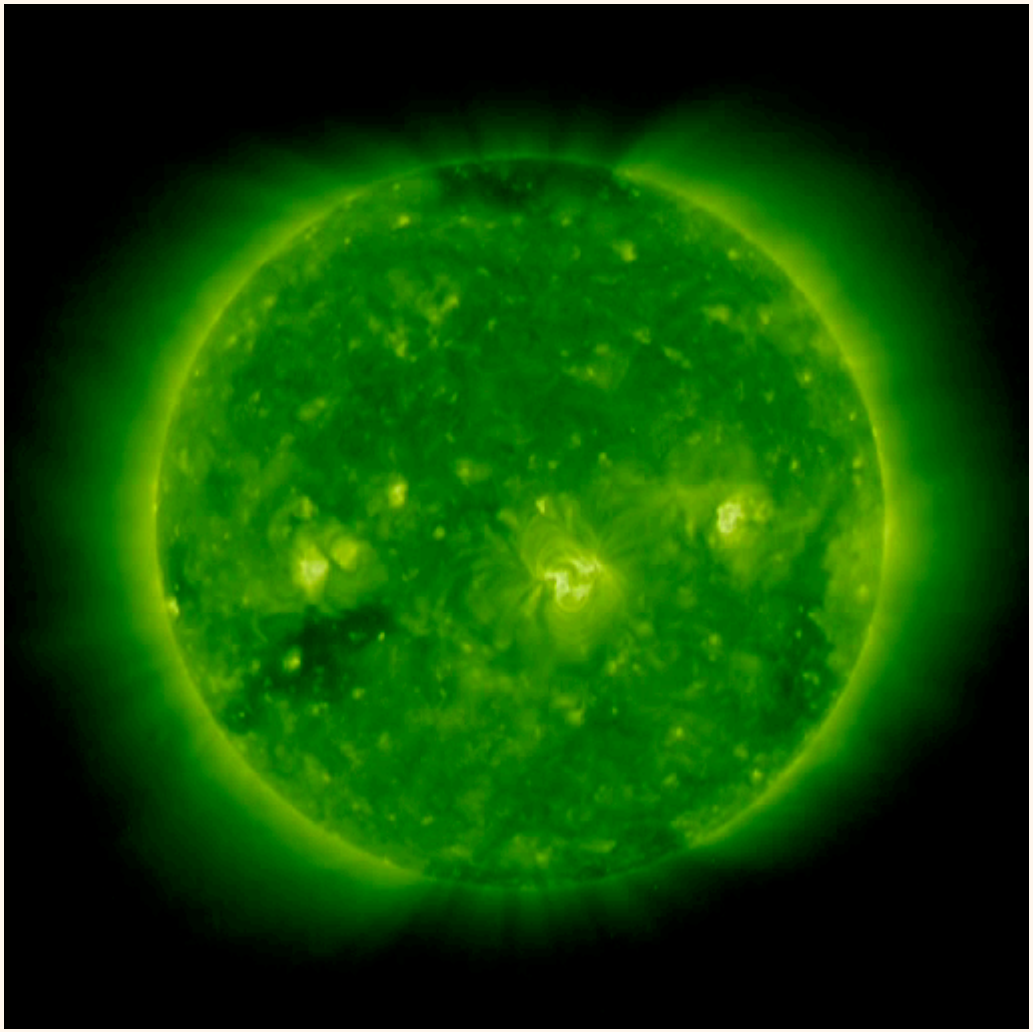




STEREO



STEREO

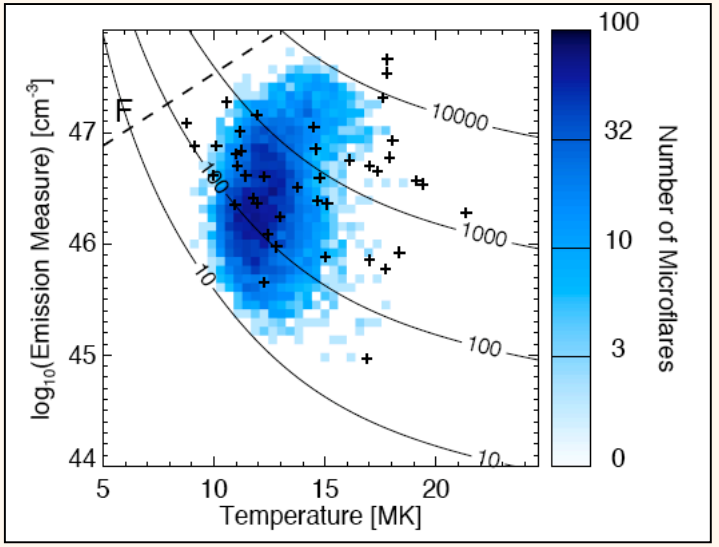


What are the outstanding physical problems? How do we solve them?

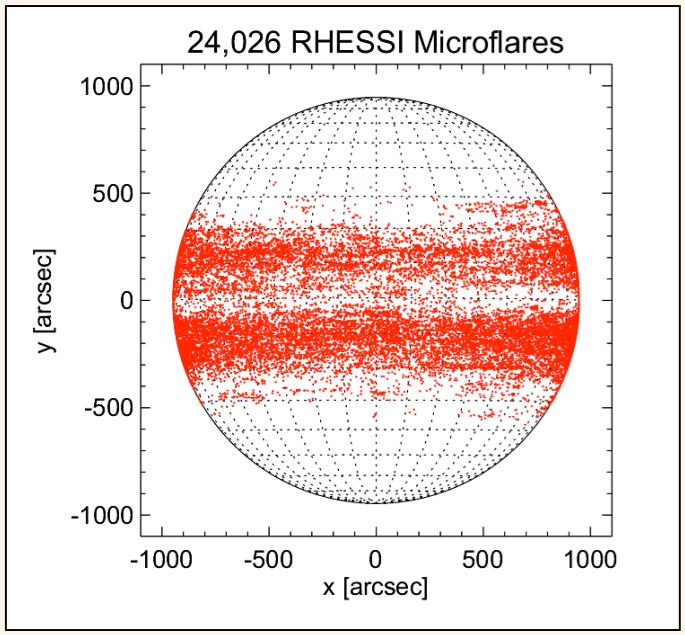
- What drives the flare instability; how do we extract energy from the low-beta corona?
- How do we understand the non-thermal physics of the impulsive phase?
- How do large-scale shock waves form, and how do they accelerate particles?

