

Machine Learning techniques applied to cosmological problems.

Martín de los Rios

Director: Dr. Mariano Domínguez

Resumen

1

Introduction to Machine Learning techniques.

2

The MeSsI (Merging Systems Identification) Algorithm.

3

Derived Results.

- A2029/2033.
- A1204.
- A267.
- Statistical analysis of the magnetic fields in merging clusters.

4

CosmoML:Machine Learning techniques applied to the CMB.

- Construction of the data set.
- Supervised methods.
- Cosmological parameters Angular distributions.

5

Conclusions.

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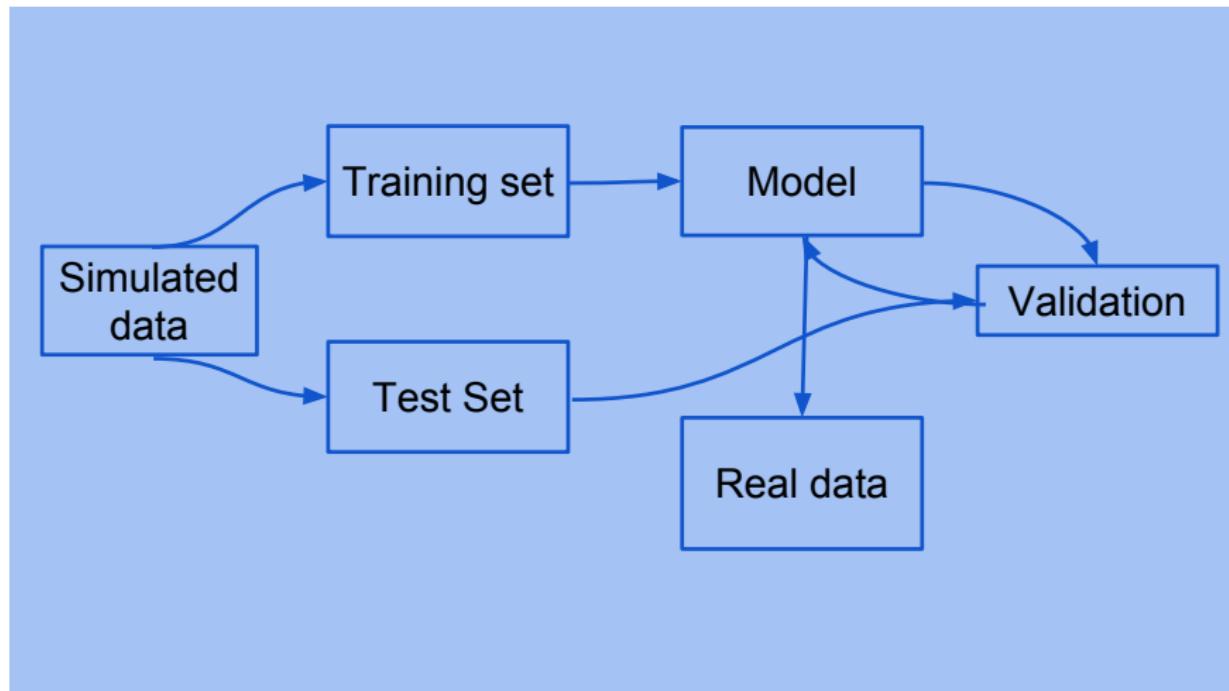
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A computer program learns to perform a task T , based on a training E and taking into account a measure P of its performance, if this measure P when making T improves with the training E.

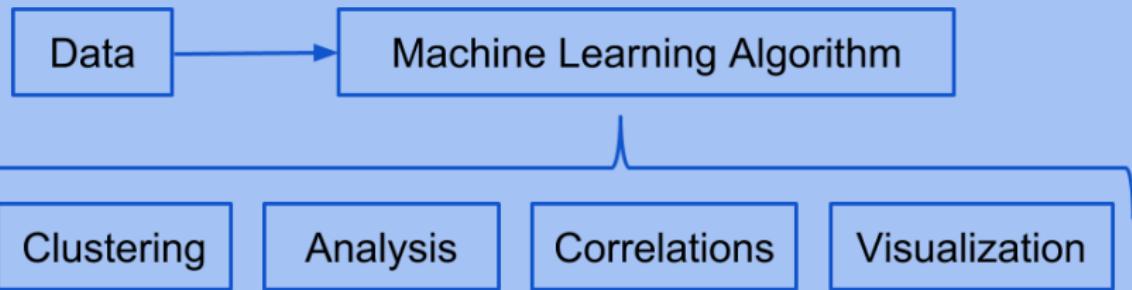
Supervised Learning.



