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THERAPEUTIC ULTRASOUND: REVIEWING THE PHYSICS AND DISCUSSING THE MATHEMATICAL CHALLENGES

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Abstract

Therapeutic ultrasound is a non-invasive medical procedure with great potential to transform the treatment of many medical disorders, including Parkinson's disease, Alzheimer's disease, and cancer. Biological effects arise from focusing ultrasonic energy to target tissue in the body, without incisions or ionizing radiation. Successful clinical outcomes hugely depend on the ability to optimise ultrasound fields between the ultrasonic source and target tissue. Considering the large dimensions (relative to the wavelengths involved) and inhomogeneity of the target medium, numerical methods for high-performance computation are crucial for optimal therapeutic ultrasound planning.

Ultrasonics Group at the Department of Mechanical Engineering, University College London has a long history of developing computational models and promoting a mechanistic understanding of physical and biological effects of ultrasound. This talk will present a review of the state-of-the-art research in therapeutic ultrasound by the Ultrasonics Group. Subsequently, the physical models and mathematical challenges will be discussed. Finally, the latest developments for solving high-frequency high-contrast Helmholtz transmission problems using a novel fast multiple-domain boundary element formulation will be discussed.
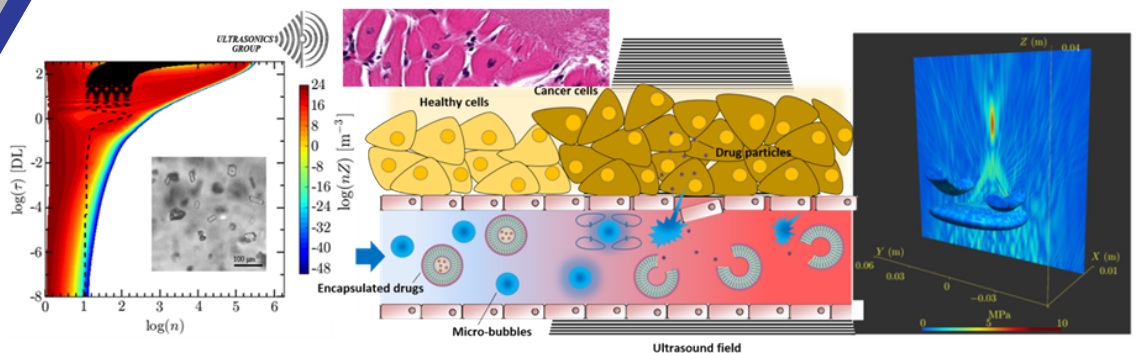
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