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Wave front solutions in the theory of boiling liquids

In an new attempt to model the phase transition from nucleate to transient boiling, Professor Marquardt from Aachen proposed to consider the the heat flow in the heating vessel rather than in the boiling liquid. In this model the heat flow in the wall of the vessel, subject to heat equation, is combined with a nonlinear Neumann boundary condition at the surface of the wall toward the boiling liquid. The nonlinearity is determined by the change of the heat conduction coefficient in the phase transition.

For the one-dimensional heat equation with a nonlinear inhomogeneous term, the existence of wavefront solutions is well known and widely used to model phase transitions. Work of Aronson and Weinberger also dealt with the more-dimensional situation and showed that there are sub-solutions which behave like wavefronts. Consequently the actual solutions must have a sudden change of state, also. However, this model with the nonlinearity in the equation rather then the boundary condition can be justified in our case for (infinitely) thin surfaces only.

Here we present an approach which provides a wavefront type sub-solution for the nonlinear Neumann problem and hence establish a first mathematical confirmation of Marquardt's model.

Further research will concentrate on the discussion of initial configurations (dry spots) which generate a wavefront type solutions and those which do not. In addition we intend to address the question how the maximum and minimum speed of the traveling wave is determined by the initial configuration and the other parameters of the data.