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***Report about the Habilitation thesis “Gravitational Lensing: From Planets to Galaxy Clusters”, submitted by David Heyrovský, by Jean-Philippe Beaulieu***

Dear Colleagues,

David Heyrovský has been an important contributor to the field of microlensing for over 25 years. He always has been at the front of the development of new methods and approaches as the field was evolving and using his work. For example, at the 1990s-2000s he helped to define the method to address the effect of limb darkening on microlensing light curves, and how it was an advantage rather than a curse to extract the properties of the lensing system and the source star. Somehow, I think that it was a perfect illustration of the work-path adopted, to be at the fore-front of a highly competitive field, but focusing more on new method developments and new challenges, rather than focusing on the extensive use of the methods. It implies deep understanding of the theoretical bases, and also caring for the overall scientific community. Such exploration work is hard, require strong mathematical skills and is very valuable for the scientific community at large. It is also showing excellent mentoring skills to be able to train PHD students on these complicated topics. It is truly remarkable and I am very impressed by his contributions and his students. David Heyrovský also has a personal style in his approach, and you do not have to see his name on the paper to know that he is the author or co-author. It is easily recognizable, and always of very high quality. There is deep originality and great talent in this work.

The first chapters of the thesis given an excellent introduction. Everything is there for the comprehension of the subsequent chapter and presented in a very clear way. I would recommend its reading to students joining the field.

As a reviewer, I know well and in depth the first topic about triple lens microlensing. Indeed, 11 triple lens have been published to date, but they are all in somehow some privileged configurations. OGLE-2007-BLG-349 was published 8 years after its discovery, showing its complexity, but in a study done in a pedestrian way : I was a co-author of this paper, so I perfectly understand its limitation, and I am able to appreciate in particular the work presented in this thesis. As a further indication of the complexity, there are more triple lens candidates in the data sets of the microlensing survey teams OGLE, MOA, KMTNet that have not been analyzed yet. It underlines the lack of proper theoretical

background about how to proceed. And it is for a good reason : given the diversity and complexity of the caustic structures, what is the right line of attack ? These two articles by Danek & Heyrovský, 2015ab, are actually setting a solid theoretical base for the first time. Fig 4.3 and 4.4 (from the introduction) are showing that we can somehow have a good initial guess for binary lens geometry even before starting the proper modeling. With these figures in mind, the reader of Danek & Heyrovský, 2015b will be struck by the complexity for triple lens and the lack of simple ways to estimate the different regimes. It is followed by the 2019 publication that is setting the stage for the modeling efforts. These three papers are in my opinion, the most complex piece of work published in stellar microlensing field to date, while at the same time, having been done with extra-care. It is truly remarkable, and it is opening a new route for rigorous approach to triple lens fitting. It is time to revisit some of these likely triple lens system that have eluded analysis over the past decade.

The other two chapters are theoretical investigations on quasar microlensing and galaxy lensing. Karamazov & Heyrovský 2021 is a very interesting way to study substructures of Dark Matter halos, one of the important questions in cosmology in 2022. It is timely, and will probably be very useful to analyse the surveys of the galactic skies to be done by the the ESA Euclid and NASA Nancy Grace Roman Space Telescopes. Again, here, we have a solid theoretical background of studies that will be very useful for the fore-coming surveys.

I have gone through the check of originality of the thesis done by the system Turnitin and it is clear that the thesis represents an original work with the negligible overlap with the existing literature written by the author.

Dr David Heyrovský is a remarkable scientist having contributed original and very creative work over the past 25 years. He has also demonstrated excellent mentoring skills, taking students on very challenging projects, and led them to successful completion. His work is a long lasting contribution to different fields, from planet hunting microlensing to cosmology.

Bien cordialement,  
Dr. Jean-Philippe Beaulieu  
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