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On Some Inverse Free Boundary Problems for Second Order Parabolic PDE's

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Abstract of Poster Presentation: We consider the inverse free boundary problem, the so called inverse Stefan problem (ISP), for a general second order linear parabolic PDE. The ISP arises when considering phase transition processes where the temperature function, phase transition boundaries and either density of the sources or boundary heat flux are unknown. ISP is not well-posed in the sense of Hadamard. We follow a new variational formulation developed recently in *U. G. Abdulla, Inverse Problems and Imaging, 7,2(2013),307-340* and reformulate ISP as an optimal control problem for the minimization of the L^2 declination of traces of a state vector with the unknown flux and the free boundary as control parameters. This formulation has the benefits of the regularization of the measurement errors, and the need to solve only a Neumann problem at each step of the minimization process. The sequence of discrete optimal control problems is introduced through full space-time discretization. We prove two energy estimates for the discrete optimal control problem. The existence of the optimal control is proved by employing energy estimates and Weierstrass theorem in a weak topology. Finally it is proved that the sequence of finite-dimensional discrete optimal control problems converge to infinite-dimensional optimal control problem both with respect to functional and control.

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