What is the Largest Flare that can Occur on the Sun?

*Jon Linker[1], Cooper Downs[1], Tibor Torok[1], Viacheslav Titov[1], Zoran Mikic[1], Roberto Lionello[1], Ronald Caplan[1], Pete Riley[1]

1.Predictive Science Inc.

The question of whether so-called superflares (energies from 10^{33}-10^{35} ergs) could occur on the Sun is of great interest scientifically. There are also obvious practical (space weather) implications. Shibata et al. (2013) suggested that flares on the order of 10^{34} ergs could occur every 800 years on the Sun, while Schrijver et al. (2012) argued that the magnetic energy for such a flare would require a sunspot 20 times greater then ever observed, and that 10^{33} ergs was a practical upper limit for flares.
Major solar eruptions such as X-class flares and very fast coronal mass ejections originate in active regions on the Sun. The energy that powers these events is believed to be stored as free magnetic energy (energy above the potential field state) prior to eruption. Therefore, the maximum free energy that can be stored in an active region bounds the largest possible eruption that can emanate from it. Using line-of-sight or vector magnetograms, the maximum energy that can be stored in a region can be estimated with the aid of the Aly-Sturrock theorem. We have investigated the active regions where the largest flares in the last 30 years have originated. We have found six cases where the maximum free energy is on the order of or greater than 10^{34} ergs. Our results suggest that 10^{34} erg solar flares cannot be ruled out based on magnetic energy storage.

