

Opponent's report on the habilitation thesis  
"Differential equations with hysteresis operators"

by Jana Kopfová

The candidate Jana Kopfová is known to me for many years, personally as well as through her publications.

The analysis of rate-independent hysteresis in terms of a nonlinear operator between function spaces originated in the late '60s, when Mark A. Krasnosel'skiĭ and his group began to study these problems. They also considered ordinary differential equations which include a hysteresis operator. The study of partial differential equations with hysteresis was taken up during the second half of the '70s by Augusto Visintin for the parabolic case. Some years later, Pavel Krejčí started to investigate hyperbolic equations with hysteresis. Since that time, many papers have been published in this area, motivated in particular by problems in continuum mechanics and electromagnetism. Indeed, the study of the balance equations for mass, momentum and energy, when coupled to a rate-independent hysteretic constitutive law, leads to differential equations with hysteresis operators, and there are also emerging applications in the life sciences. On the other hand, because the most important examples of hysteresis operators can be equivalently formulated in terms of variational inequalities, albeit of a rather specific type, methods of convex analysis play an important role here.

Dr. Jana Kopfová entered the field at the end of the '90s. Her habilitation thesis collects seven of her papers which span the major part of her work on these subjects. It begins with a carefully written introduction. In it she presents the most important examples of hysteresis operators, the play and the Preisach operator and reviews results and techniques used in dealing with differential equations. Quite to the point, she emphasizes the importance of certain inequalities specific to those operators. The papers collected show that she masters a broad range of methods from PDE analysis, to bear upon the subject of rate-independent hysteresis. For example, she uses the Galerkin as well as the semigroup approach, the latter in the  $L^1$ -setting, she discusses two-scale convergence and homogenization, and in the paper (A6) on magnetohydrodynamic flow she employs Nash-Moser iteration. All those papers are serious and well thought-out additions to the state of the art, and have been well received by the international 'hysteresis community' of scientists. I particularly like the recent paper on magnetohydrodynamic flow because of its technical level. Her papers are accurate, to the point and nevertheless – in comparison with many others – rather readable.

To summarize, Jana Kopfová works on an internationally competitive level with firm and broad foundations in mathematical analysis. If I may, I recommend her for habilitation.

München, 12.4.2010



Martin Brokate