DESCRIPTION FOR THE GENERAL PUBLIC

The main objective of the project in the field of theoretical geophysics is the construction of a universal model in the form of a stochastic cellular automaton integrating fundamental empirical laws describing statistical properties of earthquakes and enabling the study of the relationship between these laws.

Analyzing the measurement data regarding the time between occurrence of successive earthquakes collected for very diverse areas of the Earth, Alvaro Corral discovered in 2004, that the probability of waiting time for the next earthquake can be described by one universal distribution, as long as the time is expressed in units corresponding to the average seismicity of the region. The existence of such a universal formula, which does not depend neither on local geological and tectonic conditions, nor on how much the area is seismically active, strongly indicates the universal nature of the mechanism for a generation of the distribution of waiting times for earthquakes.

The subject of the project's research is just this universal mechanism for generating earthquakes, and more specifically, the construction of a possibly simple model of the mechanism in the form of a stochastic cellular automaton. The model will be an extension of investigated for almost ten years the so-called Random Domino Automaton, describing the slow accumulation of energy and its abrupt releases, controlled by specific probabilistic rules.

The construction and analysis of Random Domino Automaton models to be studied requires the use of advanced mathematical methods (including stochastic processes, graph theory, analytical combinatorics, differential equations, Markov processes), physical (including complex systems and, generally speaking, statistical physics) as well as knowledge of seismology and the ability to carry out numerical simulations.

An innovative element of the project are methods of analytical description applied to stochastic cellular automata (conventionally tested numerically) developed by the principal investigator of the project for almost 10 years. This approach has already resulted in significant achievements, also in the field of searching for new mechanisms useful in explaining the generation of earthquakes. In particular, his discovery of the existence of a dual stationary state (for a certain class of parameters of Random Domino Automaton) was interpreted as a property that “sheds light on the so-called earthquake supercycles, consecutive occurrences of several large earthquakes” - as it was presented in the editorial exposition "New dynamic modeling helps explain mega-earthquakes" by Mark H. Kim (AIP Scilight) of the recent article Z. Czechowski, A. Budek, and M. Białecki "Bi -SOC-states in one-dimensional random cellular automaton" published in the prestigious journal CHAOS.

The model being in the center of the project – like every adequate model of earthquakes – must reproduce the observed dependencies, such as the Gutenberg-Richter law, the Omori law and others. The scientific goal of the project is to interpret these observed laws through the rules of energy release and to study the dependence between these laws on this basis. In particular, the implementation of the research will determine whether, for example, the Gutenberg-Richter distribution is necessary to achieve the observed shape of the waiting time distribution, or if another (hypothetical) distribution would be equally good and, consequently, whether and how local deviations from the Gutenberg-Richter distribution manifests itself in changing a shape of the curve for waiting times.

Issues investigated in this project strictly in the field of theoretical geophysics are of fundamental importance for a better understanding of the most basic mechanisms of generating of earthquakes and its statistical properties.