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Berkeley, Oct 7, 2023

To whom it may concern,

This is a report on the manuscript titled "*Studying tomographic cross-correlations between CMB gravitational lensing potential and galaxy surveys*" which was submitted by Chandra Shekhar Saraf, a PhD student at Copernicus Astronomical Center in Warsaw, in partial fulfilment of the doctorate requirements. The thesis comprises 122 pages in total (105 numbered) and is composed of 6 chapters and an extensive bibliography. The thesis discusses original contributions by the author to various aspects related to cross-correlation of lensing potential derived from cosmic microwave background (CMB) anisotropy data and galaxy surveys. The topic is very timely in the advent of new generation of galaxy surveys and current and forthcoming CMB experiments. Some of the results of the thesis, Chapter 3, were already published in one of the top refereed journals in the field, Monthly Notices of Royal Astronomical Society, as an article co-authored by the thesis author and his supervisors.

Two first chapters of the thesis provide an overview of the current status in cosmology, giving the theoretical background and introducing methodological and mathematical concepts relevant for the thesis. The description is rather high level, but it demonstrates the author's familiarity with modern cosmology, the discussed topics are selected very appropriately and provide sufficient background for the follow-up chapters.

Chapter 3 describes the application of the cross-correlation techniques to analysis of data collected by the Planck and Herschel (the HELP sample) satellites. The techniques applied are standard but state-of-the-art and are extended to cover the cases of non-overlapping sky areas. The results, derived here for the first time for these two specific data sets, are scientifically interesting and the follow-up, thorough discussion of some selected systematic effects and their potential impact on the derived results is very valuable.

Chapter 4 studies impact of redshift bin misassignment on the results of the cross-correlation analysis in multiple redshift bins (redshift tomography). The study is based on simulated data and the author proposes a new approach to correcting for this effect in the analysis. This is an interesting and original methodological development, thoroughly validated via simulations.

Chapter 5 presents a tomographic cross-correlation analysis of the Planck lensing maps and the galaxy catalog derived from DESI observations, DESI-LIS, capitalizing on the methodological developments discussed in Chapter 4. This Chapter provides also a detailed comparison with the previous work in this area, concluding that the presented analysis leads to a better agreement with the standard cosmological model, than it was hinted but the previous analysis, resolving some of the reported discrepancies.

Chapter 6 provides then a brief summary of all the results and highlights of the thesis. It is followed by extensive bibliography, which covers adequately previous work in the areas relevant for the described work.

This is a very solid thesis which combines interesting, methodological improvements to the state-of-the-art methods and applications to the actual data sets. The obtained results are of current interest in the field and some of them were already published in a leading journal. The proposed methods should be found useful in the analyses of the future data.

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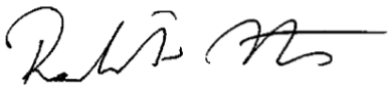
This thesis is well-written and presents the results and arguments in a clear and compelling way. It convincingly demonstrates the author's expertise in the covered scientific topics.

The results described in this thesis presents original and valuable contributions to modern observational cosmology and the thesis conforms with the formal and customary requirements expected of such a work.

Therefore, I request that this dissertation be admitted to a public defense.

Yours sincerely,



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