The Fractal Dimensions and the Maximum Sunspot Numbers in the Solar Cycles

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Fractal dimension is a parameter quantitatively describing the characteristics of an irregular time series. In this study, we used the fractal dimension to analyze the irregular aspects of the solar activity by examining the time series of daily sunspot number. For this, we considered the relative sunspot numbers since 1850 from SIDC (Solar Influences Data analysis Center) and then estimated the annual and the cycle variations of the sunspot number fractal dimension. We examined the relationship between the fractal dimension and the maximum sunspot number in each solar cycle. As results, we found that: (1) For the annual variation, there are two fractal dimensions with one bending point. The fractal dimension for short time scale ($\leq$ 11 day) is smaller than that for long time scale; (2) For the cycle variation, there are three fractal dimensions with two bending points. The fractal dimensions for the short time scale ($\leq$ 11 day) and for the long time scale ($>$ 100 day) are almost same and smaller than the fractal dimension of the intermediate time scale; (3) There is an inverse relationship between the fractal dimension and the maximum sunspot number in each solar cycle. Our results suggest that this relationship can be adopted to predict the coming maximum sunspot number by calculating the fractal dimension of the sunspot numbers in the increasing phase years in the solar cycle.