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Fractal Structure of inter-event distances: three examples for the aftershock series of Landers, Northridge and Hector Mine mainshocks (Southern California)

Maria-Dolors Martinez (1), Marisol Monterrubio (1), Xavier Lana (2), and Carina Serra (2)

(1) Universitat Politècnica de Catalunya, Dept. Física Aplicada, Barcelona, Spain (dolors.martinez@upc.edu, marisolmonterrub@hotmail.com), (2) Universitat Politècnica de Catalunya, Dept. Física i Enginyeria Nuclear, Barcelona, Spain (francisco.javier.lana@upc.edu, carina.serra@upc.edu)

The mechanism of the complex spatial distribution of aftershocks is illustrated by several fractal analyses of the series of distances, Δ, between consecutive events. These fractal techniques are applied to inter-event distance series corresponding to the aftershock series of Landers (1992), Northridge (1994) and Hector Mine (1999) mainshocks (Southern California). A first picture of this complex mechanism is offered by the concept of lacunarity. The persistence, anti-persistence or randomness is quantified by the Hurst exponent. At the same time, long/short range persistence or anti-persistence is determined by means of the autocorrelation function and the exponent β of the power spectrum density, S(ω), modelled by the power law $\omega^{-\beta}$. The self-affine character of these series is analysed using semivariograms and Hausdorff exponents. Additionally, comparisons among Hurst, Hausdorff and β exponents permit to assess if the series of Δ could be modelled by filtered Gaussian noise series. Finally, the formulation based on the reconstruction theorem quantifies the complexity (minimum number of nonlinear equations), loss of memory (Kolmogorov entropy) and predictive instability and chaotic behaviour (Lyapunov exponents and Kaplan-Yorke dimension) of the mechanism.