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Energy flows and the spatio-temporal structure in the earthquake source

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This paper presents the results of a statistical analysis of the energy flows and spatio-temporal dynamics of foreshocks and aftershocks in the earthquake source. Data from the USGS/NEIC World Catalogue of Earthquakes from 1973 to 2019 (https://earthquake.usgs.gov) were used. Starting from general physical concepts based on the Umov-Poynting theorem and the phenomenological theory of earthquakes, we formulated the following question: What are the directions of energy flows in the earthquake source before and after the formation of a main rupture in it?

A non-standard technique has been developed for the experimental study of this problem. The epicentral zone of the main shock is considered as a kind of track detector, and the foreshocks and aftershocks are considered as tracers, marking the propagation of a factor that has energy and stimulates the excitation of foreshocks and aftershocks in a stressed rock mass.

The method of superposition of epochs in the temporal and spatial coordinates was used. The main shocks performed the function of reper for synchronising the sequences of fore- and aftershocks. Each main shock was assigned a conventional time equal to zero, from which the time of observation of foreshocks and aftershocks was counted. The epicenters of each main shock coincided with the origin of the coordinates. The distances from the main shock to the associated foreshocks and aftershocks were calculated.

By processing and analyzing a large amount of observational data, it has been found that, on average, foreshocks move closer to the epicenter of the main shock over time, while aftershocks move away from the epicenter.

It is shown that after the main shock, "activation waves" occur in the earthquake source, spreading from the epicenter of the main shock to the periphery of the focal zone. The speed of propagation of such activation has been estimated. On average, it is about 5-10 km/h. It is shown that in the process of relaxation of the accumulated stresses in the source zone, its "deactivation", a a likeness of wave structure is observed in the spatio-temporal evolution of aftershocks.

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