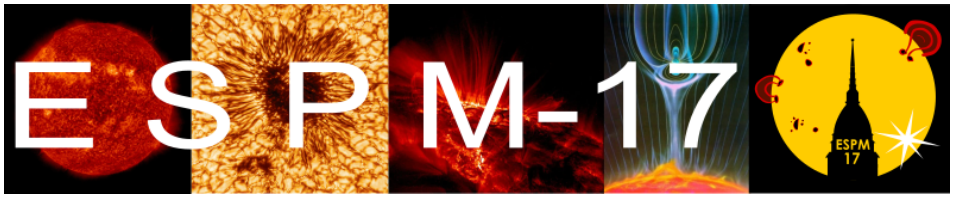

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The relation between magnetic field inclination and apparent motion of penumbral grains

Bright heads of penumbral filaments, penumbral grains (PGs), show apparent horizontal motions inward, toward the umbra, or outward, away from the umbra. Using high-resolution spectropolarimetric observations and numerical simulations of sunspot penumbrae, we aim to prove whether the direction of these motions is related to the inclination of the penumbral magnetic field.

Magnetic-field information in the penumbras' photosphere was retrieved by means of height-stratified spectropolarimetric inversions of 5 data sets obtained with Hinode, Swedish Solar Telescope, and GREGOR. An analogous information was provided by numerical simulations of a sunspot in the form of time series of visible-surface slices and vertical cuts.

On a sample of 444 inward- and 269 outward-moving observed PGs we show that 43 % of the inward-moving PGs have magnetic inclination larger than the inclination in their surroundings and 51 % of the outward-moving PGs have the inclination smaller than the surrounding one. The opposite relation of inclinations is observed at only one-fifth of the inward- and outward-moving PGs. A similar statistics is valid also for 226 inward- and 107 outward-moving PGs tracked in the simulations. Moreover, videos of numerical simulations show that some PGs can change their direction of motion and the relation of inclinations during their evolution.

We conclude that the difference in magnetic field inclinations inside and outside PGs is an important factor that influences the direction of apparent PGs motions, but it is not the only one and the relation is more complex.

Primary authors: Dr SOBOTKA, Michal (Astronomical Institute of the Czech Academy of Sciences); Dr SCHMASSMANN, Markus (Leibniz-Institut für Sonnenphysik)

Co-authors: Dr JURČÁK, Jan (Astronomical Institute of the Czech Academy of Sciences); Dr CASTELLANOS DURÁN, Juan Sebastián (Max Planck Institut für Sonnensystemforschung)

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