Description for the general public

The main goal of the project is to analyse of new classes of processes which exhibit anomalous diffusion behaviour. Many real phenomenon posses anomalous diffusion property and very often the classical models are inappropriate to description of complex systems. Therefore there is a need to examine of new class of anomalous diffusion processes which have similar properties as analysed real data. The main problem which appears in analysis of such phenomenon is a proper identification of anomalous diffusion type and therefore the appropriate model design. After proof of theoretical properties of such processes it is possible to identify them on the basis of given vector of observations. The main hypothesis of this research project is: advanced methods of stochastic modelling and appropriate statistical analysis of real data allow for the proper identification and description of the underlying phenomenon. Finding of the appropriate model, which would have similar properties as analysed vector of observations, not only allows for a better understanding of the analysed phenomenon and its proper mathematical description but most of all, it is particularly important from the applications point of view, it allows for the correct inference and forecasting of the future behaviour of the analysed process.

Within the project the investigators are planning to concentrate on three new classes of anomalous diffusion processes. The first class contains the subordinated processes with stationary increments which exhibit anomalous diffusion property. Here we will take under account the processes with so-called normal subordinators. We will show the main theoretical properties of such systems. Moreover, there will be analysed the problem of a proper identification of such models for real data. The new statistical methods for parameters' estimation will be developed. The second class of anomalous diffusion processes that will be examined within the project contains subordinated processes with inverse subordinators. The methods of analysis of such kind of processes require to apply of the advanced theory of inverse processes. In this case the research team is planning to analyse the theoretical properties of such models taking into account the asymptotic behaviour of finite dimensional distributional characteristics and the structure of dependence, especially in infinite variance case. We are planning also to apply the advanced statistical methods that allow for testing and estimation of appropriate parameters. In the next group of anomalous diffusion processes there are systems which are constructed on the basis of the classical long-memory system, namely fractional Levy motion and its special case, fractional Brownian motion. Similar as in previous cases, we are planning to concentrate on main theoretical properties of analysed models and develop new statistical methods for identification of such systems and estimation of their parameters. Apart of proof of theoretical results we are planning to introduce of new techniques that allow for testing end estimation in such models. The theoretical results obtained within the research project will be applied to real time series which exhibit anomalous diffusion property, namely to physical and financial time series as well as to the data describing parameters of indoor air quality.

Submitted project will have not only theoretical importance involving the development of the theory of stochastic processes describing the phenomenon of anomalous diffusion but first of all it will be important from the practical point of view. Anomalous behaviours are observed in a variety of phenomenon therefore their appropriate stochastic description allows not only for finding of a suitable theoretical model with similar properties as the analysed data, but above all, to make inferences about the future behaviour of the analysed process. This is extremely important from the point of view of civilization development. Theoretical results obtained within the range of the project will allow for development of new tools for statistical inference and parameters estimation of examined processes. Thus it will be possible to apply of these processes for description of many real phenomena.