Modified gravity simulations

On the road to build reliable emulators for modified gravity models

Christian Arnold

05.05.22, Marseille

ICC, Durham University

Institute for Computational Cosmology

European Research Council
Established by the European Commission

Durham University

Why modified gravity?

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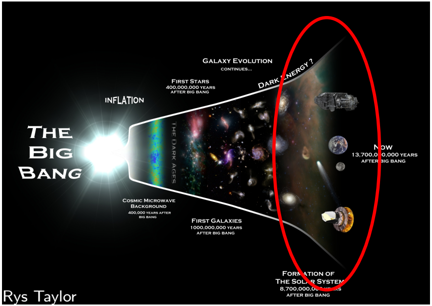

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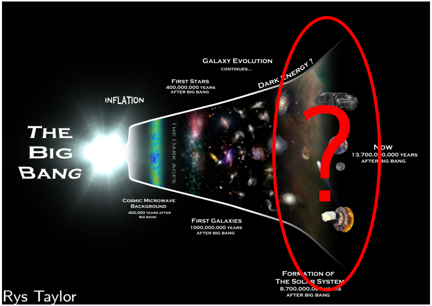

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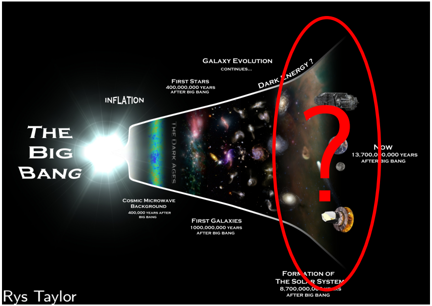
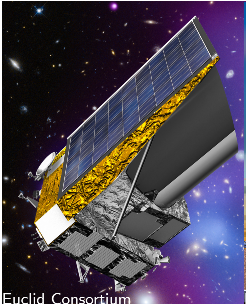
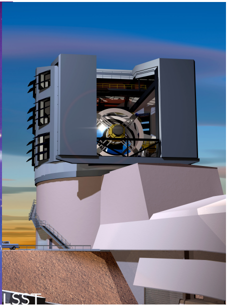


Rys Taylor


Euclid Consortium


LSST

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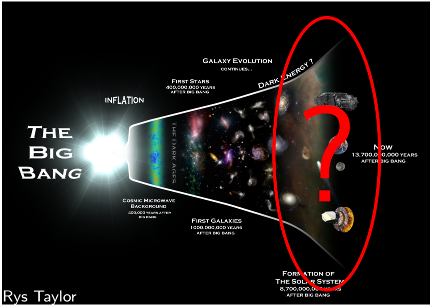

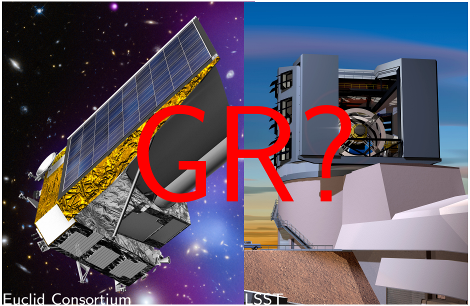

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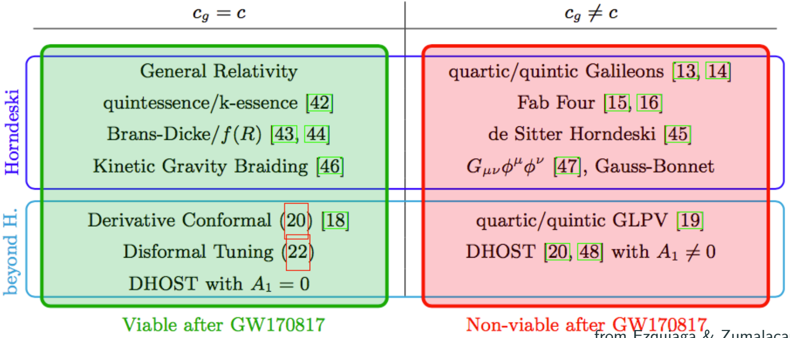
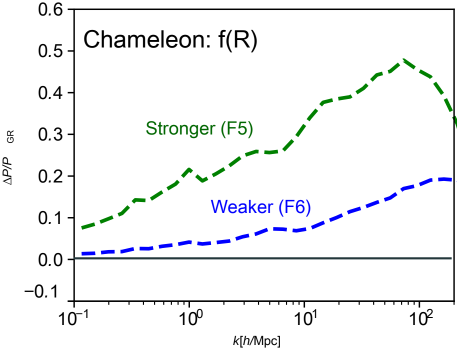


