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The Pre-eruptive Configuration of Large Solar Events

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Coronal mass ejection (CME) models can be divided into two groups depending on the state of the coronal magnetic field prior to the eruption. The models of the first group assume that a magnetic flux rope exists prior to the eruption whereas the models of the second group rely on the existence of sheared magnetic arcades that become unstable and erupt once some critical state is reached in the corona. On the other hand, all models and simulations agree that the erupting structure is a flux rope. In our presentation we will review recent indirect and direct evidence for the existence of pre-eruptive flux ropes in solar active regions. Indirect evidence for pre-existing flux ropes are soft X-ray (SXR) and EUV observations of S- or reverse S-shaped (sigmoidal) regions and also non-linear force-free field extrapolations that use data from photospheric vector magnetograms as boundary condition. The availability of high sensitivity data recorded with unprecedented spatial and temporal resolution in hot, flare-like EUV wavelengths by the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO) has revealed the existence of coherent structures identified as hot flux ropes. In a recent study of a large database of M-class and X-class flares that were observed at 131, 171, and 304 Å with the AIA relatively close to the limb, the flux ropes were identified in 131 Å images using morphological criteria and their high temperatures were confirmed by their absence in the cooler 171 and 304 Å passbands. Hot flux ropes were found in 32% of the flares but almost half (49%) of the eruptive events contained a hot flux rope configuration. We will argue that these percentages should be considered as lower limits of the actual rates of occurrence of hot flux ropes in large flares. We will also discuss how long before the eruption we have the first hints of the structure which eventually erupts and whether we can determine that the pre-existing structure is what erupts.