Photospheric Signatures of Granular-scale Flux Emergence and Cancellation at the Penumbral Boundary

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We studied flux emergence events of sub-granular scale in a solar active region. New Solar Telescope (NST) of Big Bear Solar Observatory made it possible to clearly observe the photospheric signature of flux emergence with very high spatial (0".11 at 7057{\AA}) and temporal (15 s) resolution. From TiO observations with the pixel scale of 0".0375, we found several elongated granule-like features (GLFs) stretching from the penumbral filaments of a sunspot at a relatively high speed of over 4 km s-1. After a slender arched darkening appeared at a tip of a penumbral filament, a bright point (BP) developed and quickly moved away from the filament forming and stretching a GLF. The size of a GLF was approximately 0.5" wide and 3" long. The moving BP encountered nearby structures after several minutes of stretching, and a well-defined elongated shape of a GLF faded away. Magnetograms from SDO/HMI and NST/IRIM revealed that those GLFs are photospheric indicators of small-scale flux emergence, and their disappearance is related to magnetic cancellation. From two well-observed events, we describe detailed development of the sub-structures of GLFs, and different cancellation processes that each of the two GLFs underwent.

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