from Ezquiaga & Zumalacarregui (2017)

Modified gravity models: Effect on the matter power spectrum



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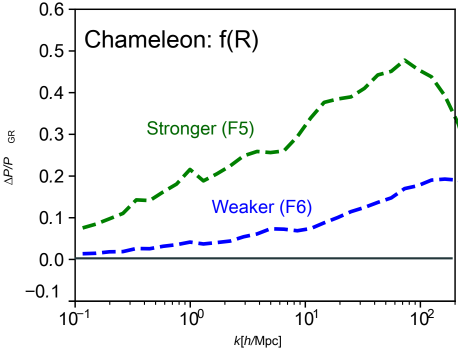

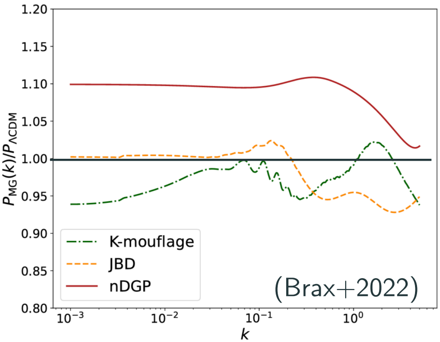

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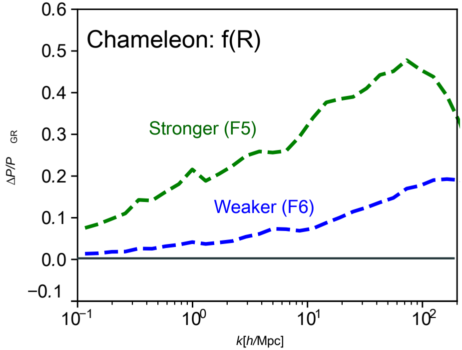

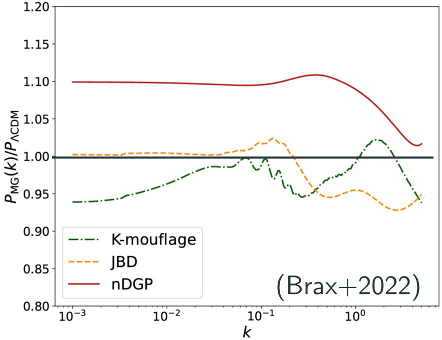

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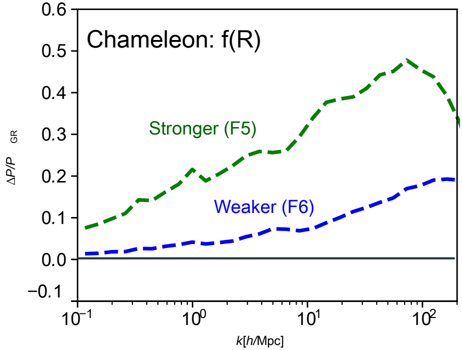

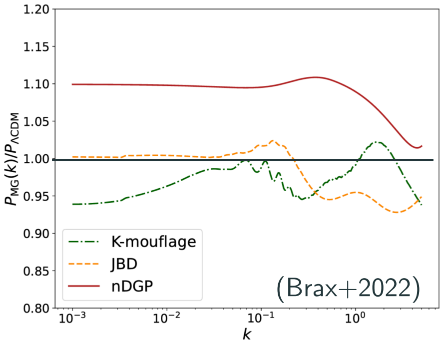

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⇒ simulations for MG

Modified Gravity Simulation Codes

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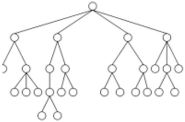

