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Doctoral thesis

*Thermodynamic analysis of processes in Hydrogen Fuel cells*

by

*Michal Pavelka*

Investigations of macroscopic systems at nanoscale require to combine mathematical descriptions on several different scales. The problem of mutual compatibility of the descriptions is the subject of multiscale nonequilibrium thermodynamics. It is this newly emerging theory that is at the center of Mr. Pavelka's thesis. Mr. Pavelka presents the general theory and develops specific new applications. In both general and applied sections of his thesis he presents also new results (published in five articles in top physics and engineering journals) that represent new important contributions to the multiscale nonequilibrium thermodynamics.

As for the general theory, Mr. Pavelka investigates in particular time irreversibility, dissipativity, and their relation. The investigation is carried in an abstract setting as well as in settings that correspond to several of its particular realizations representing important and well studied mesoscopic dynamical theories (as for example fluid mechanics and kinetic theory).

In applications, Mr. Pavelka concentrates on exergy analysis providing means of calculating efficiency losses in engineering devices. This type of analysis is widely used but Mr. Pavelka carries it to a multiscale analysis and shows its limitations and generalizations. In addition to this general contribution he applies the exergy analysis to fuel cells. This application is carried to detailed solutions obtained by numerical calculations and compared with results of experimental observations.

The thesis is very well organized and very well written. Mr Pavelka clearly demonstrates his ability to grasp a newly emerging field in physics and to bring to it mathematical rigor and important new contributions. His work is very creative. His interest in the field, his curiosity, and his ability to do scientific research and to carry it to a conclusion are manifestly demonstrated throughout the thesis. I, in addition, know about all his qualities mentioned above also from my experience of working with him.

*Mr. Pavelka's thesis is of exceptionally high quality and I strongly recommend its acceptance.*

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