A27a Helioseismic Detection of the Subsurface Magnetic Flux Emergence

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We detect the rising magnetic flux in the shallower convection zone of the Sun by observing acoustic power reduction, and evaluate its rising speed. Solar active regions including sunspots are thought to be the results of the flux emergence from the deep convection zone. These regions sometimes cause flares and eruptions to affect the interplanetary space. However, the physical nature of subsurface rising fields and the formation of sunspots are still remained unclear. Here we aim to reveal the rising speed of the solar magnetic flux in the shallow convection zone, before the active region are created.

We apply six different Fourier filters to the Doppler data of NOAA AR 10488 taken by SOHO/MDI, to detect the reduction of acoustic power at six different depths from -15 to -2 Mm. The filtered powers show reductions before the start of flux appearance at the visible surface. The start times of these reductions show a rising trend, first at several km s^{-1} in a depth range of 15–10 Mm, then $\sim$1.5 km s^{-1} at 10–5 Mm, and finally at $\sim$0.5 km s^{-1} at 5–2 Mm. If we assume that the power reduction is actually caused by the rising magnetic flux, the rising rate of the order of 1 km s^{-1} is well in accordance with previous observations and numerical simulations. Moreover, the gradual deceleration supports our simulations and theoretical model that the rising flux slows down in the uppermost convection zone, just before its further emergence into the solar atmosphere.