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Agraïments

Aquesta tesi és la constatació de que els somnis són possibles, sinó tots, almenys alguns, com el meu, que ja des de petit era investigar en cosmologia. Arribar fins aqui però, no hauria estat en absolut possible sense el suport incondicional de la meva famíla. A ells el meu profund agraïment pel seu amor, recolzament, i comprensió. També vull donar les gràcies al meu director de tesi, que m'ha introduit en aquest món tant apassionant que és la recerca i que m'ha permès i ajudat a situar-me en la interassíssima interfície que hi ha entre les noves observacions cosmològiques de precisió i els models teòrics que es van desenvolupant. He tingut la sort també de poder treballar i col.laborar amb moltes i variades persones i aprendre molt de cadascuna d'elles. Finalment, no puc deixar també de donar gràcies a tots els meus amics i amigues, especialment els companys d'universitat i el meu grup de la parròquia, els quals molts cops han hagut de suportar el meu humor i el monotema constant de la tesi, però que sempre m'han acompanyat amb alegria i esperança. A tots vosaltres, gràcies.

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Chapter 1

Introduction

The structure formation in the universe starts with a very tiny fluctuations in an almost homogeneous density field. As the universe expands, these inhomogeneities will grow through gravitational instability and end up forming galaxies, clusters of galaxies, and the very nice large scale structure that we see today in big surveys, like the Sloan Digital Sky Survey. The structure formation is intimately related to the expansion of the universe. Different cosmological models will give different expansion histories, and, consequently, different growth of structure. And, even if the expansion is the same, the growth of structure does not need to be. It is clear then, that if data are good enough, the growth of structure can be a very useful tool to discriminate between cosmological models. Or, in case that from theoretical backgrounds we have already chosen one model, it can also be used to constrain its parameters.

In the first part of this thesis we will look at several non-standard cosmological models. These models have been introduced in the literature mainly to explain the accelerated expansion that we see the universe is currently undertaken. We want to study if they can also reproduce the observations of the large scale structure and its evolution. For doing so we will first introduce a formalism to compute the growth of structure in non-standard cosmologies. Then, for each of these non-standard models, we will focus in computing observables like the linear growth, the skewness, or the cluster number counts. These will ultimately allow us to constrain the cosmological parameters of the model or evaluate if it has to be ruled out.

Cosmology is currently entering a gold unprecedented precision era for which a lot of observational data will be (or is) available to be analysed. We can study the large scale structure of the universe and its evolution by performing count in cells, and n-point correlation functions of the data. The results of these measurements are important, but it is also very important to understand their errors well if we want to constrain cosmological parameters.

In the second part of this thesis we will look at the cross-correlation between CMB-temperature maps and galaxy (or other dark matter tracers) surveys maps. This cross-correlation is a way to measure the Integrated Sachs Wolfe (ISW) effect, which can be directly related to the growth of structure. We will use the ISW signal dependence in redshift and in angular scale to constrain Ω_Λ and the equation of state parameter w. In this part of the thesis we will also focus on studying different error estimators for the sky maps cross-correlation measurements. We will actually present a new method, which estimate the errors in the configuration space. This method will be compared with other error estimators widely used in the literature: the Jack-knife, the Monte Carlo errors and the theoretical harmonic space errors.

The problem of bias. In order to compare models to observations we need to address a crucial point: does light trace mass? In other words: how well the structure we see traces the dark matter we can't see?. Are the observations biased tracers of the mass?. This is a key point to be abble to compare models of growth of structure with observations in the real world. Unfortunately in detail, this requires understanding how star's and galaxies form and shine.

As the the universe expands, the dark matter clumps into halos and filamentary structure. This can be very clearly seen in dark matter cosmological simulations, which allow us to study the gravitational clustering separately from other (but also interesting) physical effects. Like galaxies, halos are not perfect traces of the underlying dark matter fluctuations, but biased ones. In fact, we believe that galaxies form inside dark matter halos, so that understanding halo bias is the first step towards understanding galaxy bias. In part three of this thesis we will use a cosmological dark matter simulation to study the halo clustering and bias. More specifically, we wonder to what extend the local bias model could be applied to the predictions and analyses of the two and three point halo correlation functions.

The thesis ends up by summarising, in a final chapter, the main achievements and conclusions. Curiously enough however, after the conclusions, comes the part four of this document. It is in fact a large summary of the thesis in catalan, one of the two official languages of the University of

Barcelona.