Methods of measuring subdiffusion parameters

Tadeusz Kosztołowicz

Institute of Physics, Świętokrzyska Academy,
ul. Świętokrzyska 15, 25-406 Kielce, Poland,
e-mail: tkoszt@pu.kielce.pl

Subdiffusion occurs in many physical systems such as porous media or gel solvent. The subdiffusion is defined by means of the relation $\langle x^2 \rangle = \frac{2D_\alpha t^\alpha}{\Gamma(1+\alpha)}$ where $\langle x^2 \rangle$ is a mean square displacement of a random walker starting from $x = 0$ at the initial moment, α is the subdiffusion parameter and D_α denotes the subdiffusion coefficient. Till now, there are only a few methods to extract the subdiffusion parameters from experimental data. In this contribution we discuss the existing methods and propose a new one. We consider the following cases:

- *Measuring subdiffusion parameter and subdiffusion coefficient in the medium transparent for laser beam* (T. Kosztołowicz, K. Dworecki, and S. Mrówczyński, Phys. Rev. Lett. **94**, 170602 (2005); Phys. Rev. E **71**, 041105 (2005).)

  The subdiffusion parameters are extracted from time evolution of the so-called near-membrane layers, which are measured experimentally by means of laser interferometry. The theoretical results are obtained from the solutions of subdiffusive equation with fractional time derivative.

- *Measuring subdiffusion parameter in a medium which is not transparent for laser light* (T. Kosztołowicz, AIP Conference Proceedings **800**, Unsolved Problems of Noise and Fluctuations, eds. L. Reggiani et al. (2005) p.569.)

  Comparing the time evolution of concentration at the surface of non-transparent medium, one finds the subdiffusion parameter inside medium.

- *Measuring subdiffusion parameter for subdiffusive system with chemical reactions* (T. Kosztołowicz and K. D. Lewandowska (submitted))

  The reaction front x_f (for the system with arbitrary values of subdiffusive coefficients of the reactants) evolves in time according to the formula $x_f \sim t^{\alpha/2}$. Thus, experimental data on x_f provide α.

- *Measuring subdiffusion parameter for electrochemical system* (T. Kosztołowicz, K. D. Lewandowska, and M. Penkowski (will be published).)

  The Cole-Cole plots of anomalous impedance of porous medium or gel depend on the subdiffusion parameters.