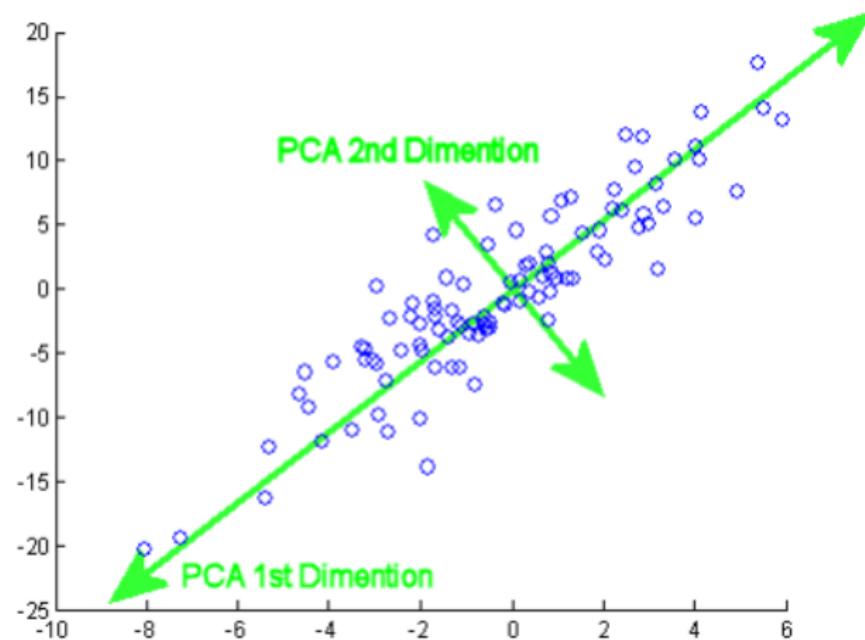
Random Forest

Support Vector Machines

Unsupervised Learning.



Principal Components Analysis.



Mixture of Gaussians

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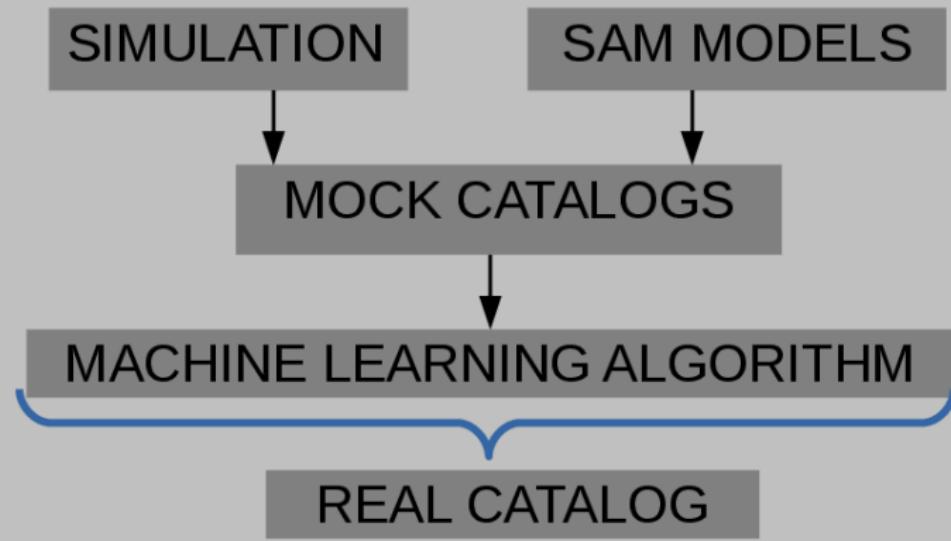
The MeSSI (Merging Systems Identification) Algorithm & Catalogue.

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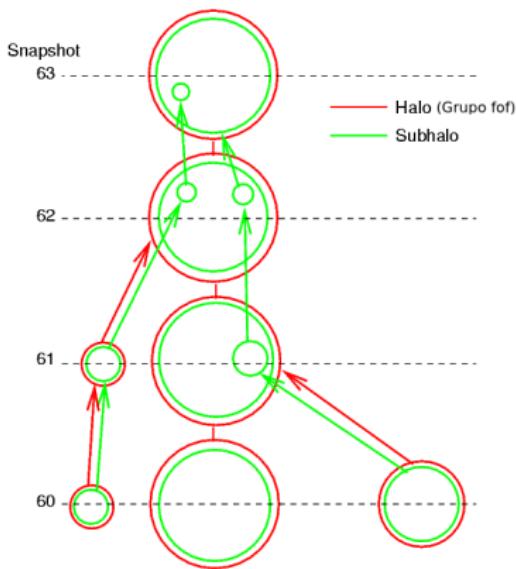
² Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina.

³ Consejo Nacional de Investigaciones Científicas y Técnicas, Rivadavia 1917, C1033AAJ Buenos Aires, Argentina.

