

## Development of fractional continuum mechanical models

The progressive miniaturization in many aspects of human activity e.g. the production of modern materials with complex micro-nano- structures; micro-nano- electromechanical devices; nanomachines, etc. needs further development of computer aided engineering techniques. To be able to create the right computer program, which enables efficient design of materials mentioned above, it is necessary to advance the mathematical models that describe their behaviour. This last mentioned aspect defines the objective of this project, where the originality comes from mathematical objects which are applied, namely fractional derivatives. These derivatives allow the description of changes of chosen variable in the physical model taking into account the 'history' of these changes.

The above mentioned mathematical models, describing the effects observed in the experiment, can be defined in many ways, therefore in the study three main aims have been defined. Each of them corresponds to a different way to use the fractional derivatives which, by its definition, include the effect of non-locality. This 'non-locality', can be interpreted in many ways, depending with respect to which variable the change is considered. So for first, in the project, we will take into account the 'fractional' change of displacement field with respect to spatial variable, then 'non-locality' specifies a volume typical for material being considered. Next, we will consider the 'fractional' change with respect to time, in this case 'non-locality' will specify a characteristic time for the analysed material. Finally, we will also consider 'fractional' change with respect to stress state, then 'non-locality' will be some disorder in the stress state, and by analogy, as in the previous cases, the 'disordered' of stress is characteristic for tested material.

The overall study should help to increase the convenience of our lives - after all no one wants to carry heavy things. Everyone dreams about replacing our PC or laptops by the much lighter mobile phones, and by the way, maybe we can fulfil the dream of Stephen Hawking and the Russian billionaire Yuri Milner of the trip to Alpha Centauri by miniaturised spaceships. This project may become a small building block for such ideas.

### Further reading

- [1] W. Sumelka. *Journal of Thermal Stresses*, 37(6):678–706, 2014.
- [2] W. Sumelka. *Mechanics Research Communications*, 56:31–36, 2014.
- [3] W. Sumelka and G.V. Voyiadjis. *International Journal of Solids and Structures*, **124**:151-160, 2017.