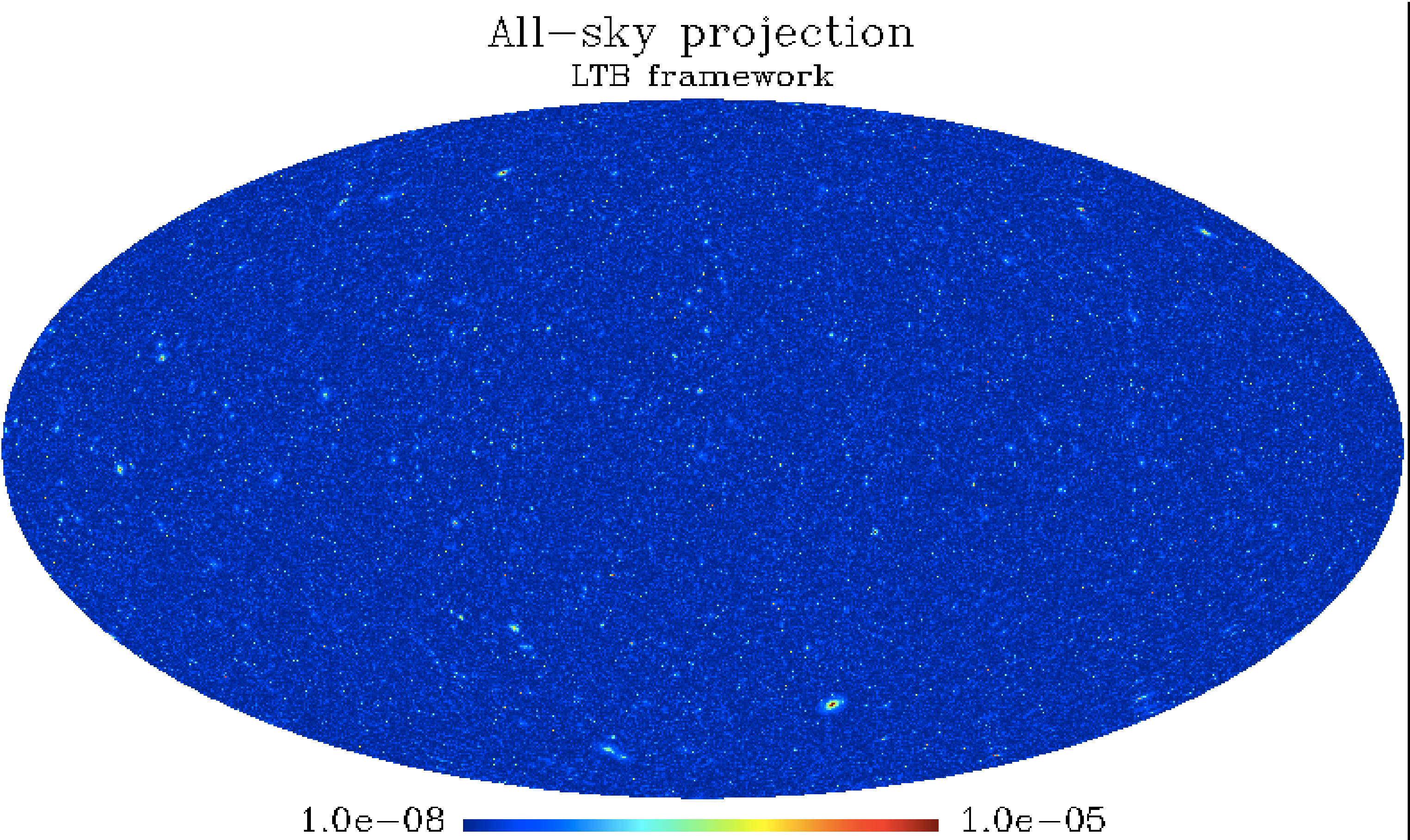
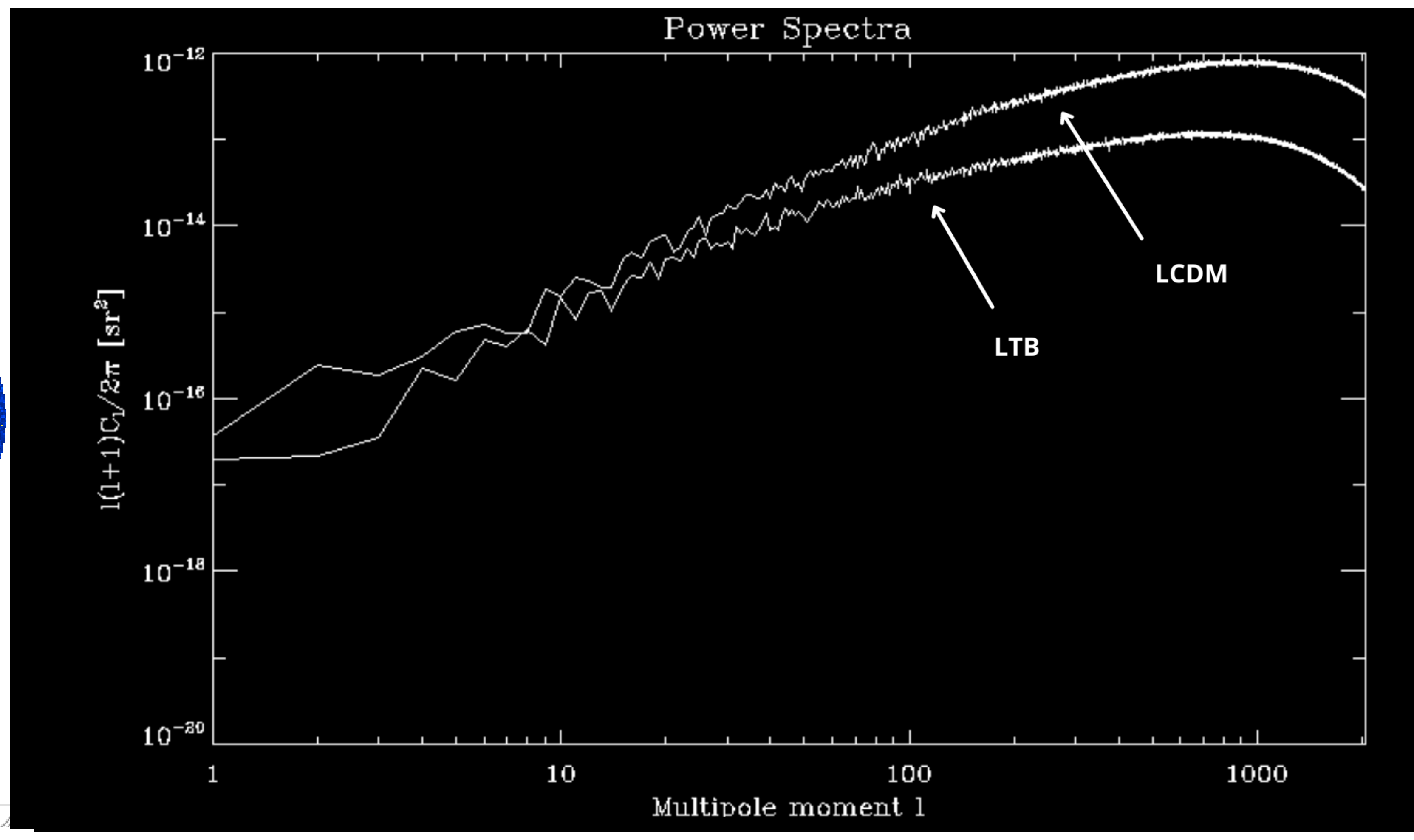
# NEW NUMERICAL APPROACHES TO TEST THE COSMOLOGICAL PRINCIPLE WITH THE EUCLID MISSION