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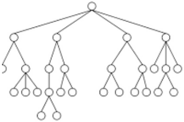

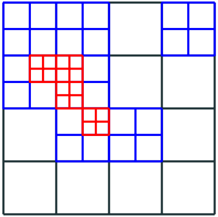

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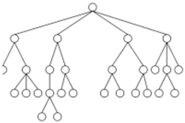

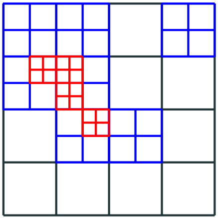

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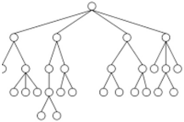

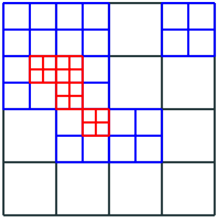

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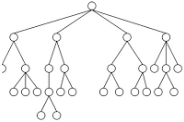

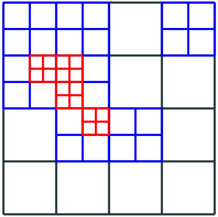

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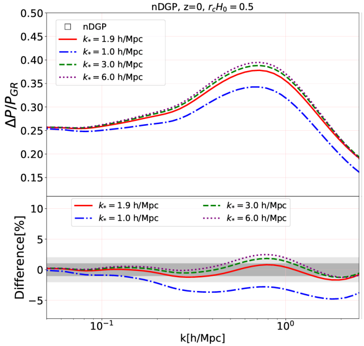
MG-EVOLUTION



Hassani&Lombriser(2020)

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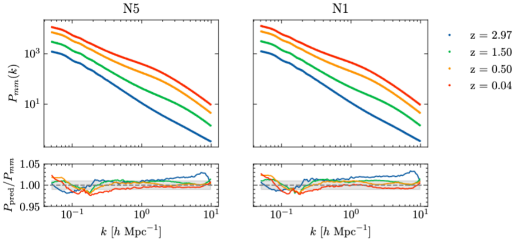
BRIDGE (preliminary)



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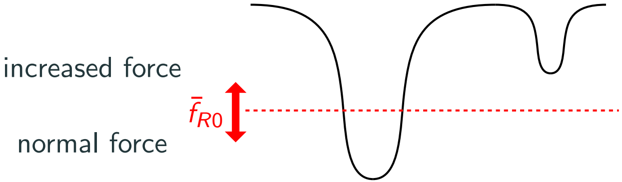

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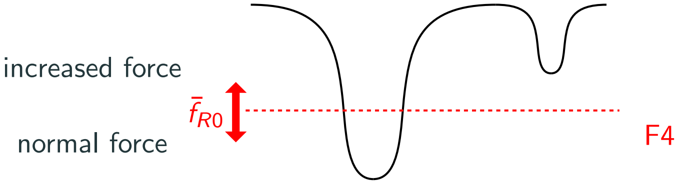

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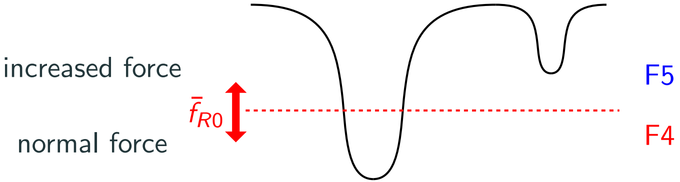

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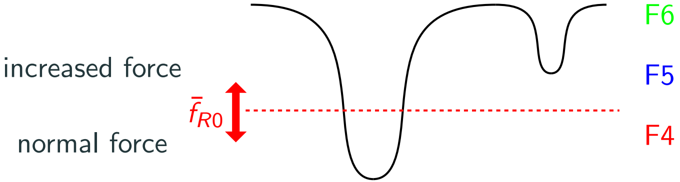

