

The Behavior of Distributions for Magnetic Polarities on the Surface of the Sun and Solar Minimum

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Time series of satellite image data for SOHO/MDI Continuum and Magnetogram from 1997 to 2010, and for SDO/HMI Continuum and Magnetogram from 2011 to 2013 are analyzed. The new time series data derived from fractal analysis of the time series images illustrated in 1200x1200 pixels from 1997 to 2013 are generated and fractal measures and packing exponents are analyzed by box-counting method. Then the occupancies of sunspot pixels in Continuum and of pixels for the positive and negative magnetic polarities in Magnetogram are calculated and packing exponents for sunspot pixels in Continuum and packing exponents for positive polarity pixels and negative polarity pixels in Magnetogram are evaluated. For packing exponents of Continuum and Magnetogram from 1997 to 2013, power spectra with peaks are calculated by using Fourier transform, respectively. A first peak which appears the power spectra is determined, and time intervals between nearest neighbor peaks are valued. The correlations between sunspot numbers and occupancies of the positive and negative magnetic polarities for 17 years are analyzed. As the correlation coefficients are calculated by using the least squares method, the correlation between sunspot number and occupancy of positive magnetic polarities has a very high correlational relationship because the correlation coefficient is 0.86 and it for negative magnetic polarities is low.

Furthermore, the behavior of occupancies of sunspot pixels in Continuum and of pixels for the positive and negative magnetic polarities in Magnetogram and the packing exponents represented with time series are described in detail and discussed. Fluctuations for occupancies of positive magnetic polarities are similar to it for Zurich number from 1997 to 2013. As observing the occupancies and packing exponents of positive and negative magnetic polarities, the two and three different fluctuations appear in (1) 1997-2005 and 2009 and (2) 2006-2008 including the time period that solar cycle 24 began on January 4, 2008, respectively. In addition, the occupancies and packing exponents of them have a single fluctuation in (3) 2010-2013. Therefore, the periods for characterizing solar activity from 1997 to 2013 are divided into three periods in (1), (2), and (3). Specially, for 2 years before solar minimum on 2008, the packing exponents start fluctuating suddenly and sharply in 2006 and the fluctuation disappears in the end of 2009.

Keywords: Time Series Analysis, Fourier Analysis, SOHO/MDI Continuum, Magnetogram, Solar Minimum