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MATHEMATICAL AND NUMERICAL MODELING OF THE HEART FUNCTION

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MINI-SYMPOSIUM PROPOSAL

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ABSTRACT

The ultimate goal of biophysical modelling research is to integrate biological and physiological information into mathematical models to improve our understanding of physiology and disease. In the case of the heart, biophysical models must handle the adaptive, multiphysics and multiscale phenomena driving cardiac motion. Heart function, itself, depends on the synchronous and synergistic action of electrophysiological, mechanical, and hemodynamics processes. The contraction and drive of each heart beat, in turn, relies on the cascade of cross-bridge cycling propagating throughout myocytes, tissue and the whole organ. In addition, these physical phenomena occur over a wide range of time-scales – from membrane depolarisation occurring over milliseconds to remodelling processes occurring over years. These factors make the mathematical and numerical modelling of the cardiac activity a very challenging topic in both the mathematical and bioengineering communities. Research has mainly focused on modelling one the physics involved in the heart, but recently also the coupling of these phenomena into an integrated system is gaining attention.

The motivation for this mini-symposium is to highlight current cutting-edge research in computational modelling in the heart and to encourage the application of computational models to clinical cases in diseases. Examples of topics that are covered by this mini-symposium are:

- processing of cardiac medical images: to obtain heart anatomy, heart structures (Purkinje system), integration/fusion of multimodal data such as electro-anatomical data, anatomical population-based data, blood velocity and perfusion data;
- modelling of the cardiac electrophysiology: normal and pathological activity such as tachycardia, fibrillation, flutter;
- study of constitutive laws for the passive cardiac mechanics and of suitable models for the active cardiac mechanics;

- simulations of growth and remodelling in the heart;
- the numerical solution of the electro-mechanical coupling and its influence on the description of pathologies;
- numerical modelling of the atrial and ventricular blood dynamics;
- modelling of the cardiac valve dynamics, in particular the fluid-structure interaction problem arising by the interaction with blood;
- mathematical modelling of coronary perfusion;
- preliminary studies towards the numerical modelling of the integrated heart function;
- application of cardiac models to clinical problems: Diagnosis, therapy planning and therapy optimization.

The final aim of the mini-symposium is to create an opportunity for the people working on cardiac modelling to discuss about the recent developments and the hot and emerging topics, to exchange and compare new ideas, and to start new collaborations.