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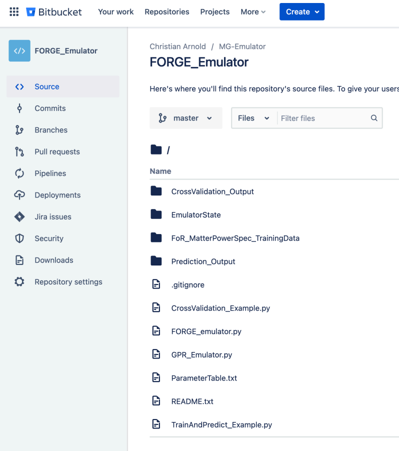

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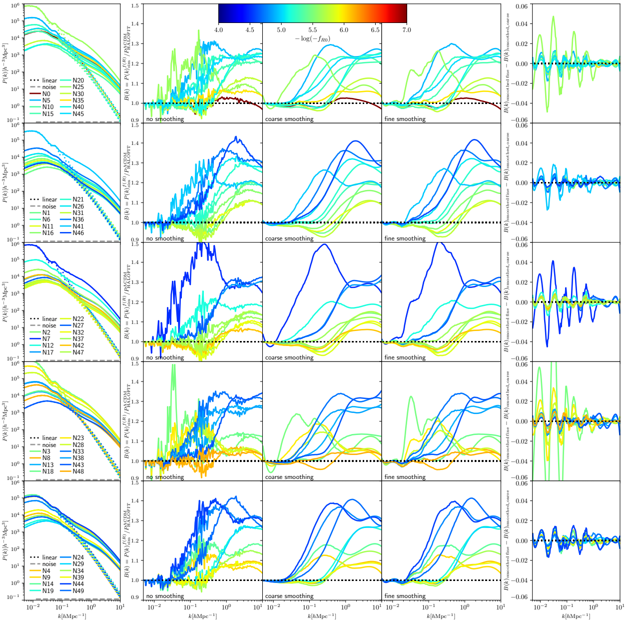

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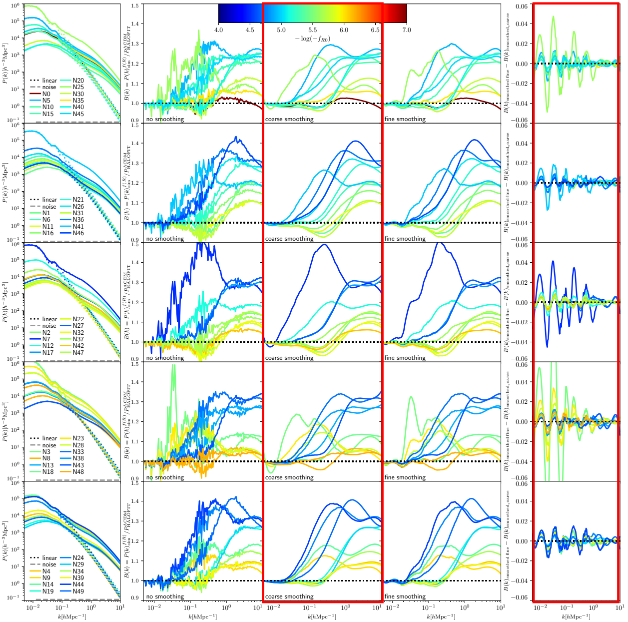