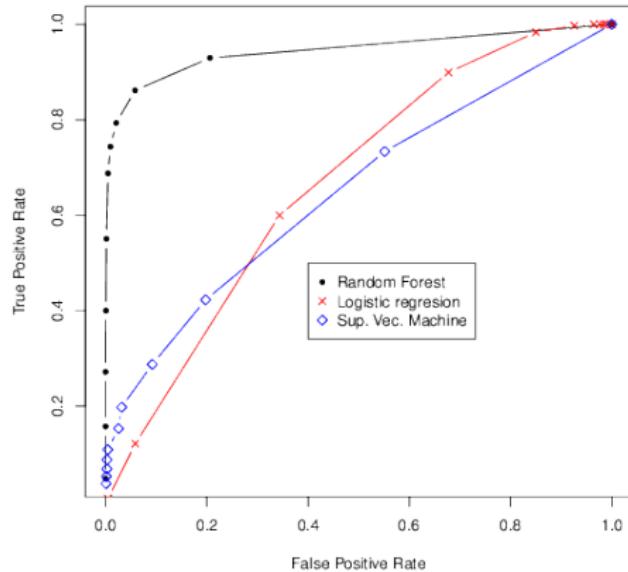


Study of the merger trees.

- Based on the subhalos merger trees, we construct the merger tree for every fof group in the simulation.



- Dressler-Shectman test.
- Non gaussianity test.
- Color.
- Number of galaxies.



- We found 61 candidates to merging clusters.
- In 32 of these we were able to identify the colliding substructures.
- 21 of these were previously classified as merging clusters by other authors.

Name	$M_1 [10^{14} M_\odot]$	$RA_1 [^\circ]$	$DEC_1 [^\circ]$	z_1	$M_2 [10^{14} M_\odot]$	$RA_2 [^\circ]$	$DEC_2 [^\circ]$	z_2
Abell 1991	5.7 ±1.2	223.58 ±0.05	18.53 ±0.09	0.0583 ±0.0003	2.6 ±1.02	223.67 ±0.6	18.67 ±0.1	0.0586 ±0.0003
Abell 1424	4.9 ±2.3	179.38 ±0.09	5.08 ±0.02	0.0760 ±0.0004	5.1 ±1.4	179.19 ±0.1	5.01 ±0.04	0.0746 ±0.0005
Abell 1589	5.5 ✓ ±0.4	190.25 ±0.01	18.53 ±0.02	0.0721 ±0.0001	1.1 ±0.5	190.34 ±0.01	18.22 ±0.005	0.0716 ±0.0002
31170	25.4 ±0.8	255.63 ±0.05	34.06 ±0.05	0.0993 ±0.0003	13.3 ±1.3	255.76 ±0.05	33.90 ±0.005	0.0989 ±0.0002
Abell 2029/33	24.3 ±4.6	227.73 ±0.05	5.68 ±0.1	0.0796 ±0.0004	13.4 ±1.8	227.81 ±0.1	6.13 ±0.2	0.0805 ±0.0009
Abell 2069	22.6 ✓ ±6.8	230.99 ±0.05	29.94 ±0.04	0.1146 ±0.0002	32 ±10	231.07 ±0.05	29.86 ±0.09	0.1146 ±0.0004
Abell 2142	18.3 ✓ ±0.6	239.61 ±0.005	27.23 ±0.005	0.0901 ±0.0004	11.3 ±1.8	239.33 ±0.005	27.5 ±0.005	0.0893 ±0.0001
Abell 1913	5.5 ±1.1	216.73 ±0.02	16.75 ±0.06	0.0530 ±0.0004	2.1 ±1.4	216.84 ±0.04	16.62 ±0.1	0.0533 ±0.0013
Abell 2399	5.1 ±0.3	329.29 ±0.02	-7.81 ±0.02	0.0576 ±0.0001	2.4 ±0.3	329.49 ±0.04	-7.79 ±0.02	0.0581 ±0.0002
Abell 85	7.4 ✓ ±0.3	10.425 ±0.005	-9.25 ±0.01	0.0559 ±0.0001	1.8 ±1.1	10.47 ±0.01	-9.51 ±0.05	0.0573 ±0.002
55731	1.9 ±0.4	244.72 ±0.06	24.21 ±0.08	0.0661 ±0.0004	2.05 ±0.3	244.63 ±0.07	24.32 ±0.08	0.0656 ±0.0005
Abell 1750	8.7 ✓ ±1.1	202.80 ±0.02	-1.89 ±0.02	0.0868 ±0.0009	7.5 ±1.6	202.82 ±0.04	-1.73 ±0.1	0.0848 ±0.0016
Abell 3158	37.24 ✓ ±1.5	55.75 ±0.07	-53.63 ±0.004	0.0633 ±0.0001	4.6 ±0.2	55.37 ±0.007	-53.48 ±0.001	0.0622 ±0.0001
Abell 376	19.7 ±1.4	41.46 ±0.006	36.89 ±0.005	0.0478 ±0.0000	4.01 ±1.09	41.72 ±0.003	36.94 ±0.007	0.0489 ±0.0002
Abell 3490	44.76 ±4.3	176.42 ±0.02	-34.37 ±0.01	0.0688 ±0.0001	116.5 ±4.04	176.1 ±0.1	-34.39 ±0.1	0.0727 ±0.001
Abell 2382	77.7 ±10.2	327.90 ±0.006	-15.66 ±0.006	0.0676 ±0.0003	6.12 ±1.1	328.167 ±0.003	-15.62 ±0.01	0.0642 ±0.0002
Abell 689	32.3 ±7.9	129.39 ±0.02	14.99 ±0.04	0.2788 ±0.0002	9.9 ±8.5	129.29 ±0.1	15.06 ±0.1	0.2791 ±0.0007
Abell 1758N	59.3 ✓ ±9	203.07 ±0.02	50.59 ±0.01	0.2768 ±0.0002	29.1 ±15.8	203.25 ±0.02	50.57 ±0.03	0.2783 ±0.0007
Abell 1758S	43 ✓ ±4	203.21 ±0.005	50.42 ±0.001	0.2742 ±0.0002	15.8 ±1.6	202.96 ±0.001	50.39 ±0.001	0.2739 ±0.0001
Abell 2631	84.9 ✓ ±2.1	354.36 ±0.001	0.26 ±0.001	0.2762 ±0.0001	77.1 ±4.3	354.60 ±0.005	0.269 ±0.01	0.2766 ±0.0002
Abell 2055	20.02 ±7.6	229.68 ±0.04	6.23 ±0.06	0.1013 ±0.0007	3.9 ±2.2	229.71 ±0.08	6.19 ±0.1	0.0997 ±0.0018
Abell 2261	65.8 ✓ ±7.6	260.60 ±0.04	32.06 ±0.06	0.2253 ±0.0007	13.4 ±2.2	261.10 ±0.08	32.27 ±0.1	0.2232 ±0.0018



