Report on "Inhomogeneous cosmology and averaging methods" by Mr. Petr Kašpar

The thesis deals with the problem of the averaging of in homogenous and anisotropic spacetimes. This is a problem of major importance in general relativity, not only in itself but also in connection with the search of a theoretical framework for one of the most important problems in modern theoretical physics: the understanding of the dark energy.

The thesis is generally well written and organized in a consistent way. The manuscripts starts with an accurate summary of the problem of averaging and gives an historic perspective of the different approacesh used to face the problem of averaging space-time geometries. the averaging problem is also connected with the more general problem of backreaction which is encountered in a variety of other fields like the cosmological perturbation theory. Particular attention is given to two of the most promising averaging schemes: the Macroscopic Gravity approach by Zalaletdinov and Buchert's equations that will be needed to describe the original contribution of the thesis. To complete the backgroud information the thesis offers a detailed review of the most important anisotropic and inhomogeneous cosmological models.

The original part of the thesis consists of two main contributions. The fist one presents a new method to perform the averaging of a space-time base on the Cartan scalars. Since these quantities are able to characterize completely a space time when it is written in a tetradic form the author shows that it is possible to combine the approach of macroscopic gravity (i.e. the introduction of bilocal averaging operators) to perform an averaging of the Cartan scalars and therefore obtain the average of the space-time. The approach has the advantage to allow the averaging of the entire Cartan class of space-time. This process is however proves to be rather involved, so the author proposes ansatzs on the structure of the averaged metric whose Cartan scalars are compared with the average of a given in homogenous and/or anisotropic metric.

The second original conribution is related to the Buchert formalism. It is well known that Buchert equations (i.e. the averaging go the scalar part of the Einstein equations) are plagued by the problem of the lack of a closure equation. The author is able to prove that this problem of the Buchert's equations is only present if one averages a general space-time and that considering LRS II spacetimes Buchert's equaltions can be closed. The price to pay is the introduction of an infinite number of auxiliary equations. However the work down offers an interesting insight on the actual effect of

Buchert' averaging procedure.

All in all the thesis work shows that the authors is able of original thinking and to convey the results in a form that fulfills the standards of current research in the field. He has been able to connect successfully topics in pure differential geometry with relevant problems in relativistic gravitation and cosmology producing non trivial results on a cutting edge research field.

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