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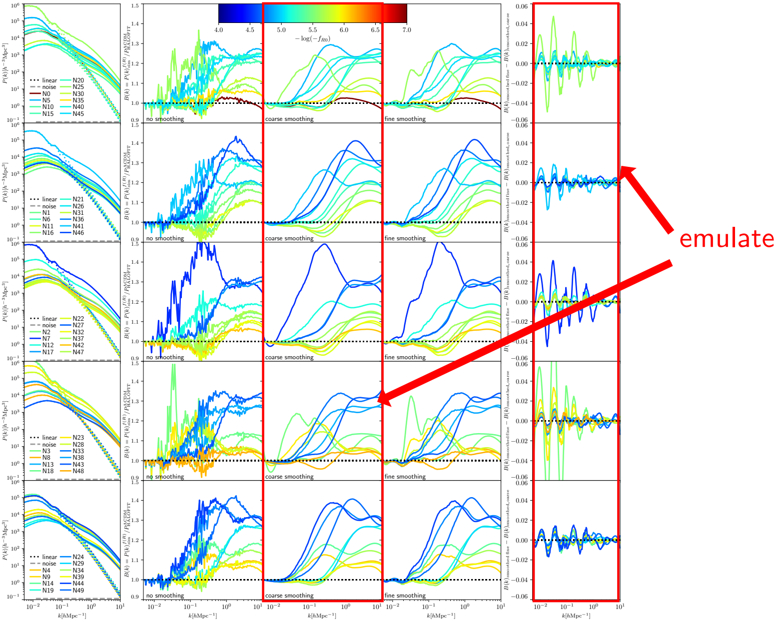
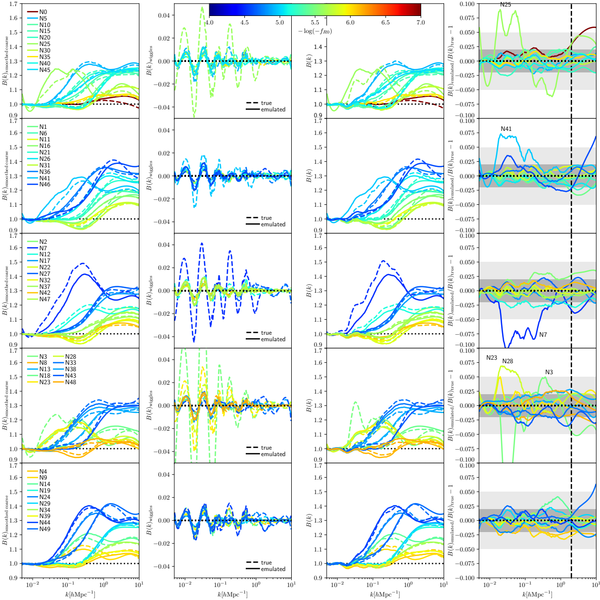


Emulator cross validation



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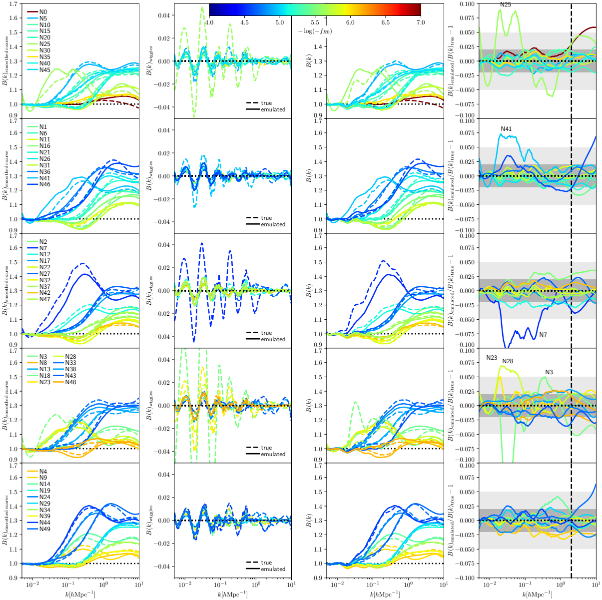
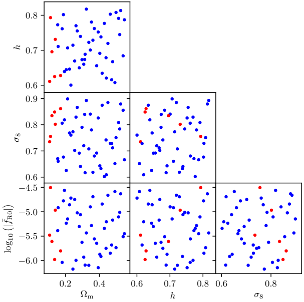
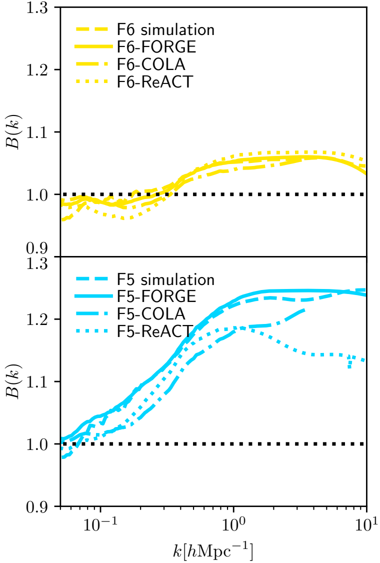




