SIMULTANEOUS ORGANIZATION OF (V,B) : THE SPICULES

V.Krishan
Indian Institute of Astrophysics
Bangalore 560034, India

Formation of large structures in a nonlinear turbulent energetically open magnetohydrodynamic system has been discussed using the concepts of self-organization processes Krishan and Mogilevskij (this proceedings). The presence of magnetic field allows the existence of long lived Alfven waves which can be easily excited by any external disturbance. The Alfven waves generate a state of aligned velocity and magnetic fields introducing large cross helicity in the system. Assuming that (V,B) are related as $\vec{V} = (1/4\pi\rho)^{1/2}\vec{B}$, the equation of motion becomes $\rho\,\partial/\partial t(\vec{\nabla}\times\vec{V}) = -(\vec{B}_o\cdot\vec{\nabla})c/4\pi\,(\vec{\nabla}\times\vec{B})$ where $\vec{B}_o$ is the ambient field and ρ is the mass density. In a compressible medium, the Alfven waves are known to decay and the spectrum condensates towards lower frequencies and hence towards smaller parallel wavenumbers K_z such that $K_\perp >> K_z$ developing large anisotropy in the process, Hasegawa (1985) until $(B_\perp/B_{oz}) \simeq K_z/K_\perp$. This gives rise to long (in the z direction) and narrow (in $\perp$ direction) MHD structures which could be identified with the spicules since they are believed to be associated with the transport of energy by Alfven waves as suggested by Osterbrock (1961). Using $V_\perp \sim 0.3$ km/sec, the velocity associated with supergranules, $\rho = 8 \times 10^{-11}$ gm/c.c. at a height of 1000 km above the photosphere, and $B_{oz} = 10$ Gauss one finds $\frac{K_z}{K_\perp} = \frac{L_\perp}{L_z} = \frac{\sqrt{4\pi\rho}\,V_\perp}{B_{oz}} \simeq 0.1$ which agrees with the dimension of spicules, where $L_\perp$ and L_z are the horizontal and the vertical extents of spicules. The aligned turbulence is further known to evolve to a state of dominant polarity with either $\vec{V}\cdot\vec{B} > 0$ or $\vec{V}\cdot\vec{B} < 0$, depending upon the initial conditions. Thus anisotropy seems to be the crucial characteristic of turbulent media.

References

Hasegawa,A., 1985. Advances in Physics, 34, 1.
Krishan,V. and Mogilevsij,E.I.,1989, This proceedings.
Osterbrock,D. 1961. Ap. J. 134, 347.

E. R. Priest and V. Krishan (eds.), Basic Plasma Processes on the Sun, 255.