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I. Analysis of candidates for interacting galaxy clusters

A1204 and A2029/A2033

Elizabeth Johana Gonzalez ^{1,2}, Martín de los Ríos^{1,2}, Gabriel A. Oio^{1,2}, Daniel Hernández Lang⁴, Tania Paez Tagliaferro^{1,2}, Mariano J. Domínguez R.^{1,2}, José Luis Nilo Castellón^{3,4}, Héctor Cuevas L.⁴, and Carlos A. Valotto^{1,2}

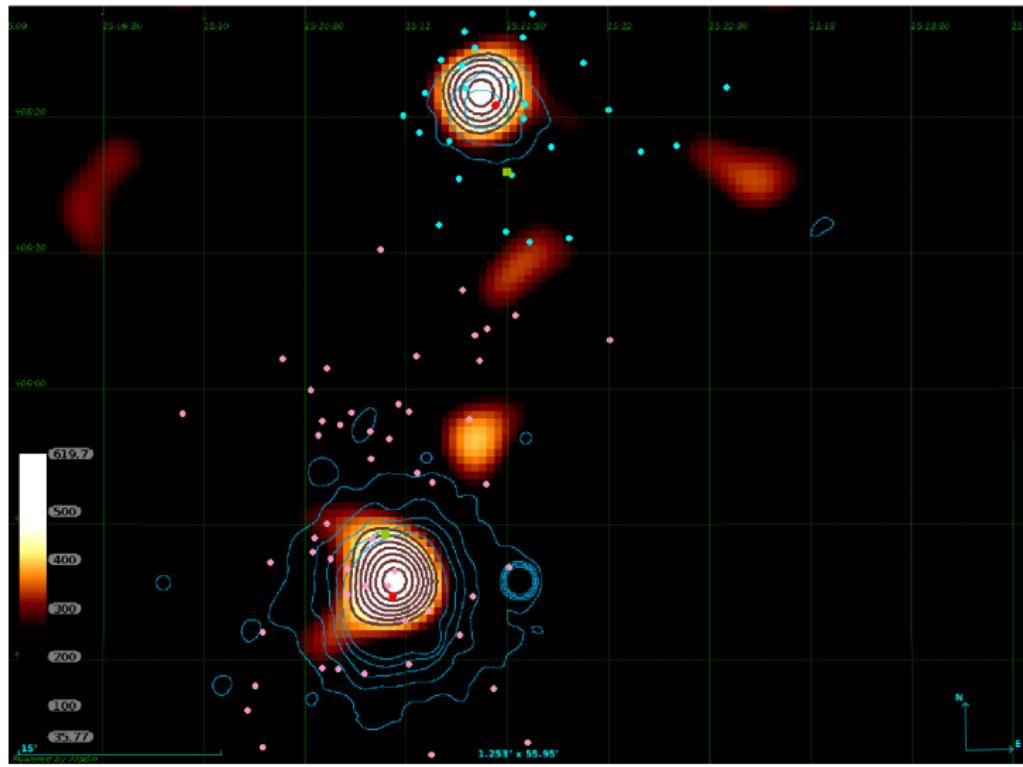
¹ Instituto de Astronomía Teórica y Experimental, (IATE-CONICET), Laprida 854, X5000BGR, Córdoba, Argentina.

² Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina.

