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Report on the habilitation dissertation presented by
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1. Memoire description.

The work is structured in 8 chapters.
The *first chapter* is a general introduction describing the scientific contest, the various types of fluid structure problems which are analysed within the memoire, with focus on the interaction with shells forming a part of the boundary of the fluid domain and with immersed elastic bodies. These models are described very precisely and the main challenges which have to be raised are introduced in a very pedagogical manner. The main technical novelties brought in chapters 2 to 8 are then very well summarized. Last but not least, this introduction contains an excellent overview of the literature in this very active field.
The *second chapter* is entitled `` Existence and regularity of weak solutions for a fluid interacting with a non-linear shell". The shell model is of nonlinear Koiter type, whereas the fluid is modelled by the incompressible Navier-Stokes system. The main result asserts existence of weak solutions for the fluid-structure system.
In the *third chapter*, entitled ``Navier–Stokes–Fourier fluids interacting with elastic shells", the author considers heat conducting fluid interacting with a nonlinear shell bounding the fluid domain. The main result asserts the existence of weak solutions. An important ingredient is an energy equality obtained via subtle regularity for the shell displacement.
The *fourth chapter* deals with the weak-strong uniqueness for an elastic plate interacting with the Navier-Stokes equation. The main result yields the weak-strong uniqueness of solutions for a flow in a variable 3D (or 2D) domain interacting with a 2D (or 1D) plate. A remarkable feature of this result is that no additional regularity is assumed for the solid displacement.
Chapter five is devoted to a variational approach to fluid-structure interactions driven by a parabolic type dynamics. This very general approach is supplemented with illustrative examples where it can be used to obtain highly untrivial existence of weak solutions results.
In the *sixth chapter* the author adapts the methodology from the previous chapter for the case fluid structure interactions driven by hyperbolic type dynamics.
In *Chapter 7* the author applies the methodology developed in the two previous chapters in order to prove existence of weak solutions for an immersed elastic solid that possibly undergoes large elastic deformations. It is remarkable that the fully nonlinear system is considered.

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Chapter 8 is entitled “Contactless rebound of elastic bodies in viscous incompressible fluids” and it introduces a theoretical framework to describe the contact of an immersed elastic body with a wall bounding the fluid. This is, to my knowledge, the first tentative to generalize the series of results initiated by Hillairet for an immersed rigid body.

2. Comments and Conclusions

This memoire is based on author’s original works, as confirmed by the plagiarism check of the Turnitin. The presented results have as guiding thread the construction of weak solutions for systems describing fluid-structure interactions. The employed methods are highly technical, requiring an in-depth knowledge of the analysis of partial differential equations. Sebastian Schwarzacher is not only an informed user of very complex and recent techniques but he has made an original contribution to this very difficult subject, namely in the analysis of the coupling of nonlinearly elastic shells models with the Navier-Stokes system. In this area, Sebastian Schwarzacher is undoubtedly a world-class specialist.

In conclusion, I consider that the habilitation memoire presented by Mr. Sebastian Schwarzacher is of an excellent level and I give a very favourable opinion on the presentation of this dissertation.

Sincerely yours,

Marius Tucsnak
Professor of Mathematics,
University of Bordeaux