



REFEREE REPORT

Doctoral Thesis of Mgr Michal Bílek
Entitled

Galaxy interactions:

dark matter vs. Modified Newtonian dynamics (MOND)

The Doctoral Thesis of Michal Bílek presents an overview of one of the recently discussed methods studied in connection to the problem of rotation curves of galaxies and related phenomena. The author separates his doctoral thesis into two parts. In the first part he presents an introduction into the framework of the modified Newtonian dynamics (MOND), shortly compares the advantages and shortcomings of the MOND theory, especially in connection to the alternative approach based on the dark matter halos, and gives an overview of his contributions to the MOND theory. In the second part of his work the autor presents all his papers related to the topic of MOND that were published in the impacted journals. The contributions of the autor are concentrated on the problem of shells created around elliptical galaxies. The MOND was efficiently applied for the spiral galaxies till the present time. The shell dynamics in the field of elliptic galaxies represents a new and promising way to understand the relevance of MOND.

The shell idea introduces a new direction in the framework of MOND and gives promising results that could put a new light on the MOND. The autor of the Doctoral Thesis contributed significantly to this new direction of research confirming the well applicability of the MOND on the elliptic galaxy level.

The thesis is well written with only small number of misprints and gives a good insight into both the general ideas of MOND, and the author contribution to the field of his research. Nevertheless, I have a general objection to the concept of the thesis, as its content is not in full agreement with the title of the thesis, according to which one could expect more extended part related to the dark matter halo models, and even a contribution in this field.

I have few comments that should be addressed by the author during the defence of his Doctoral Thesis.

1. The first comment is related to the research of the shell structures around elliptic galaxies that have extension above 100 kpc. The autor have to make some estimates of the role of the cosmological constant on the shell phenomenon, as the effect of the cosmic repulsion reflected by the cosmological constant has been shown to be relevant for the motion of





satellite galaxies of the Milky Way on the scales above 100 kpc in one of the referee works.

2. The autor have to present some comments on the shortcoming of the MOND in relation to the optical phenomena, as the gravitational lensing and the Sachse-Wolfe effect.
3. The author has to explain in detail the GR extentions of the MOND theory. Generally, the origin of the relativistic modifications of the MOND have to be exposed.
4. The autor have to comment the most fundamental failure of the MOND related to the missing mass problem considered on the scales larger than the galaxy scale, especially on the cosmic scales. The autor states that he considers the most promising explanation of the missing mass problem based on the existence of baryonic matter in the form of unseen non-luminous objects. However, then the problem of correctly tuned primordial nucleosynthesis arises. Moreover, this problem occurs on the level of hundred of percent, being thus a fundamental problem.
5. The author should specify the objects considered for gravitational friction calculation in the MOND framework.
6. The relation of the MOND to the globular cluster velocity-dispersion profiles has to be commented in some detail.
7. I expect some comments of the author also in relation to the Modified Gravity (MOG) theory developed by Moffat. This theory introduces additional physical fields that could even be related to the braneworld models inspired by String Theory and presents a fully consistent account for all the relativistic phenomena corrected by the additional fields.

Despite the presented objections and comments, I would like to conclude that the presented Doctoral Thesis clearly demonstrates the high abilities of Mgr Michal Bílek for the scientific work. The results of his research presented in a very well respected scientific journal (Astronomy and Astrophysics) evidently support the opinion of his ability to realize high quality original scientific research. Therefore I recommend him to obtain the scientific degree of PhD.

In Opava, 5th August 2015

Prof. RNDr. Zdeněk Stuchlík, CSc