M13b 3-dimensional Evolution of an Emerging Flux Tube in the Sun

○真柄 哲也 (Montana State University)、Dana Longcope (Montana State Univerisity)

The objective of this study is to investigate the dynamical behavior of emerging magnetic field in the solar atmosphere by means of 3-dimensional MHD numerical simulation of a buoyant magnetic flux tube. From the recent simulations we have done, it is found that there are two kinds of evolutinary phases of emerging field lines: expansion phase and gradual phase. The outer field line of flux tube, which emerges earlier than the inner field line, shows a simple expansion after it comes to the solar atmosphere. On the other hand, the inner field line takes a gradual phase at first, in which the field line shows a waving behavior with gradual rise, and then it enters an expansion phase.

We try to understand this simulation result by focusing on the physical process related to the Rayleigh-Taylor instability. We think that the important point is the distance of footpoints of emerging field line. For the outer field line of flux tube, this distance is almost comparable to the local value of the critical wavelength of R-T instability (λ_{RT}), although the inner field line has a much larger footpoint distance than this value when it emerges. This fact causes the outer field lines (emerging early) to make a simple expansion, however it makes the inner field lines (emerging late) waving and prevents them from expanding smoothly. As the height of inner field line increases, the density of gas sustained in this field line decreases because of the continuous drain of mass towards the footpoints, leading to the increase of the local value of λ_{RT}. When this value becomes comparable to the footpoint distance, then the field line changes the phase and expands rapidly.