

**A review for the doctoral thesis of Helena Cibulková, submitted to the Faculty of
Mathematics and Physics, Charles University**

I read the doctoral thesis of Mrs. Cibulková: *Distribution functions of asteroid physical properties*. The author developed two methods for two distinct observational datasets in order to derive the distributions of asteroids' spin axes and shape elongation, and to find correlations between these distributions and other parameters such as size, composition and orbit. I find this work interesting, methodic, unique, and highly relevant for contemporary asteroid science. The developed methods could be applied on future observational datasets consist of sparse photometric data such as LSST and GAIA that are going to be the main source of information about asteroids. Moreover, the multiple and varied methods the author developed for cancelling different observational biases ("de-biasing") are relevant for dealing with large datasets outside of the field of astronomy and astrophysics. The distributions and correlations that the author have found and confirmed, including the null correlations, will open (and close) research paths for future studies of asteroid parameters, the physical mechanisms that affects them, and their formation. From the text it is clear that Mrs. Cibulková is able to conduct creative scientific work in a methodic and elegant way. I would like to congratulate the author on her job, and wish her good fortune in her future doings.

I would like to give a few comments that, I believe, will improve the thesis:

1. **Add physics.** For every correlation the author studies, a physical explanation should be given. A good example, that is actually given in the thesis, is the correlation between asteroid size and latitude of the spin axis, due to the YORP effect that modifies the spin axes of small bodies. The author should elaborate on the other studies correlations such as the motivation to search for correlation between the spin axis and composition/taxonomy (carbonaceous asteroids have higher albedo and therefore might be prone to (or less prone to) be affected by the thermal YORP effect). This will not just give physical context to the study but will also help the author, and the readers, to reach more decisive conclusions (e.g., the YORP effect is indifferent to the albedo value).
2. **Add Summaries.** Many correlations were studied in this thesis, and many were found to show null results. While less appealing, these can still have important meaning for planetary scientists studying asteroids and solar system formation. However, all these null results are lost in the text, since they were not summarized in the final chapter. I suggest the author construct a large table summarizing for each studied correlation: the involved parameters, relevant conditions and criteria, and the KS test result (and any other information she finds fit).
3. **Beware of completeness.** Whenever you use the first X asteroids (e.g., page 25, first 10,000 asteroids from the Lowell database), or the DAMIT database, you introduce bias against small-sized, faint asteroids that, of course, were discovered after the large bodies, therefore are not in the list of "first" objects, or in the list of DAMIT. Therefore, even though this sample is complete, it introduces new biases to whatever sample you study. I think you are aware of that in some cases, but miss that, or just do not mention it, in other cases (such as in page 25).
4. **English style.** I suggest the author will choose the present tense and stick with it along the thesis, writing "we focus..." and not "we will focus..." or "we focused...". In addition, I suggest the author will avoid using words such as "Next", "After" and

“Also”. Almost none of the many studies the author has conducted are not timely dependent in one another, thus using these words is pointless. For example, instead of writing: “Next, we also focused...”, just write “We focus...”.

Specific comments:

Page 13: “... in these statistical studies having a new method...” -> “... in these statistical studies by having a new method...”

Page 14: “Since the echo power steeply decreases with the distance to the object...” -> “Since the echo power steeply decreases with the distance to the object and back to the Earth, ...”

Page 15: “ 10^{-5} ” -> in what units?

Page 20: “... was created isotropic.” -> “... was created isotopically.”

Page 22: “For one asteroid, we could ...” -> “Per a single asteroid, we could ...”

Page 25: “We calculated the Kolmogorov-Smirnov (KS) test for this distribution if it is compatible with a uniform one and we found that the probability QKS that they belong to the same parent distribution is ...” -> “We calculate the Kolmogorov-Smirnov (KS) test to verify if this distribution is compatible with a uniform one. We find that the probability QKS, that the two distributions belong to the same parent distribution, is ...”

Page 25: “either toward the Earth or opposite from the Earth, they found λ .” -> did they find λ or the distribution of λ ?

Page 26: “(for one asteroid there were...” -> “(per asteroid there were...”

Page 27: “The bottomline...” -> “The bottom line...”

Page 29: Explain Rx and Rz from Eq. 3.18.

Page 30: “Then we applied the Eq. 3.18...” -> “Then we applied Eq. 3.18...”

Page 37: Figure 3.20. The shift presented in figure 3.20 is less than 30 degrees. A page earlier you wrote any longitude shift of 30 degrees is below the uncertainty, and therefore it cannot be trusted as a significant value. Why is it different for the data presented in Fig. 3.20?

Page 58: “We can see that the differences between populations with small and high inclinations of orbits.” -> “We can see that the differences between populations with small and high inclinations of orbits is large.”

Page 72: “... it seems it cannot explain...” -> “... according our study it cannot explain...”

Page 73: “... we did not found...” -> “... we did not find...”

All the best, the reviewer