

Vladimír Karas  
Astronomical Institute  
Academy of Sciences  
Boční II 1401  
CZ-14131 Prague

vladimir.karas@cuni.cz

Prof. RNDr. Jiří Anděl, DrSc.  
Proděkan pro studijní záležitosti  
Matematicko-fyzikální fakulta UK  
Ke Karlovu 3  
12116 Praha 2

Supervisor's report on the PhD Thesis submitted by Michal Bursa

## **HIGH-FREQUENCY QUASI-PERIODIC OSCILLATIONS AND THEIR MODULATION BY RELATIVISTIC EFFECTS**

Michal Bursa worked out his Thesis within the framework of doctoral studies in the branch of Theoretical Physics, Astronomy and Astrophysics (F1), a joint programme of the Charles University in Prague (Faculty of Mathematics and Physics) and the Astronomical Institute of the Academy of Sciences. This Thesis was submitted for defense in January 2006 and contains results of mainly theoretical and numerical kind. It deals with one of current topics of relativistic astrophysics, namely, the processes shaping the lightcurves of X-ray binaries in which high-frequency quasiperiodic oscillations (HFQPOs) occur. The emphasis is given to strong-gravity effects, such as the gravitational focusing of light in black hole sources.

The thesis consists of four chapters; each of them tackles a specific issue related to HFQPOs. The text offers just a most brief introduction to the subject and it quickly proceeds to a particular puzzle (the sources under consideration still present many unanswered questions). The problems explored are: frequency relations between twin peaks; an example of possible way to constrain the black hole angular momentum from twin-peak frequencies; an oscillating torus as a representation of the resonance model; a detailed numerical investigation of the oscillation lightcurves predicted by the torus model. Two things I value most are (i) a sophisticated numerical treatment of the relativistic ray-tracing, which in several aspects goes beyond similar works published elsewhere in the literature (signal from non-axisymmetric 3D structures is explored), and (ii) discussion of the mutual twin-peak frequency relations, which has been noticed and quoted also by other people in the field. The thesis addresses also several other open issues, such as the apparent source dichotomy, and the author presents his views on them: I am sure these will be subject of lively debate and perhaps controversy, and look forward to the defense as another opportunity for clarification of yet unclear points.

I appreciate the style of the Thesis, which is very well focused on the actual subject of the work, attempts to reveal the essence of the model (rather than hide it), and which is sometime sufficiently provocative. Regarding formal aspects, both the language and graphics are careful and precise. Part of Thesis results was published while the rest is in preparation.

Michal has worked out his Thesis in Prague, but he has also developed a very fruitful collaboration with our distinguished colleagues, especially in Göteborg and Opava. Also, he has never missed any opportunity to discuss problems with other experts at conferences and summer schools he took part, and so supervising this work was a pleasure and fun also for the supervisor.

**I conclude that the submitted work contains new scientifically valuable results and it proves to be on sufficient level. I recommend this Thesis to be admitted for the defence and advice that Michal Bursa be awarded PhD degree.**

Vladimír Karas

Prague, 27/03/2006