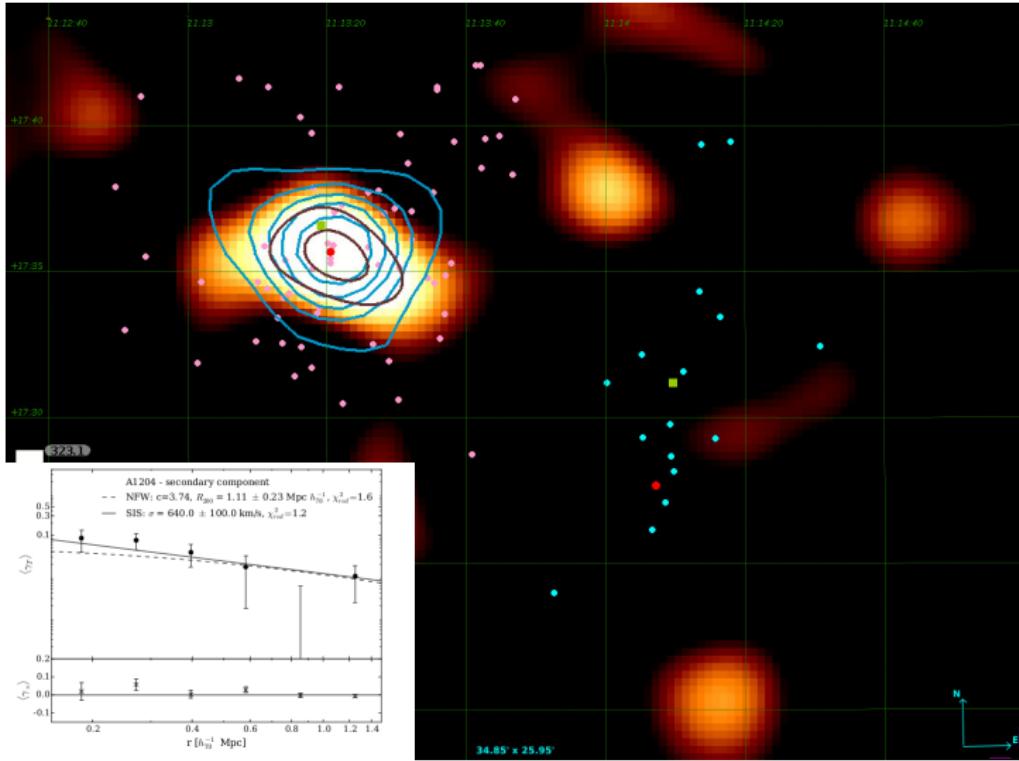
³ Instituto de Investigación Multidisciplinario en Ciencia y Tecnología, Universidad de La Serena. Benavente 980, La Serena, Chile.

⁴ Departamento de Física y Astronomía, Facultad de Ciencias, Universidad de La Serena. Av. Juan Cisternas 1200, La Serena, Chile.

A2029/2033



A1204



II. Analysis of candidates for interacting galaxy clusters: A267, a merging fossil group.

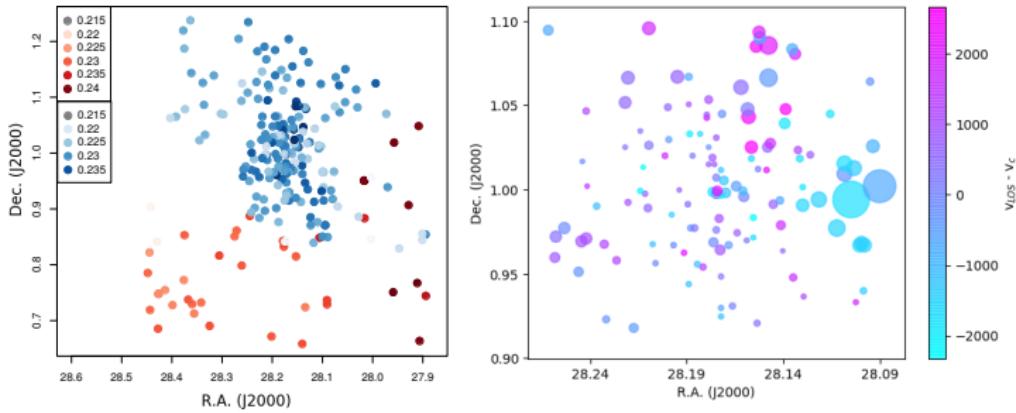
Elizabeth Johana Gonzalez ^{★1,2}, María Jose Kanagusuku^{1,2}, Martín de los Rios^{1,2}, Gabriel A. Oio^{1,2}, Daniel Hernández Lang⁴, Tania Aguirre Tagliaferro^{1,2}, Mariano J. Domínguez R.^{1,2}, José Luis Nilo Castellón^{3,4}, Héctor Cuevas L.⁴, and Carlos A. Valotto^{1,2}

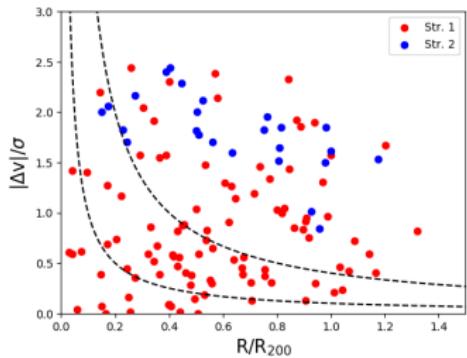
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- $\approx 40\%$ Fossil groups have a major merger $z < 0.8$.
- $\approx 15 - 25\%$ Fossil groups have a major merger $z < 0.3$.

