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Bonn, ...

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You should probably use `\chapter*` for acknowledgements at the beginning of a thesis and `\chapter` for the end.

Contents

CHAPTER 1

Introduction

Testing Kolokythas et al., 2020. new line

CHAPTER 2

Theoretical Background

2.1 Clusters and groups of galaxies

Throughout the Universe galaxies are not homogeneously distributed, but rather are aggregated in massive cosmic structures called galaxy groups or galaxy clusters. Galaxy clusters feature masses typically surpassing $M \gtrsim 3 \times 10^{14}\, M_\odot$, while galaxy groups lie closer to $M \sim 3 \times 10^{13}\, M_\odot$ (Schneider, 2006). Furthermore, advancements in X-ray astronomy have revealed that these structures serve as significant emitters of X-ray radiation (Cavaliere, Gurksy, and Tucker, 1971). It is well understood that the emission stems from a hot intergalactic gas known as the intracluster medium (ICM), characterized by temperatures in the 10^7 to 10^8 K range and constituting the bulk baryonic component of galaxy clusters (Schneider, 2006).

2.1.1 The Intracluster Medium (ICM)

Within the deep dark matter gravitational potential of galaxy clusters, sufficiently high temperatures are achieved to fully ionize lighter elements and partially ionize heavier elements, forming a plasma. This hot, diffuse and optically thin plasma emits copious amounts of X-ray radiation and is called the Intracluster Medium (ICM). In particular, X-ray analysis of the ICM have enabled a wide variety of cosmological studies regarding large-scale structure formation within the Universe (Kravtsov and Borgani, 2012).

2.1.2 Emission Processes within the ICM

A key result from electrodynamics is that accelerated charges radiate energy. We refer to this radiation as bremsstrahlung or "free-free" when a free charged particle, typically an electron, is accelerated by the electric field of other charges, typically ions. In the ICM, this process dominates at temperatures above $k_B T_\mathrm{e} \gtrsim 2\,\mathrm{keV}$, where the total emissivity at solar metallicity scales approximately as $\epsilon_\mathrm{ff} \propto T_\mathrm{e}^{0.5} n_\mathrm{e}$. At lower temperatures $k_B T \lesssim 2\,\mathrm{keV}$, line emission becomes significant, where

roughly $\epsilon \propto T_{\rm e}^{-0.6} n_{\rm e}$. Consequently, in the relevant energy range of $0.1 - 2.4$ keV, one roughly finds

$$\epsilon_{0.1-2.4\rm keV} \propto n_{\rm e}^2$$

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CHAPTER 3

Data Reduction

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List of Figures

List of Tables