Making a prediction for independent simulations and comparing to other emulators



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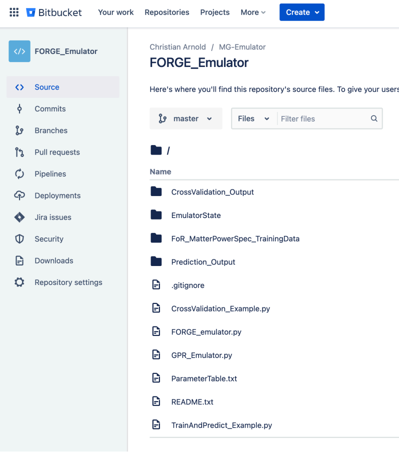

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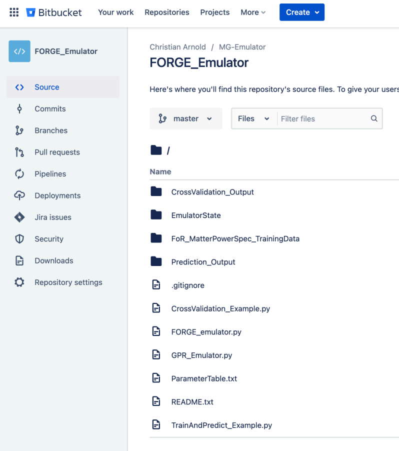

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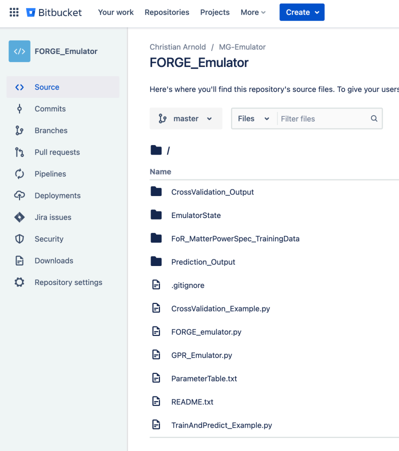

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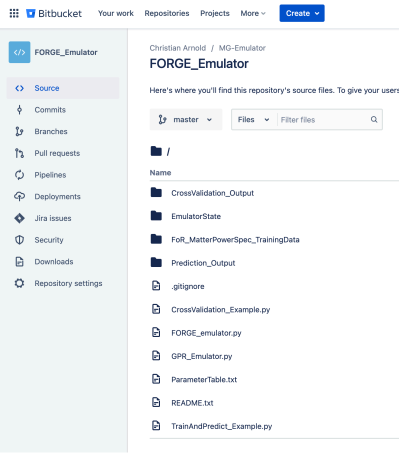

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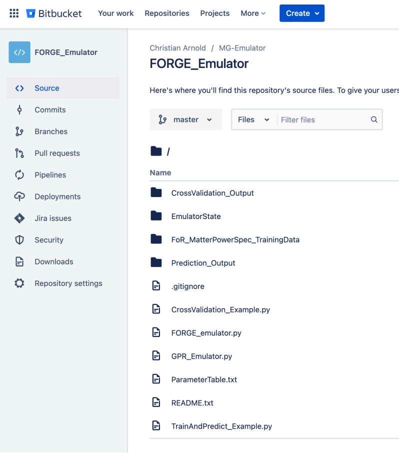

