Evidence for convection in Sunspot penumbra

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Recently discovered twisting motions in penumbral filaments are assumed to be the upflowing domains of overturning convection viewed from an inclined vantage point. We are interested in finding out if these motions are in any way related to heat transport from below. We present an analysis of twisting motions in penumbral filaments in sunspots located at heliocentric angles from 30° to 48° using three time series of blue continuum images obtained by the Broadband Filter Imager (BFI) onboard *Hinode*. The relations of the twisting motions to the filament brightness and the position within the filament and within the penumbra, respectively, are investigated. Only certain portions of the filaments show twisting motions. In a statistical sense, the inner point of the twisting portions of the filaments are brightest and possesses fastest twisting motions with mean horizontal velocity of $2.1\,\mathrm{km\,s^{-1}}$. The middle and outer points of the twisting portion of the filaments, which are less bright, have mean velocities of $1.7\,\mathrm{km\,s^{-1}}$ and $1.35\,\mathrm{km\,s^{-1}}$, respectively. The observed reduction of brightness and twisting motion velocity towards the outer points of the filaments may be due to reducing upflow along the filament's long axis. No significant variation of twisting motions in the studied region of viewing angles were found. The obtained correlation of brightness and velocity is what is expected if overturning convection causes the twisting motions, since larger flow velocities imply transport of a larger energy flux. This supports the idea that convective motions in the presence of a magnetic field are the source of the energy needed to maintain the brightness of the filaments.