Contribution ID: **338** Type: **Poster**

Probing the substructures of solar flare ribbons

Solar flares are among the most spectacular and energetic phenomena in the solar system, and understanding their driving mechanisms is of paramount importance in solar physics. It is widely accepted that magnetic reconnection is the primary mechanism behind solar flares; allowing for the conversion of magnetic energy into plasma energy, resulting in the acceleration of particles such as electrons and ions. These accelerated particles form electron beams that deposit energy into the coronal plasma locally, and transfer energy globally when they impact the chromosphere, responsible for the characteristic ribbon-shaped emission of Hydrogen 656.3nm (Hα). Using the high-resolution Swedish 1-m Solar Telescope (SST) and CRisp Imaging SpectroPolarimeter (CRISP), we studied the substructures of Hα ribbons in unprecedented temporal and spatial resolution (i.e. 43 km per pixel and a cadence varying in time between 0.2 and 1.2 s). We have identified and analyzed small-scale substructures within the ribbons, referred to as "riblets". We present our definition of riblets and a detailed analysis of their statistical and kinematic properties during an X-class solar flare observed on 10 June 2014. By examining the riblets at this resolution and exploring their evolution in the context of SDO/AIA 304 A and RHESSI contours, we can probe the microphysics of energy deposition in the chromosphere with a high degree of precision. We present our analysis of a new class of rapidly evolving sub-structures with mean lifetimes of 11s that exhibit linear and non-linear dynamics, providing valuable constraints on 1D radiation hydrodynamic models of electron beam physics.

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Session Classification: Coffee break and poster session 2

Track Classification: Multi-scale energy release, flares and coronal mass ejections