Physics Reports 733 (2018) 1–193

Contents lists available at ScienceDirect

Physics Reports

journal homepage: www.elsevier.com/locate/physrep

Large-scale galaxy bias

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ARTICLE INFO

Article history:
Accepted 22 December 2017
Available online 9 January 2018
Editor: M.P. Kamionkowski

Keywords:
Cosmology
Dark matter
Galaxy bias
Galaxy clustering
Large-scale structure
Primordial non-Gaussianity

ABSTRACT

This review presents a comprehensive overview of galaxy bias, that is, the statistical relation between the distribution of galaxies and matter. We focus on large scales where cosmic density fields are quasi-linear. On these scales, the clustering of galaxies can be described by a perturbative bias expansion, and the complicated physics of galaxy formation is absorbed by a finite set of coefficients of the expansion, called *bias parameters*. The review begins with a detailed derivation of this very important result, which forms the basis of the rigorous perturbative description of galaxy clustering, under the assumptions of General Relativity and Gaussian, adiabatic initial conditions. Key components of the bias expansion are all leading local gravitational observables, which include the matter density but also tidal fields and their time derivatives. We hence expand the definition of *local bias* to encompass all these contributions. This derivation is followed by a presentation of the peak-background split in its general form, which elucidates the physical meaning of the bias parameters, and a detailed description of the connection between bias parameters and galaxy statistics. We then review the excursion-set formalism and peak theory which provide predictions for the values of the bias parameters. In the remainder of the review, we consider the generalizations of galaxy bias required in the presence of various types of cosmological physics that go beyond pressureless matter with adiabatic, Gaussian initial conditions: primordial non-Gaussianity, massive neutrinos, baryon–CDM isocurvature perturbations, dark energy, and modified gravity. Finally, we discuss how the description of galaxy bias in the galaxies' rest frame is related to clustering statistics measured from the observed angular positions and redshifts in actual galaxy catalogs.

Contents

Sections marked with * are of a more technical nature and are not essential for the remainder of the section.

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https://doi.org/10.1016/j.physrep.2017.12.002

* Sections that are more technical in nature and not essential to the understanding of later sections are marked with an asterisk.