PhD Thesis: Modified Gravity from Cosmic Web Environment-Dependent Galaxy Clustering and Weak Lensing

Martin Kärcher supervised by Sylvain de la Torre and Julien Bel

11th Februrary 2022

Who am I?

2016

Peter Herrmann on Unsplash

$\Longrightarrow$

2019

Wikicommons-en:User:Pph

$\Downarrow$

2020

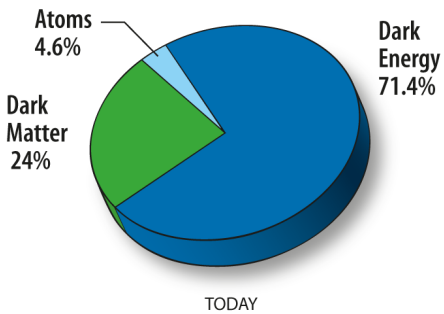
Taken from ITP Website

$\Longleftarrow$

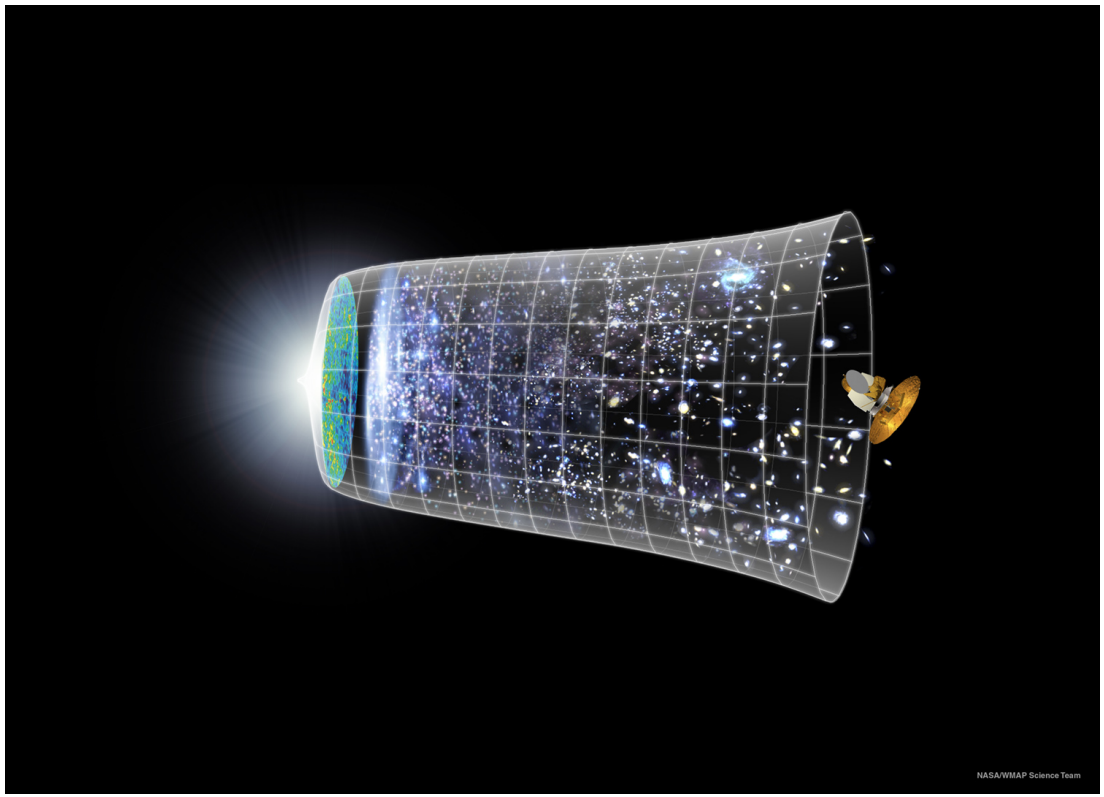
2021

Florian Wehde on Unsplash

Current ΛCDM Model



NASA / WMAP Science Team



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ΛCDM = Cosmological constant and cold dark matter

