Generalized diffusion equation with fractional derivatives. Zubarev's NSO method

P. Kostrobij[a], B. Markovych[a], O. Viznovych[a] and M. Tokarchuk[b,a]

[a] *Lviv Polytechnic National University, Department of Applied Mathematics, 12 S. Bandera Str., 79013 Lviv, Ukraine*

[b] *Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine, 1 Svientsitskii Str., 79011 Lviv, Ukraine*

In Refs. [1–3], by using the Zubarev nonequilibrium statistical operator method [4] and the maximum entropy principle for the Renyi entropy, we consider a way of obtaining generalized (non-Markovian) diffusion equation with fractional derivatives. We found a solution of the Liouville equation with fractional derivatives [5] at a selected set of observed variables.

By modeling of memory function, a generalized diffusion equation of the Cattaneo–Maxwell type with fractional derivatives is obtained taking into account space-time non-locality. Dispersion relations for the diffusion equation of the Cattaneo–Maxwell type are found. A frequency spectrum, phase and group velocities of particles are calculated.

1. P. Kostrobij, B. Markovych, O. Viznovych, M. Tokarchuk, Journal of Mathematical Physics. **57** (9), 093301 (2016).
2. P. Kostrobij, I. Grygorchak, F. Ivashchyshyn, B. Markovych, O. Viznovych, M. Tokarchuk, J. Phys. Chem. A. **122**, 4099–4110 (2018).
3. P. Kostrobij, B. Markovych, O. Viznovych, M. Tokarchuk, Physica A. **514**, 63–70 (2019).
4. B. B. Markiv, R. M. Tokarchuk, P. P. Kostrobij, M. V. Tokarchuk, Physica A. **390**, 785–791 (2011).
5. V. E. Tarasov, Fractional Dynamics: Applications of Fractional Calculus to Dynamics of Particles, Fields and Media. Nonlinear Physical Science, Springer Berlin, Heidelberg, 2010.