Solar Flares: avalanche models & forecasting

Morales, Laura F.[1,2]

[1]*Departamento de Física, Facultad de Ciencias Exactas y Naturales, UBA,*
[2]*Instituto de Física del Plasma (UBA/CONICET)*

Solar flares are the manifestation of intermittent and impulsive release of energy in the corona. The spatial coincidence of flares with magnetic structures at the solar surface leaves no doubt that flares draw their energy from the Sun's magnetic field. Since they are produced very rapidly magnetic reconnection seems to be a good fit for the physical mechanism responsible for extracting that energy. Observations of flares from the extreme ultraviolet to soft and hard X-rays revealed that the frequency distribution of solar flare energy release follows a well-defined power law, spanning 8 orders of magnitude in flare energy (Aschwanden, 2011 and references there in). In the early '90s Lu & Hamilton incorporated Parker's insight for coronal heating and proposed a way to explain the observed power-laws assuming that solar flares are avalanches of several reconnection events occurring in a solar coronal loop.

In a previous manuscript (Morales & Charbonneau, 2008) we have designed an avalanche model for solar flares that uses magnetic field lines as basic dynamical elements. We assume an idealized representation of a coronal loop as a bundle of magnetic flux strands wrapping around one another. The model operates by means of a two-dimensional cellular automaton with anisotropic connectivity, where linear ensembles of interconnected nodes define the individual strands collectively making up the coronal loop. The system is driven by random deformation of the strands. To represented magnetic reconnection we assumed that when the angle subtended by two strands crossing at the same lattice site exceed some preset threshold is realeased. We have shown that this system produces avalanches of reconnection events characterized by scale-free size distributions that compare very well with existing observations (Morales & Charbonneau, 2008 and 2009).   In this work we extend the models predicting capabilities of extreme flares by characterizing the waiting times between avalanches, particularly we study the behavior of the extreme avalanches produced and discuss the possible implications for flare forecasting.