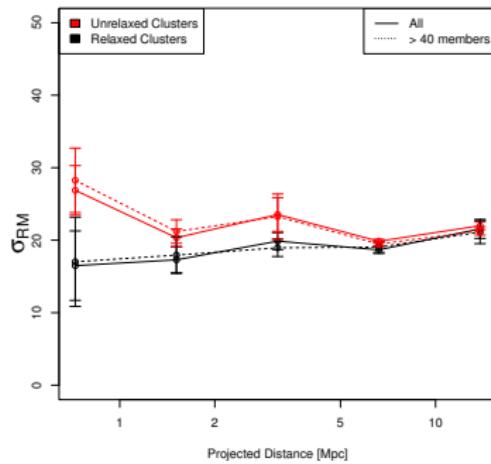
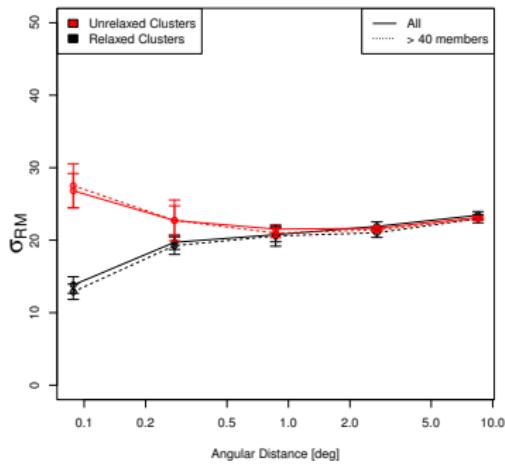
Faraday Rotation Measure dependence with galaxy clusters dynamics

F.A. Stasyszyn^{1,2*} & M. de los Rios^{1,2,3}

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CosmoML: Machine Learning techniques applied to the Cosmic Microwave Background.

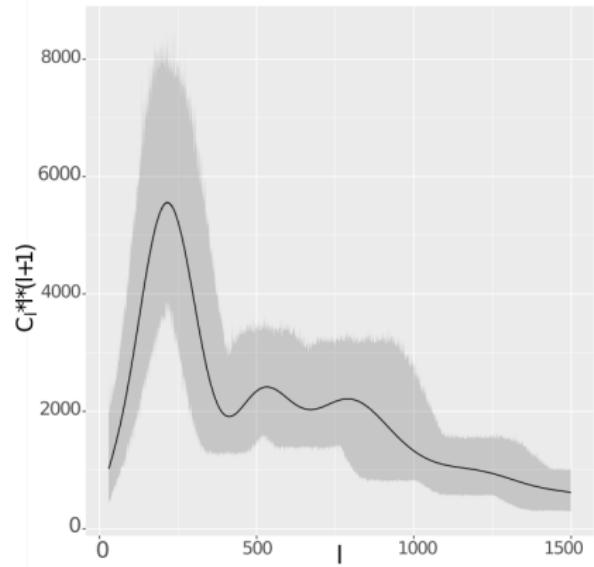
Martín de los Ríos[★], Mariano J. Domínguez R.^{★ 1,2,3}.

