2012 Special Program in Applied Mathematics and Applied Mechanics

Image-based computational model for focused ultrasound ablation of liver tumor

2012 - 12 - 12 (Wed.)
15:00 - 17:00
308, Mathematics Research Center Building (ori. New Math. Bldg.)

High intensity focused ultrasound (HIFU) is a rapidly developing medical technology for a non-invasive tumor ablation therapy in various organs of the body. Liver cancer is the second leading cause of death in Asia and is now known as one of the most leading causes of death in the world. Focused ultrasound treatment of liver tumor is problematic, because large blood vessels act as a heat sink. Convective cooling can reduce the necrosed volume and liver can regenerate. To avoid the damage of large blood vessels and regeneration of the tumor, a basic understanding of the factors that can affect the tumor ablation is necessary for the planning and optimization of the treatment. The influence of blood vessels and focused location on the temperature distribution during HIFU therapy is investigated. A three-dimensional acoustic-thermal-fluid coupling model enables to compute the temperature field in the hepatic cancerous region. The model is based on the nonlinear Westervelt and bioheat equations as well as the nonlinear Navier-Stokes equations for the blood flow in the liver parenchyma. The effect of acoustic streaming is also taken into account. The mathematical model was validated by comparison with the magnetic resonance thermometry measurements. The numerical experiments were carried out in a patient specific liver model. Liver geometry was reconstructed on the basis of MRI image, including hepatic vein, hepatic artery, and vena cava. A surgical planning platform for the non-invasive HIFU tumor ablating therapy in real liver geometry on the basis of the MRI image is under construction.