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Report on the Habilitation Dissertation of Dr. Heyrovský

Dear the Dean of Faculty of Mathematics and Physics,

The thesis that I evaluate complies the recent contribution of Dr. Heyrovský to the latest reseaches on gravitational lensing. It is based on the latest six papers published on renowned scientific journals from the reseaches conducted done by Dr. Heyrovský and his collaborators during the 2015 -- 2021 period.

The thesis treats three distinctive areas of research, including

- (1) microlensing by three-body lenses (in collaboration with Kamil Sanek),
- (2) quasar microlensing (in collaboration with Lukas Ledvina)
- (3) lensing impact of small-scale substructure in galaxy-cluister lenses (in collaboration with Michal Karamazov and Lukas Timko).

Below, I give a more detailed description on the individual topics.

(1) 3-body microlensing

By the time of writing the thesis, there were 11 microlensing events with clear detections of three-body lens systems, and majority of them are involved with extrasolar planets. Since the writing of the thesis, more of such lensing events have been detected, and many more will be found from future ground- and space-based lensing surveys. Analyzing three-body lensing events is very difficult because of the complexity and diversity of caustics and critical curves that are induced by three-body lenses. The works of Dr. Heyrovský and collaborators focus on this different lensing regime of lensing and provide a comprehensive overview on the critical curves and caustics of three-body systems. In a series of publication, they classified topology of critical curves and caustic, and explained the crietria for the classification.

(2) quasar microlensing

Dr. Heyrovský and his collaborators investigated the possibility of using microlensing in investigating the light emitting region of remote quasars. In a similar way, microlensing can also be used to investigate the surface brightness profile or structure of stars in the Galaxy. They investigated the effect of microlesnig on the X-ray spectral line profile by conducting simulations of the emission from the central region of the quasar accretion disk, from which the light from the quasar originates.

(3) galaxy-cluster lensing

In this area, Dr. Heyrovský and his collaborators conducted researches on making improved mapping of the total mass distribution of gravitationally lensed clusters. The goal of this work is to increase the spatial resolution of lensing mapping. For this purpose, they studied the lensing influence of a single massive object on the dark matter halo of the cluster.

The thesis is well written so that readers even with little knowledge on the gravitational lensing field but with some background on physics and mathematics can follow the topics treated in the thesis without the need to find additional references. The figures are well prepared to help readers to understand the topics mentioned in the text. In the thesis, the author starts with the concept of gravitational lensing, and then develops into more detailed cases of a point-mass lens (Chapter 3) and binary lens, and even more sophisticated systems (Chapter 4). The description and introduction of related mathematical expressions are well organized to the level of a textbook.

Especially, the descriptions on the three-body lensing are very thoroughly written, and the contents of the research have been found by the authors from long-term researches on the issue. Their works are very original in the sense that the topic had not previously been investigated by other researchers to the level of their works. In this sense, Dr. Heyrovský is known as the world-class specialist on three-body lensing. I, the evaluator, am personally greatly benefitted from the results of the author's research, and able to publish many papers by simply applying the scientific principle found by Dr. Heyrovský to actual microlensing events. This is why my publications are cited frequently in the thesis, and I am very honored for this.

I am not an expert on the scientific issues (2) and (3), and thus reverse my evaluation on the author's works due to my lack of understanding in the related fields. However, considering the expertise of Dr. Heyrovský, I have no doubt on the originality and scientific importance of their works.

The thesis is written based on the results from the researches done with collaborators, mostly PhD students that Dr. Heyrovský has guided. These scientific results have been published, and thus there appear to be some highlighted parts indicating coincidence with previous publications. However, I want to note that this result of coincidence check does not imply that the work is not original and far from plagiarism. Researchers in the microlensing society are very well aware of that Dr. Heyrovský is the greatest expert of the related fields and his works are very original.

In summary, I do not hesitate to claim that Dr. David Heyrovský is an excellent scientist and will be a great asset to your university.

Yours sincerely,

Cheongho Han