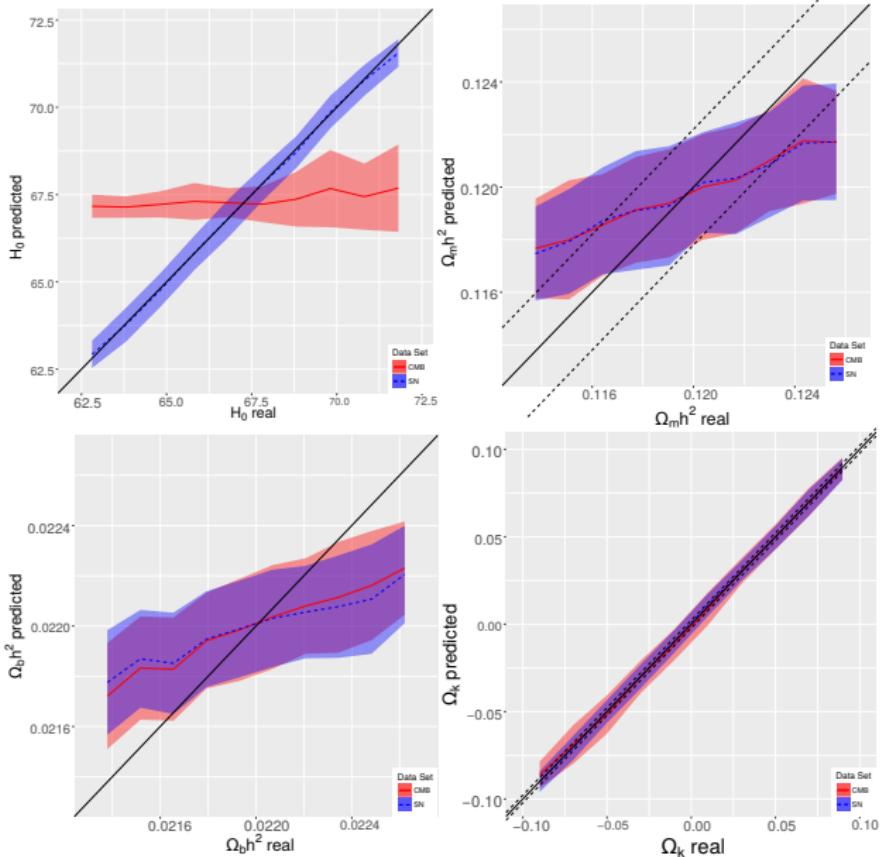
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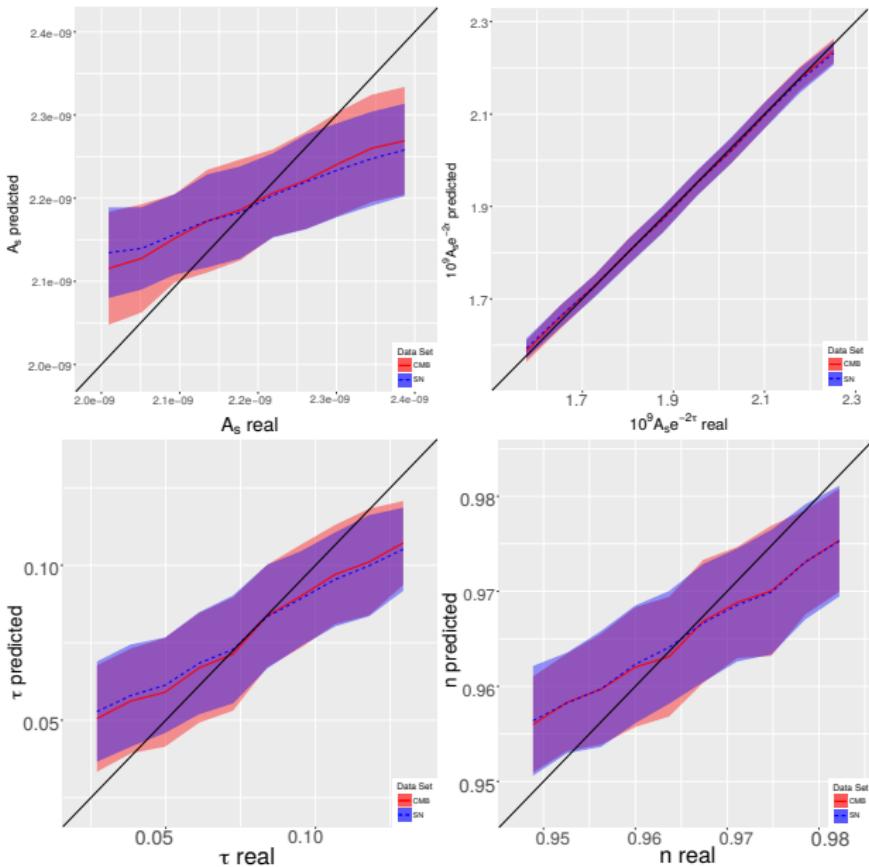
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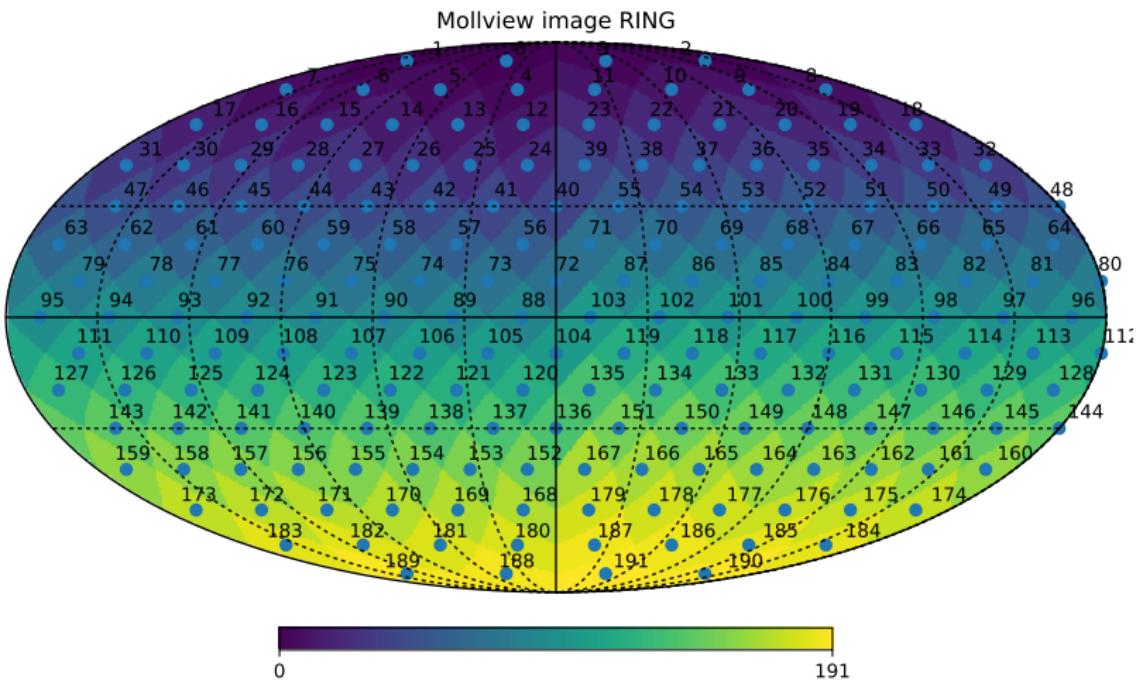
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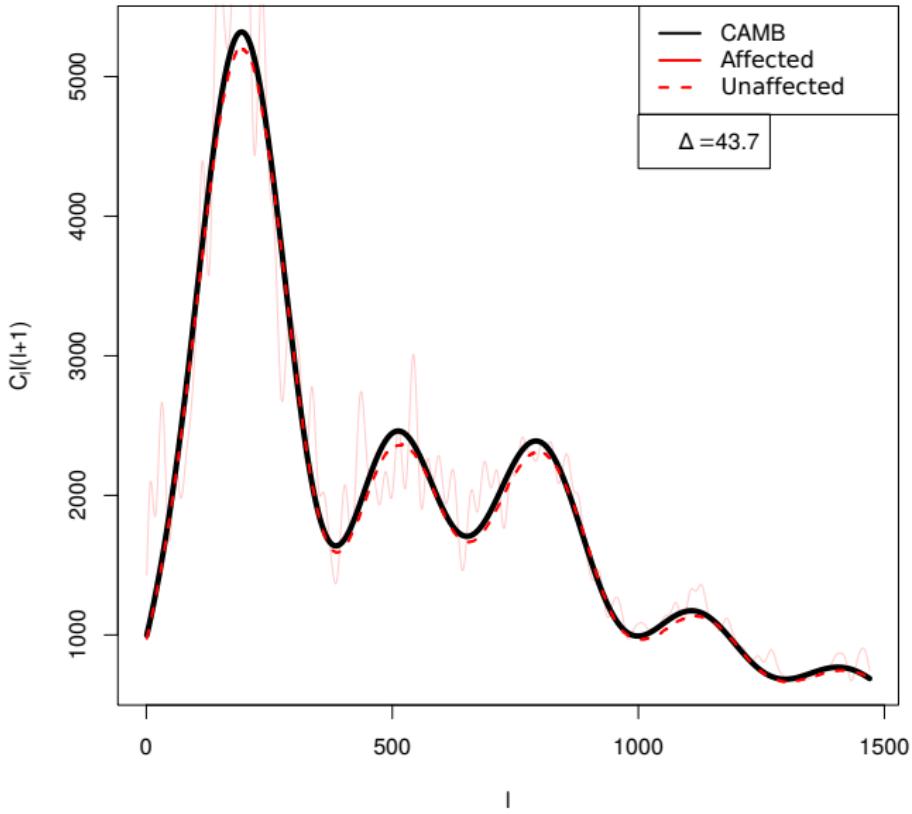
