Habilitation thesis reader's report

Masaryk University	
Faculty	Faculty of Science
Field of Habilitation	Theoretical Physics and Astrophysics
Applicant	RNDr. Jiří Kubát, CSc.
Affiliation	Astronomický ústav, Akademie věd ČR, Ondřejov
Habilitation Thesis	Hot stars and their atmospheres
Reader	Prof. Andrzej Pigulski, Ph.D.
Affiliation	Uniwersytet Wrocławski, Instytut Astronomiczny, Wrocław, Poland

Physics of stellar atmospheres is one of the most difficult branches of astrophysics, in which a good knowledge of physics and computational methods is still an essential competence. Despite an enormous growth in the computational power in the last two decades, the astrophysical problems related to the calculation of model atmospheres are sometimes too difficult to be solved in a reasonable time. This forces a modeller to make different assumptions and simplifications that require a very good understanding of the input physics and numerical methods that are applied. In this context, the scientific work of Dr. Jiří Kubát provides an important and significant contribution to the field.

The habilitation thesis of Dr. Jiří Kubát "Hot stars and their atmospheres" consists of twenty one papers published in the years 1994-2012. They are all related to numerous problems in modelling the atmospheres and stellar winds of different hot stars: white dwarfs, central stars of planetary nebulae, hot post-AGB stars, main sequence stars, and Population III objects. It has to be noted that many papers are devoted to the diffucult problems of the non-LTE treatment and modeling the atmospheres in spherical geometry. The habilitation thesis includes many interesting results of which – in my opinion – the most interesting and valuable are the following:

- Dr. Kubát developed his own code which enables to calculate non-LTE model atmospheres both in plane-parallel and spherically symmetric geometry. The published series of papers "Spherically symmetric model atmospheres using approximate lambda operators" explains details of the code. The code was subsequently used to calculate the emergent flux that was fitted to the observed spectra of some stars to derive their stellar parameters. One of the examples is the Be star $\varkappa$ Dra (Paper 16).
- The effects of sphericity in the atmospheres of different stars have been studied in detail (Papers 2, 5, 9) and found to be non-negligible even in the atmospheres of stars with high gravity (Paper 2).
- An alternative method to solve the radiative equilibrium equation, based on thermal balance of electrons was developed (Papers 8 and 11). It was later implemented e.g. in the FASTWIND code.

- The first complete solutions for two-component steady-state line-driven stellar winds were derived (Paper 10). The work was later extended in other papers of the series entitled "Multicomponent radiatively driven stellar winds" by Dr. Kubát and his Ph.D. student Jiří Krtička (Papers 12-14).
- Development (together with his students, esp. Daniela Korčáková and Victor Votruba) of new methods and more general models that can be used in complicated cases of non-spherical geometry and moving media.

In this context, the twenty one papers included in Dr. Kubát's habilitation thesis form – in my opinion – a significant contribution to the field. It has to be remembered that the thesis comprises less than a half of over fifty papers Dr. Kubát published in refereed journals up-to-date. This is a very good scientific achievement. The papers are reasonably well cited; the total numer of citations to his papers (according to the ADS) amounts to 767 at the time of writing.

It has to be also pointed out that already five Ph.D. students completed their theses under the supervision of Dr. Kubát. This is a very good achievement showing clearly that Dr. Kubát knows how to work and lead young people and build a scientific team.

Finally, I am pretty sure that Dr. Kubát is also a good lecturer. I had the opportunity of listening to his lectures and conference talks. Paper 19 is a very good introduction to modelling of stellar atmospheres. His plans concerning the changes of courses on physics of stellar atmospheres at Masaryk University look reasonable.

Concluding, I have no doubt that Jiří Kubát's habilitation thesis "Hot stars and their atmospheres" meets the standard requirements for a habilitation thesis in the field of Theoretical Physics and Astrophysics.

Reader's question(s) to answer to defend the habilitation thesis:

1. Does your code enable to model amospheres of Wolf-Rayet stars?
2. Does your code enable (or can be extended) to model colliding winds in massive hot binaries? Which most important problems are encountered to model emergent flux in such a case?

In Wrocław, on September 14, 2013