Scientific Highlights from TG3 subgroups

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(1) Origin and emergence of solar magnetism

- We are now able to get cyclic magnetic activity in a fully nonlinear dynamo simulation, resolving self-consistently convection under the influence of rotation, large stratification and magnetism.
- Another recent achievement is the first self-consistent generation of magnetic wreaths at the base of the convection zone that have become unstable and started to rise to the top (surface) of the numerical domain (Fig. 1).
- Development of improved mean field solar dynamo models that take into account physical ingredients such as mutli-cellular and/or time varying meridional circulation, magnetic pumping, North-South asymmetry, irregularity in the cycles or improved source function for the poloidal field has been accomplished.

Nelson et al. 2011, 2013a, 2013b

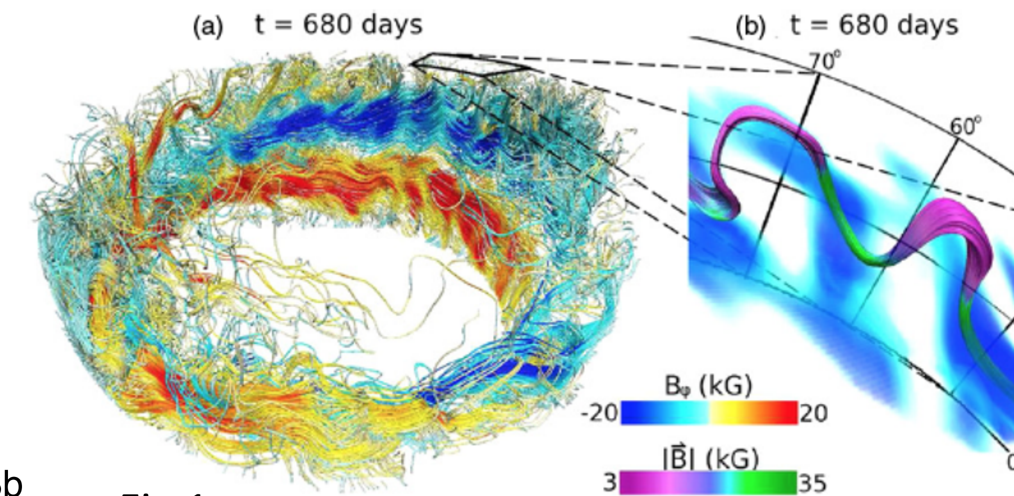

Fig 1

(2) Shock formation in the solar atmosphere

- The first simultaneous observations of an H alpha Moreton wave and EUV wave have been made, using the SMART telescope at the Hida Observatory. From this observation, it was found that fast EUV wave Is basically the same as Moreton wave (i.e., MHD shock/wave), whereas the slow EUV waves are pattern propagation and the wave-like disturbances (Fig 2).

Comparison between Halpha Moreton wave and EUV wave

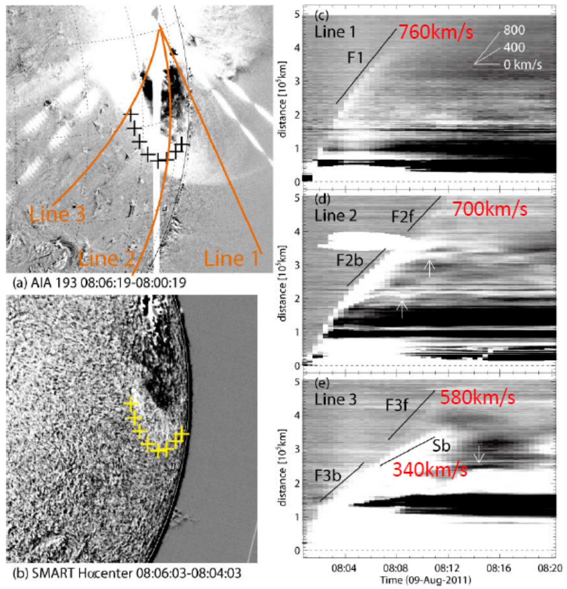

Fig 2 Asai et al. 20

(3) CME-ICME connection

- The 3-part structure of cornal mass ejections near the Sun have been identified at 1 AU in plasma data.
- Advanced modeling for solar eruption and CME release has been developed in the CAWSES-II program.
- Coronal Mass Ejections have been both observed and modeled to evolve with increasing heliocentric distance.
- Three-dimensional MHD modeling of the solar wind structures associated with the 13 December 2006 coronal mass ejection event has been made (Fig. 3).
- Coronal sheaths has been detected at 1AU.

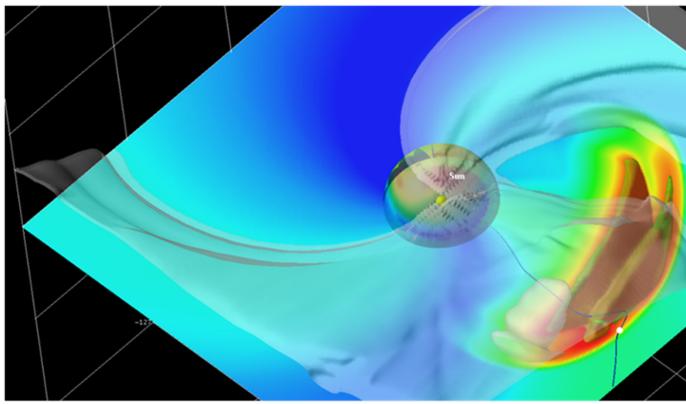

Fig 3
Kataoka et al. 2009

(4) Coronal hole and high speed solar wind

- The polar region that is covered by coronal hole is the roots of the high speed solar wind that influences the space environments around the earth.
- The magnetic fields in the polar region are constructed from small patches and large patches, with the threshold for the classification of the patches being 10^18 Mx. The large patches are the root of the open field from the polar region and the roo of the high speed wind.
- During the rising phase of Cycle 24 that corresponds to the period of the polar reversal, only the large patches with the major polarity in the polar region is decreased and there are no changes to the small patches. Comparing the photospheric magnetic field to the coronal activity, it was found that polar X-ray jets occur above the large *patches.*

(5) 3D structure of ICME and solar wind

- ICMEs are found to sweep out interplanetary space plasmas and magnetic fields
- ICMEs can coalesce with other ICMEs and high speed streams/CIRs
- Multiple flaring and multiple CME releases lead to a very complex solar wind, leading to both deflection and retardation of ICME propagation.
- Multiple shock formation can lead to compounding of sheath fields, which in turn can cause the generation of great magnetic storms.

(6) Solar wind - magnetosphere interface

- The magnetopause is a complex region with a boundary of plasmas and currents flowing.
- Simple tangential and rotational discontinuities at the interface are the exception rather than the rule.
- Intense plasma turbulence in the interface lead to additional effects such as wave-particle interactions and diffusion
- The exact nature of "viscous interaction" is still not well understood.

(7) Substorm variability and radiation belts

- Both chorus and PC 5 waves during high solar wind stream HILDCAAs cause relativistic electron acceleration.
- Although chorus is thought to be a dominant wave leading to relativistic electron losses, other wave modes are still being investigated.
- It is now well accepted that radial diffusion of relativistic electrons are driven by ULF waves, the latter of which have been shown to be present during intervals of prolonged substorm/convection activity. However for $E_e > 6$ MeV, a combination of chorus acceleration and transport from a source region inside geostationary orbit are required to explain observations.