Analysis of Small-scale Flares using Genetic Algorithm

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Coronal heating is one of the long-standing problems in solar physics. So far, two primary mechanisms have been proposed to explain how the corona is heated, namely small-scale magnetic reconnection and wave dissipation. To estimate the contribution of small-scale magnetic reconnections, so called nano-flares, to heat the corona is crucial to solve the coronal heating problem. To reach this goal, we develop a new method to analyse small-scale flares based on the combination of a numerical simulation and a machine learning technique. firstly, we obtain the light curves of the coronal loops from SDO/AIA multi-wavelength observation. Secondly, we carry out thousands of one-dimensional hydrodynamic simulations which calculate the time evolutions of coronal loops heated by flares which have various heating rates, durations, and occurrence times. Thirdly, we observe the simulated coronal loops by some SDO/AIA channels in a pseudo-manner. Then, we randomly make some “genes” which have the information of the combination of some pseudo-observed light curves. Comparing observed and linear superposition of pseudo-observed light curves, the genes are optimized based on the genetic algorithm which is one of the machine learning techniques. Repeating the optimization, finally, we estimate the occurrence frequency distribution of flares as a function of energy. As a result, we reveal that the coronal loops are heated by smaller flares dominantly in a specific energy range.

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