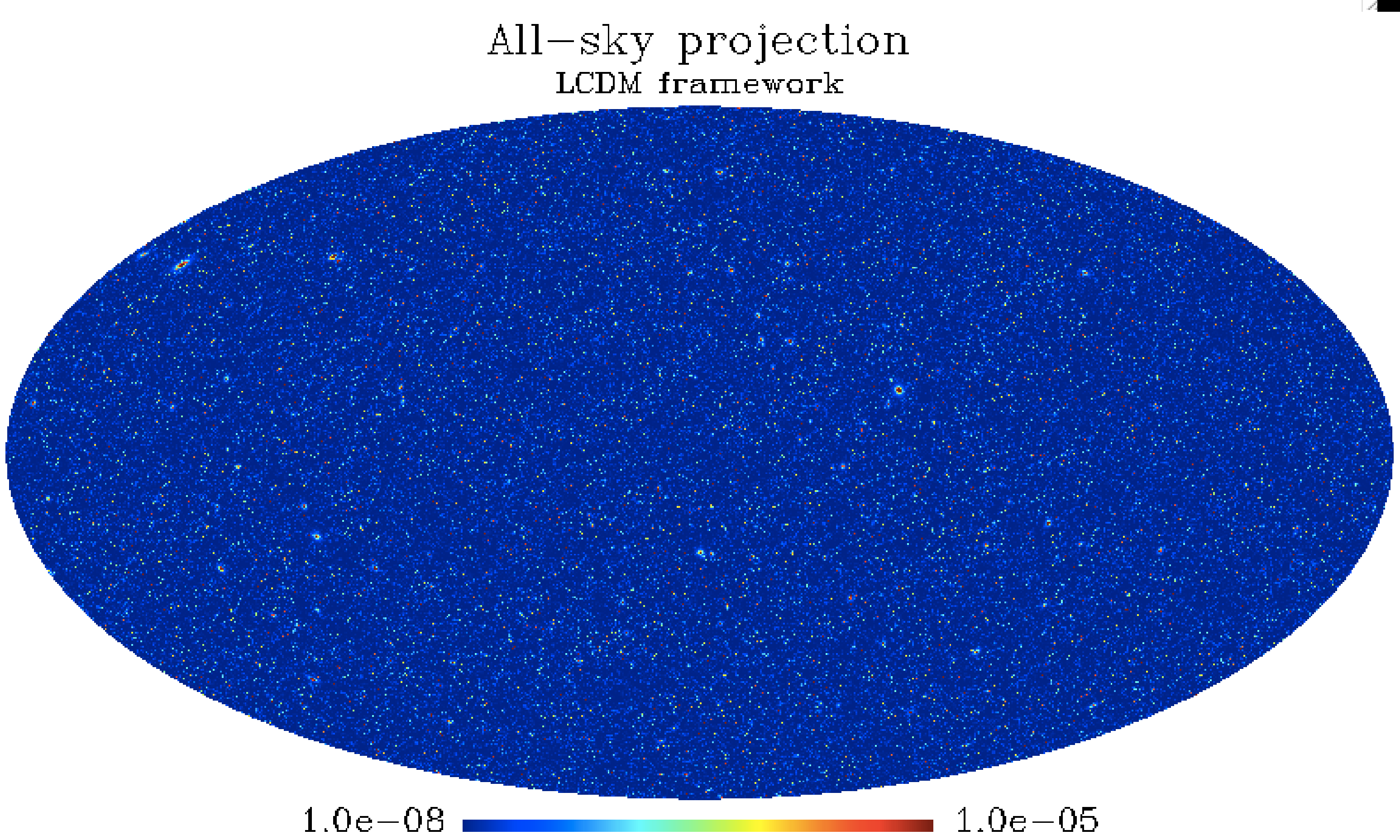
SARA NÓBREGA, ANTÓNIO DA SILVA & JOSÉ MIMOSO

