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

Email: vladimir.karas@cuni.cz

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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 Tomáš Pecháček

Point Processes as a Mathematical Tool to Describe Black Hole accretion Disc Stochastical Variability

Tomáš Pecháček 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 in Ondřejov. This Thesis was submitted for the defence in spring 2008 and contains results of mainly theoretical kind. The thesis deals with one of current topics of (relativistic) astrophysics, namely, the processes shaping the lightcurves and power spectra of accreting objects – compact stars and galactic nuclei. The emphasis is given to the mathematical description of the avalanche-type processes. Some attention is paid also to strong-gravity effects, such as the Doppler boosting and gravitational focusing of light in black-hole sources, which eventually determine the observed form of the signal, mainly in X-rays.

This thesis consists of four chapters, the first one providing a brief introduction to the subject and the relevant mathematical techniques employed later in the text. The second chapter develops a practical approximation to general relativistic light propagation in Schwarzschild metric. Albeit this may look like a simplistic approach to the problem (given all the sophistication available in various numerical and analytical approaches and described in the vast literature), the approximation captures the main ingredients of the GR effects, is rather accurate, and its errors can (and have been) evaluated. So the only missing bit here is a generalization of the approximation formula to the Kerr metric. The third chapter contains the main results of the thesis, namely, a detailed discussion of the avalanche mechanisms in terms of point processes. What

I value most is the mathematically rigorous approach to the statistical description of the power spectra, which has been developed by Tomáš in entirely independent way. This chapter addresses also several other open issues, such as the importance of relativistic effects and whether one could dig their signatures out of the observed power spectra. I am sure that these issues will be subject of lively debate (perhaps controversy) and look forward to the defence discussion as another opportunity for the clarification of various points, unsettled as yet, e.g. the transfer of power among different frequencies. Obviously, the results of the third chapter still need to be carefully confronted with the actual observational evidence, and the authors' work will attract interest of the community once such comparisons are published.

I appreciate the mathematical style of the thesis, which is very well focused on the actual content of this work and demonstrates that the author has a lot of knowledge in the difficult field and plenty of material for his future research, although the composition is difficult for the reader unfamiliar with all details of the mathematical formalism (such as the supervisor) and could be further elaborated, so that the results can achieve wider impact. Regarding the formal aspects, the print appears to be acceptable and as careful and precise as the author could have possibly achieved by the deadline. Although the volume of this thesis is only moderate (about 100 pages), it clearly demonstrates that the author has achieved new results and is abound with original ideas that he can pursue in his own scientific career. Some of the thesis results were already published while the rest is either submitted or in preparation at the time of writing this report.

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

Vladimír Karas
(Associate Professor of Astrophysics in Prague)