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*To: Prof. Zdeněk Stuchlík
Institute of Physics
Silesian University in Opava
Opava
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Boston, 22nd November 2021

Referee's report on Ph.D. Thesis presented by Gabriela Urbancová

Dear prof. Stuchlík,

In order to fulfill the requirements for the degree of Doctor of Philosophy (Ph.D.) at the Institute of Physics of the Silesian University in Opava, Mgr. Gabriela Urbancová has prepared the Thesis titled "X-ray binary systems and the internal structure of compact stars". The Thesis was prepared under the supervision by doc. Gabriel Török and submitted for defense in autumn 2021. The Thesis presents the original research conducted by the candidate and described in five sections, which are supplemented by including four papers published in respected journal. One of the articles is the first-author publication and the entire Volume extends over 130 pages. The introductory sections provide the reader with an explanatory summary and an overview of main aspects of the adopted research, as well as the list of relevant references in the literature and additional author's publications in conference proceedings.

The main aim of the presented research is to set constraints on the equation of state (EoS) of neutron stars within General Relativity framework. Following a useful overview of selected aspects of the exploration of relativistic binary stellar systems with neutron stars by X-ray observations, in particular the basic properties of neutron star models and the motion of surrounding matter in the Hartle-Thorne approximation for compact stars, the author describes the oscillations of matter flows close to the innermost stable circular orbit (ISCO), where the effects of strong gravity dominate.

The introductory chapters read well and they provide a broader context, references to the literature and a description of numerical approaches beyond what is included in the specialized papers. This part could be even used as an informative article for general public and students. I only lack some more extensive description of the involvement of the candidate's home institution in the present-day X-ray satellite missions, which would be very

useful and it could distinguish this text from a multitude of introductory essays. Further, I believe that also the original text is mathematically correct, however, in order to obtain a complete picture, one needs to examine also the introductory sections in the mentioned papers and combine different pieces of information.

Paper I deals with the features of optical appearance of matter circulating near ISCO. Very relevant for the observational constraints on isolated compact star models, Paper II discusses aspects of the braking index. In Paper III, quasi-periodic oscillations of the accreting gas are studied with realistic neutron star EoS models. Finally, in Paper IV, where Gabriela is the leading author, the matter oscillations are explored in the Hartle-Thorne external space-time geometry. The novel context of the latter paper is the implementation of the universal relations that have been recently reported to hold among neutron star parameters. As a suggestion for a discussion during the upcoming defence, I would like to learn more about the current state of realistic EoS that allow for very high compactness and, therefore, possibility of motion near the neutron star ISCO. Furthermore, how these depend on spin of the star?

I have not noticed errors in the scientific arguments and derivations. The language of Thesis is scientifically accurate and cultivated; the illustrations are technically perfect. I consider the presented work to be very significant and satisfactory.

I conclude that the presented dissertation meets the requirements expected for Ph.D. theses and the Candidate has demonstrated her qualifications in the field. Therefore, I recommend admission of the Candidate to the subsequent stages of the procedure, including the public defense.

Yours sincerely,



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