External Examiner Report on Doctoral Dissertation for PhD Degree

Candidate: **Mgr. Juraj Lörinčík**

Title of Doctoral Thesis: **Magnetic reconnection and its manifestations in solar flares and eruptions**

Supervisor: RNDr. Jaroslav Dudík, Ph.D.

Institution: Charles University, Faculty of Mathematics and Physics

The presented doctoral thesis is by its nature observational. It is devoted to disentanglement of complex 3D reconnection topologies in the solar corona and analysis of their temporal evolution during ongoing magnetic reconnection. The author employs mainly space based EUV time series of images from the Atmospheric Imaging Assembly (AIA) with high spatial resolution and magnetograms from the Helioseismic and Magnetic Imager (HMI), both onboard the Solar Dynamic Observatory (SDO).

While the notoriously known cartoons visualising the main features of solar flare models, including reconnection of coronal magnetic fields, are generally two dimensional and often oversimplified, the real flare related processes taking place in the solar corona are inherently three dimensional and of much higher complexity. The thesis summarises the effort of the candidate to unravel these complex 3D topologies of reconnecting magnetic fields in the corona and associate them with the recent 3D flare models (reconnection geometries) introduced in Sec. 3.2.3. In this view I find the task taken on by the candidate and posed by the topic of the thesis as highly challenging.

The thesis consists of four introductory chapters covering basic information on the Sun, solar atmosphere, solar flares and eruptions, 3D magnetic reconnection and instrumentation. The introductory chapters are well written, provide a good review for the reader and beside almost 400 items in the Bibliography demonstrate a deep insight of the candidate into the solar physics generally.

The focal point lies in the fifth chapter. It consists of five commented peer-reviewed papers co-authored by the candidate and published in the prestigious The Astrophysical Journal. In the papers authors identify various aspects of 3D reconnection important for driving and evolution of solar flares, often for the first time ever, so there can not be any doubts on delivery of new original results. The five peer-reviewed publications themselves demonstrate that the candidate succeeded and the results of the thesis contribute to the state of art discourse in the field. I appreciate that the main achievements of the thesis are in a well arranged way summarised in Chap. 6 (Conclusions) and an inspirational outlook for the future work is given in Sec. 6.2 (Future prospects).

The scope of the thesis is, in my view, very sharply focused, leaving aside much wider spectrum of flare processes and related physics. During the defence I would therefore appreciate, if the candidate could indicate possible impacts of the processes identified in his thesis (various magnetic connectivity, slipping reconnection, etc.) on other aspects of flare physics or on the contemporary numerical models of solar flares in a wider context, albeit I understand that this discussion goes behind the scope of the thesis.

The work is written in excellent English, with very few clerical errors, and the style and layout is good. It is also worth to mention that the candidate co-authored 10 peer-reviewed publications in total, nine in The Astrophysical Journal and one in Astronomy and Astrophysics.

In my opinion the candidate clearly demonstrates creative abilities in his research field and the thesis decidedly meet the required standard of a doctoral thesis to justify the award of a PhD.

External Examiner/Opponent: Doc. RNDr. Michal Varady, Ph.D.

Department of Physics
Faculty of Science, University of J.E. Purkyně
Pasteurova 15
400 96 Ústí nad Labem

20th August 2021