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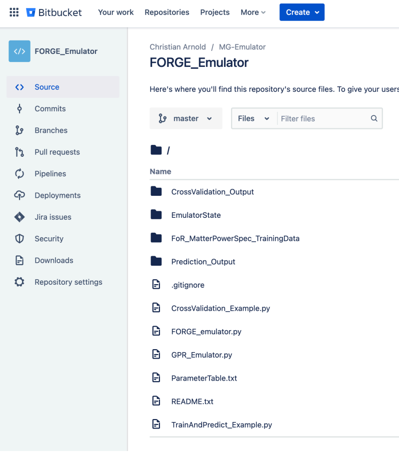
- Larger simulation suites for training: MG-GLAM



MG-GLAM

Fast full N-body simulations of generic modified gravity: conformal coupling models

arXiv:2110.00328

Cheng-Zong Ruan,[a] César Hernández-Aguayo,[b,c] Baojiu Li,[a] Christian Arnold,[a] Carlton M. Baugh,[a] Anatoly Klypin,[d] and Francisco Prada[e]

[a]Institute for Computational Cosmology, Department of Physics, Durham University, South Road, Durham DH1 3LE, UK

- Based on GLAM (Kyplin&Prada 2018)

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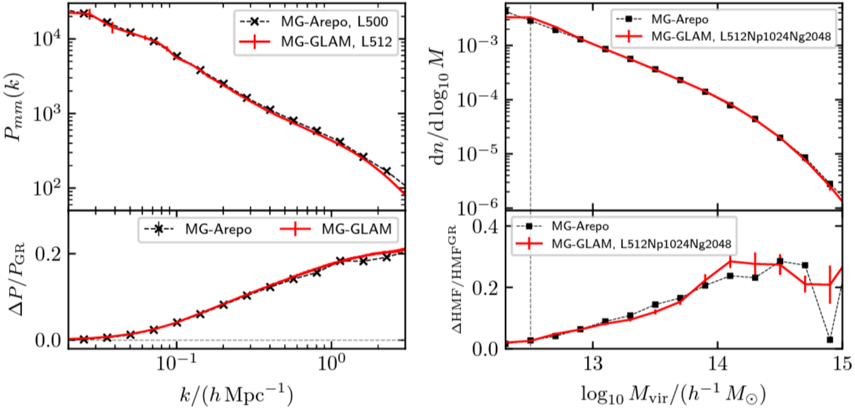
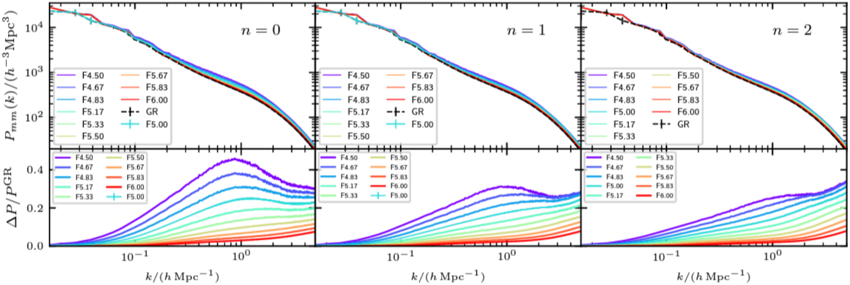
- f(R) run with 2048^3 particles in a $1\mathrm{Gpc}/h$ box with a 4096^3 grid takes $\approx 27\mathrm{h}$ on one cosma8 node (128 cores)

MG-GLAM - accuracy

Compare $\approx 500\mathrm{Mpc}/h$ boxes with 1024^3 particles of MG-GLAM (2048^3 grid) and AREPO



MG-GLAM - power spectrum



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- Data analysis requires fast predictions for a certain parameter set
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- Fast simulation methods can now offer the speed and accuracy for this also for MG-models