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Subject
Thesis report
Marta Aleksandra Dziełak

Dear Sir or Madam

Report on the thesis Constraining the geometry of the accretion flow in black hole X-ray binaries by Marta Aleksandra Dziełak:

The thesis consists of a short Outline, a complete Introduction to the topic of the PhD thesis and three scientific papers, plus a complete Bibliography of the work that was cited in this work. I will comment on the different parts of the thesis below, but let me start by saying that the amount of work presented in this thesis is comparable to the amount of work required to obtain the PhD degree at my own University. The number of papers is what we expect from a PhD student here, and the fact that the three papers have been published in prestigious international journals in our field of research, with a well-established reviewing process, is a testimony of the solid work presented here.

The Introduction is very well structured, explaining what black holes are and the existence of black hole in binary systems that emit in the X-ray band because of accretion. The PhD candidate (I will call her by her name from now on) then explains the spectral properties of these systems, giving details of the physical components that produce the spectra. This part is very well structured and provides the right sequence and pace to understand the physics of these systems. Marta then explains the variability properties of these sources, including the steady-state power spectra, Fourier-frequency resolved energy spectra and energy-dependent (time) lags of the signal coming from these objects.

Using the descriptions she made of the spectral and timing properties of these systems, Marta then explains the so-called accretion states of black-hole transient sources. Finally, she describes the geometry of these systems, a topic that is very current and a subject of a heated debate in the community.

The next three chapters reproduce the three refereed papers that Marta led during her PhD. In two of the three papers she is first author, which in Astronomy is an indication of who conducted the analysis, did most of the interpretation and took the lead in writing the manuscript. The letters from the coauthors of those papers confirm all this.

In the first paper, Marta tested a large number of models containing relativistically broadened disc reflection on the spectra of the rising part of an outburst of the black-hole system GX 339−4 with data obtained from NASAs mission RXTE. Interestingly, Marta finds that the best-fitting parameters, e.g., black-hole spin (or disc truncation) radius and system inclination, depend significantly on the model used to fit the data. This very important result should be taken up by the community since it

highlights the dependence of properties of black-hole systems upon assumptions made in the models.

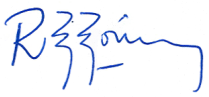
The second paper, in which Marta is second author, explores the X-ray spectra of the black-hole binary MAXI J1820+070 during the rising part of an outburst with data from two NASA missions, NICER and NuSTAR. This work shows that there are significant changes, by a factor of at least 10, of the inner radius of the accretion disc, with the inner-disc radius decreasing as the outburst progresses. More interestingly, this paper shows that there are least two Comptonising components in this source, one located very close to, and the other located far from, the accreting back hole

Finally, the last scientific paper studies the variability properties of the black-hole binary MAXI J1820+070 using NICER data. Marta identifies several components, with different time scales, that give rise to the observed broad-band variability. She then studied the energy dependent properties of these variability components, and discovered that the fastest component displays the hardest spectrum. Finally, Marta compared the time-averaged spectrum and the spectrum of this fast component and concluded the system has at least two Comptonising zones with different temperatures and optical depths (notice that this is consistent with the findings described in paper number two above). Interestingly, the findings in this paper are consistent with work we did in different black-hole system, MAXI J1348−630, namely that the corona in these two sources cannot be described by a single Comptonising region.

The thesis is of a very good scientific level. The Chapters connect to each other and show a clear progression of understanding and level of sophistication in analysing data of black-hole X-ray binaries. The thesis is well written, with a logical presentation that is very easy to follow.

Marta demonstrated that she has the skills and knowledge to deal with the data reduction, analysis, modelling and interpretation, and that she can carry out research independently, which is one of the main requirements to obtain a PhD. As I wrote at the beginning, a thesis like this one would be sufficient to obtain a PhD at my University.

Summing up, I consider the doctoral thesis of Marta Aleksandra Dziełak to be a valuable contribution and to meet the criteria prescribed by the law for a doctoral dissertation. Therefore, I request that this dissertation be admitted to a public defence.



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