Contribution ID: **406** Type: **Oral Presentation**

Patterns in a reaction-diffusion double porosity system

Tuesday, 1 June 2021 15:25 (15 minutes)

We study the behaviour of a system of equations that describes diffusion with chemical reactions caused by microorganisms in a double porosity medium. The objective is to find various classes of nontrivial limit solutions at large time (the patterns), especially simultaneous spatial-temporal patterns. In contrast to a classical reaction-diffusion system (RDS), our system contains four reaction-diffusion equations (RDE) describing the transport of nutrients and the dynamics of bacteria in fractures and blocks, with exchange terms. This system occupies an intermediate place between the Turing's RDS, which can have only spatial or temporal patterns separately, and a wavy RDS, which can have simultaneous spatial-temporal patterns in the form of standing waves. We show analytically, for a reduced version of the system, that spatial-temporal patterns can exist but in another form than a standing wave. The full system has been analysed numerically. Among with known patterns, we have detected a nontrivial simultaneous spatial-temporal pattern that has the form of travelling flashes. They correspond to the Hopf-Andronov temporal oscillations in blocks and to Turing's spatial fluctuations in fractures.

There results have been used to analyse the behaviour of an underground storage of hydrogen. We show several different scenarios of the evolution of such a storage and discuss the optimal regime.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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Session Classification: MS24

Track Classification: (MS24 - Invitation Only) Mathematical and computational challenges related to porous media - Special session in memory of Andro Mikelic