INSTITUTO DE ASTROFÍSICA E CIÊNCIAS DO ESPAÇO, FACULDADE DE CIÊNCIAS, UNIVERSIDADE DE LISBOA

The cosmological principle states that the Universe is homogeneous and isotropic and is the basis of modern cosmology. The upcoming ESA/Euclid satellite mission will test this paradigm allowing us to assess whether the non-homogeneous Lemaitre-Tolman-Bondi (LTB) models should be considered to accurately describe observations locally and at intermediate cosmological scales. This project proposes to address the problem of modeling the galaxy cluster population in the context of LTB models, and the development of new numerical tools that may be used to provide ways of confronting model predictions with observations from galaxy surveys and the CMB. The Planck Sky Model (PSM) is a software package that produces simulated galaxy cluster catalogues and all-sky CMB/SZ effect maps. Our objective is to modify the galaxy cluster component of the PSM to a LTB framework.




Comparing to the standard LCDM model, in the LTB universe there is an underdensity provided that it is a void profile where the number of clusters is less than the former model. The overall power is smaller on large multipoles l, due to the diferences of the matter density parameters of the two models at large radii. The two Power Spectra have different forms essentially because the omega matter density parameter and the volume element are calculated in different ways. These results concern the first phase of this project, that is, the modifications of the background properties in the LTB framework. We observe a behavior that agrees with expectations. The second on-going phase of this project is to modify the details of the mass function of LTB clusters in the PSM code.

The LTB model is an inhomogeneous model where the observer is often placed at the centre of a local underdense void of a few Gpc and approaches asymptotically Einstein-de Sitter at large radius. It is described by 5 parameters: $\Omega_{in}$ (density parameter inside the void); $\Omega_{out}$ (density parameter outside the void); $H_0$ (Hubble constant); $r_0$ (the size of the void) and $\Delta_r$ (the width of the transition to uniformity). Here we have used: $\Omega_{out} = 1$; $\Omega_{in} = 0.3$ ; $H_0 = 66$ km $s^{-1}$ Mpc$^{-1}$; $r_0$=1500 Mpc and $\Delta_r = 450$ Mpc. We compare our results with the standard $\Lambda$CDM model where $\Omega = 0.3$ and $\Omega_\Lambda = 0.7$.

Acknowledgments: SNFN acknowledges FCT funding from DarkRipple- PTDC/FIS-OUT/29048/2017. JPM and AdS acknowledge funding from FCT Projects No. UID/FIS/04434/2020, No. CERN/FIS-PAR/0037/2019, No. PTDC/FIS-OUT/29048/2017 and IF/01135/2015.

Ciências ULisboa

instituto de astrofísica e ciências do espaço

FCT Fundação para a Ciência e a Tecnologia