M36a A Fast-filament Eruption Observed in the Hα Line: Imaging Spectroscopy Diagnostic and Modeling

Denis P. Cabezas, Kiyoshi Ichimoto, Ayumi Asai, Satoru UeNo (Kyoto University), Tomoko Kawate (NIFS), Satoshi Morita (NAOJ), Ken-ichi Otsuji (NICT), and Kazunari Shibata (Kyoto University)

On 2017 April 23, a fast filament eruption was captured by the Solar Dynamics Doppler Imager (SDDI) onboard the SMART telescope at Hida Observatory. The eruption was recorded in a wide spectral window around the Hα line (-9 to +9Å) which enabled us to perform a detailed imaging spectroscopy analysis. Our observation reveals characteristics of highly blue-shifted plasma over 8Å, indicating that part of the filament was ejected towards the Earth with a velocity larger than 360 km s^{-1}. By combining the line-of-sight and plane-of-sky velocity vectors at the filament apex, we derive the true velocity and acceleration profiles, whose maximum value of the fast component is about 500 km s^{-1} and 2.5 km s^{-2}, respectively. The acceleration process of the eruption is further investigated by using the toroidal ring-current model, which takes into account the action of the magnetic forces on a ring-current expansion. We numerically solve the equation of motion for different scenarios in which the electric current is determined by (i) conservation of magnetic flux, (ii) conservation of total energy, and (iii) constant current. A remarkable match between the observation and simulation (scenario ii) profiles is achieved when we include in the computation the effect of mass loss. Such a mass loss is identified in our data as downflows at the foot-points of the filament. We discuss the acceleration process of the filament eruption emphasizing the importance of combining numerical modeling and observations.