Opponent review of doctoral thesis

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Title: Numerical Methods of Image Analysis in Astrometry
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The submitted work deals with methods of high-precision astrometry which is necessary for follow-up observing of asteroids especially so called Near-Earh-Objects (NEOs). The aim of this work is closely related to Kleť Observatory´s astrometric needs. This observatory uses the biggest telescope in Europe which dedicated to follow-up astrometry of NEOs.

The thesis is divided in nine chapters. After brief introduction, the second chapter describes problems of detection of asteroids and comets on images acquired with large reflector telescope equipped with CCD camera. The third chapter contains a basic mathematical theory, the next chapter introduces Kleť observatory and its equipment – KLENOT telescope. The fifth chapter deals with data acquisition and image pre-processing. The chapter six describes methods chosen for faint object detection on uneven background and its astrometry. It is the most important part of the work. Kleť observatory is positioned in the central Europe – in the area with significant light pollution. This light pollution causes steep background brightness gradients which strongly limit the observing of faint objects. Creation of synthetic numerical flat-fields studied in this chapter brings significant improvement. The seventh chapter contains comparison of methods proposed in previous chapter and very important for incorporation of these methods in standard astrometry work-flow at Kleť Observatory. The impressive illustration of improvement reached in astrometry of faint objects is explained in the eighth chapter where the first astrometry results of the first and only one known interstelar body 1I/2017 U1 Oumama is presented. The last chapter contains clear conclusions which led to implementation of described methods.

The work contains a rich author's bibliography which attests great experience with given branch.

From my point of view, the aim of this work is extremely important for human existence – early detection of NEOs may help us to avoid great material damages, loss of life and even also destruction of human civilization in future. The work is written intelligibly, mathematical methods are correct and reached results are conclusive. Historical remarks about astronomical observation and astronomical equipment are interesting for me.

Some elementary mathematical terms should not be described in the doctoral thesis (cartesian and spherical coordinate system and their mutual transforms, normal density function, arithmetic mean, median, etc.). Some small formal mathematical errors were found, however, they do not demean the quality of this work.

I **recommend** the submitted doctoral thesis for a defence and the **award of a Ph.D**.

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