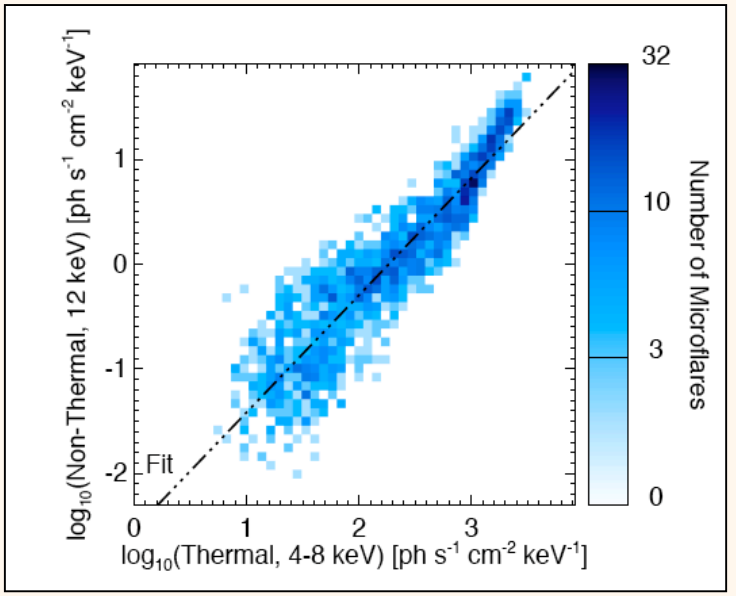
Hints from RHESSI microflares*

Thermal



Spatial

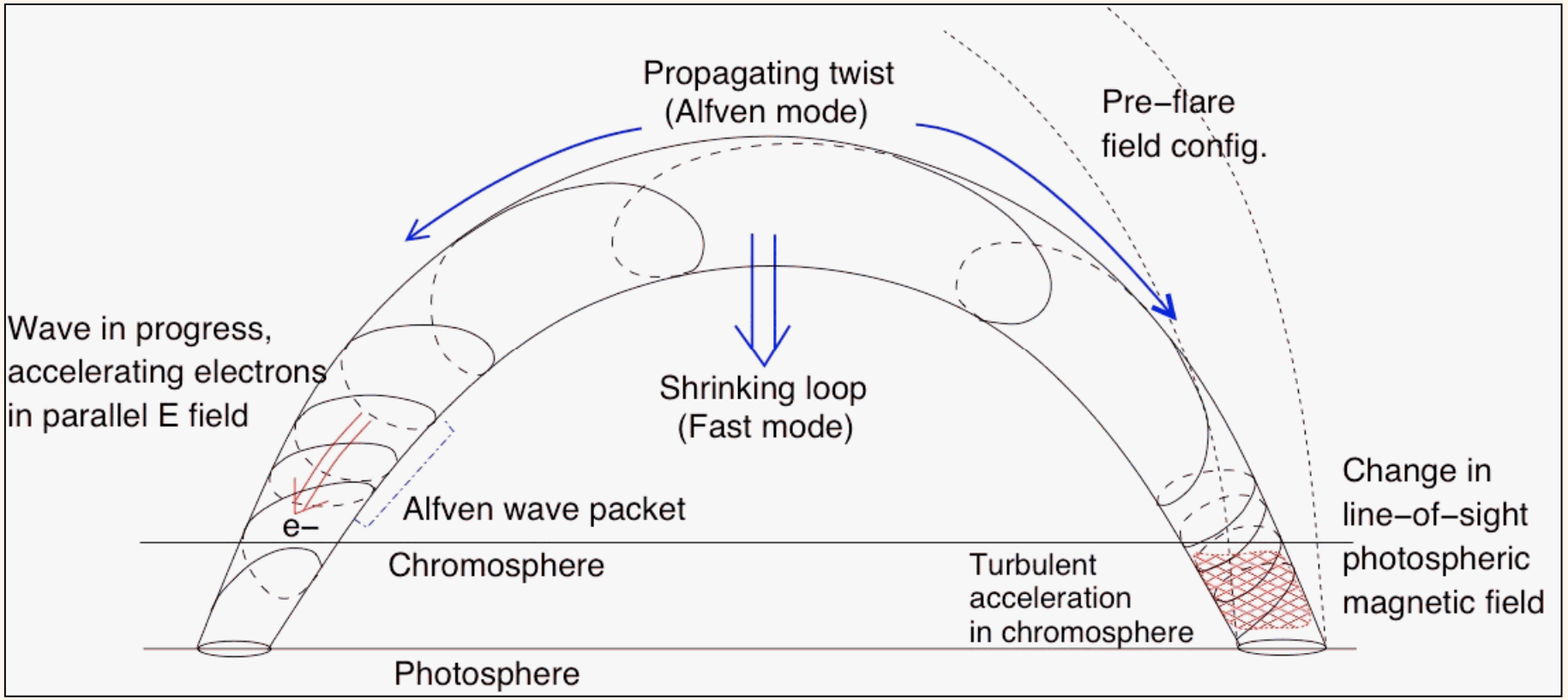




Nonthermal

*_cf_. Hannah poster

Understanding the impulsive phase requires more than ideal MHD



Fletcher & Hudson 2008

http://solarmuri.ssl.berkeley.edu/~hhudson/cartoons/

Conclusions

- The next solar maximum is arriving and we have excellent tools for understanding the hard problems of flare/CME occurrence
- As a first this time, we have stereoscopic tools and can work in 3D
- The solutions to the problems will involve application of “space plasma physics”, as for the aurora - the corona can serve as a Rosetta Stone to help map this knowledge into astrophysics at large