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ORIGINAL ARTICLE

Frequency dependence of solar flare occurrence rates—inferred from power-law distribution

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Abstract Based on the frequency dependence of the power-law distribution of the peak fluxes in 486 radio bursts in 1–35 GHz observed by Nobeyama Radio Polarimeters (see Song et al. in Astrophys. J. 750:160, 2012), we have first suggested in this paper that the events with power-law behaviors may be emitted from the optically-thin regions, which can be considered as a good measure for the flare energy release. This result is supported by that both the power-law and optical-thin events gradually increase with radio frequencies, which are well fitted by a power-law function with similar indices of 0.48 and 0.80, respectively. Moreover, a flare occurrence rate is newly defined by the power-law event number in per unit frequency. Its values in lower frequencies are evidently larger than those in higher frequencies, which just imply that most flares are trigged in higher corona. Hence, the frequency variation of power-law event number may indicate different energy dissipation rates on different coronal heights.

Keywords Flares · Radio radiation · Statistics

1 Introduction

The power-law distributions and indices of total energy release, the peak count, and event duration in solar flares are simulated by the avalanche model (Lu and Hamilton 1991), and reported in a wide range of wavelengths, such as hard X-ray, soft X-ray, radio, and EUV (see a review paper of Charbonneau et al. 2001). Hence, the power-law distribution may be intrinsically associated with the flare energy release processes.

On the other hand, there are different statistical methods used to analyze the power-law distributions, such as the regression method, the maximum likelihood method, and etc. Some fundamental problems are not solved in these methods, e.g., how to determine the smallest event, above which power-law distribution followed? The uncertainty to select the lower cutoff or boundary of power-law distributions may cause the power-law indices to be deviated from their theoretical values in a broad range.

A recent statistics has been performed by Song et al. (2012) by using an improved maximum likelihood method (Clauset et al. 2007, 2009), to analyze 486 solar radio bursts in 1–35 GHz observed by Nobeyama Radio Polarimeters during 1994–2005. The method works very well in pool statistics, with consistency in different radio frequencies. Especially, the lower cutoff of power-law distribution is determined self-consistently in this method, which is useful for general power-law analysis in astrophysics. The power-law indices of the peak count in the radio bursts of six frequencies in 1–35 GHz always vary around its theoretical value of 1.8 with a tendency that the values in lower frequencies are a little larger than those in higher frequencies (see Fig. 1 of Song et al. 2012).

The value of power-law index is actually determined by the ratio between the numbers of relatively smaller and larger size events, and has nothing to do with the absolute value of according size. A smaller or harder index just means the more larger size events in the distribution in comparison with the relatively smaller size events at a given frequency

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