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3D view of transient horizontal magnetic fields in the convection zone with Hinode

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Abstract. We obtain the 3D structure of a *transient horizontal magnetic field* (THMF) during its evolution through the photosphere with extensive use of SIR (Stokes Inversion based on Response function). The SIR code allows us to retrieve information on the magnetic and atmospheric parameters along the line of sight from the observed Stokes profiles.
The temporal evolution of an event is as follows: the horizontal field appears inside the granule but near its edge at $\Delta t = 0$ s; 130 s later, the vertical fields with positive and negative polarities appear at both ends of the horizontal filed; at $\Delta t = 260$ s, the horizontal field disappears, leaving the bipolar vertical magnetic fields.
We retrieve the 3D structure of the event using the SIR code. We clearly identify an isolated flux tube with magnetic field strength of ~ 400 G in the convection layer. The vertical size of the tube is smaller than the thickness of the line forming layer of the Fe I 630 nm lines. The flux tube is not horizontal, it is a clear Ω-shaped-loop structure with the apex located near the edge of a granular cell. The flux tube is located at around $log\tau =\sim 0$ at $\Delta t = 0$ s, and moves higher in the atmosphere ($log\tau \sim -1.7$) at $\Delta t =$130 s. The observed Doppler velocity is maximally 2 km s^{-1}, and is consistent with the upward motion of the structure as retrieved from the SIR code. The magnetic flux carried by this THMF is estimated to be 2.9×10^{17} Mx without any assumption of the vertical structure.
We here successfully detect the 3D evolution of the THMF for the first time. THMF is an isolated magnetic flux tube embedded in the granular convection cell. The Ω-shaped loop structure emerges from below the photosphere (the line formation layer), rises through this layer to the chromosphere (and possibly to the corona), while essentially maintaining the flux tube structure.