Lothar-Collatz-Kolloquium für Angewandte Mathematik

Donnerstag, den 13. Oktober 2022, um 17:15 Uhr, im Hörsaal 5

Prof. Dr. Rainald Löhner*
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HIGH-FIDELITY SIMULATION OF PATHOGEN PROPAGATION, TRANSMISSION AND MITIGATION IN THE BUILT ENVIRONMENT

Zusammenfassung/Abstract:

The current pandemic has renewed interest in pathogen propagation, transmission and mitigation. In particular, the relative impact of transmission via `large droplets' versus `small droplets' or aerosols, as well as possible changes to existing heating, ventilation air-conditioning (HVAC) systems has been debated throughout 2020.

In order to derive the required physical and numerical models, the talk will start by summarizing the current understanding of pathogen (and in particular virus) transmission and mitigation. The ordinary and partial differential equations that describe the flow, the particles and possibly the UV radiation loads in rooms or HVAC ducts ducts will be presented, as well as proper numerical methods to solve them in an expedient way. Thereafter, the motion of pedestrians, as well as proper ways to couple computational fluid dynamics (CFD) and computational crowd dynamics (CCD) to enable high-fidelity pathogen transmission and infection simulations is treated.

Numerous examples (classrooms, offices, hospitals, subway cars, airplanes) of studies carried out over the last two years indicate that high-fidelity simulations of pathogen propagation, transmission and mitigation in the built environment have reached a high degree of sophistication, offering a quantum leap in accuracy from simpler probabilistic models. This is particularly the case when considering the propagation of pathogens via aerosols in the presence of moving pedestrians.

The talk will conclude with an outlook and current research areas. Of particular interest is the re-design of HVAC systems taking into account pathogen transmission. This implies designing for several cost functions (comfort, pathogen transmission, energy consumption) under varying and uncertain conditions. It is in this context that adjoint-based techniques offer clear advantages over conventional genetic or finite-difference based optimizers.

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