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Energy distribution of small-scale flares derived using genetic algorithm

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To understand the mechanism of coronal heating, it is crucial to derive the contribution of small-scale flares, the so-called nanoflares, to the heating up of the solar corona. To date, several studies have tried to derive the occurrence frequency distribution of flares as a function of energy to reveal the contribution of small-scale flares. However, there are no studies that derive the distribution with considering the following conditions: (1) evolution of the coronal loop plasma heated by small-scale flares, (2) loops smaller than the spatial resolution of the observed image, and (3) multiwavelength observation. To take into account these conditions, we introduce a new method to analyze small-scale flares statistically based on a one-dimensional loop simulation and a machine learning technique, that is, genetic algorithm. First, we obtain six channels of SDO/AIA light curves of the active-region coronal loops. Second, we carry out many coronal loop simulations and obtain the SDO/AIA light curves for each simulation in a pseudo-manner. Third, using the genetic algorithm, we estimate the best combination of simulated light curves that reproduce the observation. Consequently, the observed coronal loops are heated by small-scale flares with energy flux larger than that typically required to heat up an active region intermittently. Moreover, we derive the frequency distribution with a power-law index of approximately 2.02 in the energy range of $10^{25.5} < E < 10^{27.5}$ erg, which supports the nanoflare heating model. In contrast, we find that 90% of the coronal heating is done by flares that have energy larger than 10^{25} erg.