Going Beyond ΛCDM

- ΛCDM fits observations very well, but still: Fine tuning, H_0-tension, σ_8-tension
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- ΛCDM fits observations very well, but still: Fine tuning, H_0-tension, σ_8-tension
- Do we need Λ in any case to have accelerated expansion? **No!**
- Modified gravity theories can describe accelerated expansion as well $\Rightarrow f(R)$, DGP,..
- For a theory to be valid it has to satisfy solar system tests, where GR is well tested $\Rightarrow$ Screening

Where to Search for Modified Gravity?

- Generally, modified gravity is developed to act on large scales
  $\Rightarrow$ Affects growth of structure
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- Generally, modified gravity is developed to act on large scales
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- Large scale structure should exhibit influence modified gravity
  $\Rightarrow$ Accessible via clustering statistics
- Different theoretical observables are sensitive to modified gravity
  $\Rightarrow$ Growth factor f, gravitational slip η or clustering statistic E_G
- Challenge lays in constraining these parameters in the most model independent way

What is Environment in Large Scale Structure?

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- Dependence bears possibilities to refine search for modified gravity

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But what is environment in terms of LSS?

- Environment is locally assigned to object, e.g. host halo mass
- LSS structure, filaments, nodes, walls, voids ⇒ Tidal tensor
- Local density ⇒ Count-in-cell, density field via interpolation
- Newtonian gravitational potential

Marked Correlation Functions

- Goal: Enhance the effect of modified gravity on statistics
- Modified gravity acts on low density regions ⇒ Naturally suppressed in clustering
- Increase impact of low density regions ⇒ Marked correlation function
- Marks are very flexible and easy to implement

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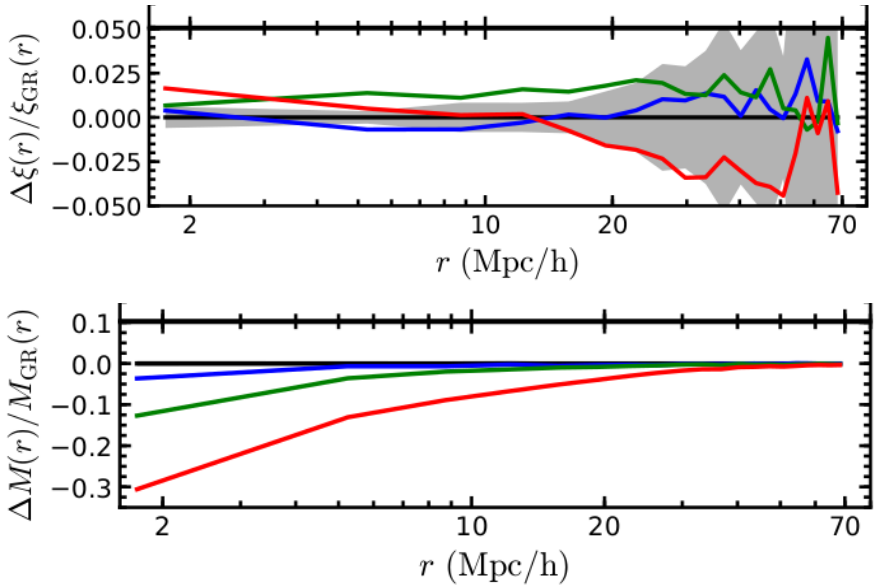

Cut-outs from Fig.3 and Fig.5 of Hernández-Aguayo et al. (2018)

Future Roadmap

- Exploit weak lensing as complementary probe to redshfit-space distortions
- Theoretical prediction of marked correlation function
  ⇒ Necessary for comparison with observations
- Explore further the impact of including environment into analysis
  ⇒ Different characterization of environments
- EFT approach to dark energy to generalize tests for MG models

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Find optimal way to detect modified gravity signatures with the use of its environmental dependence in the most model independent way

Thank you for your attention!