Parameter	Minimum	Maximum	Planck
$\Omega_m h^2$	0.1131	0.1263	0.1197
$\Omega_b h^2$	0.02131	0.02269	0.022
Ω_k	-0.1	0.1	0
H_0	62.31	72.31	67.31
n	0.9469	0.9841	0.9655
A_s	1.988×10^{-9}	2.408×10^{-9}	2.198×10^{-9}
τ	0.021	0.1349	0.078

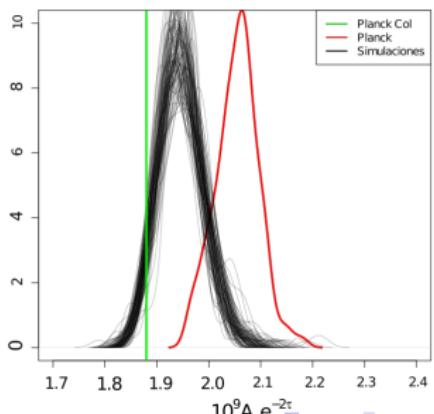
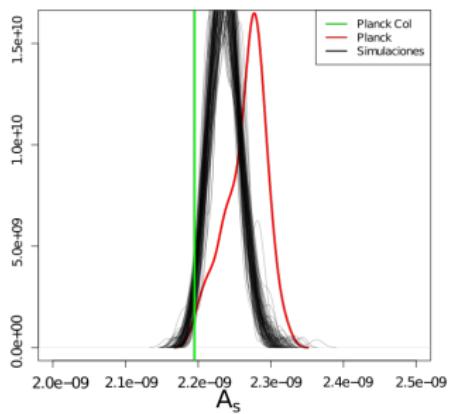
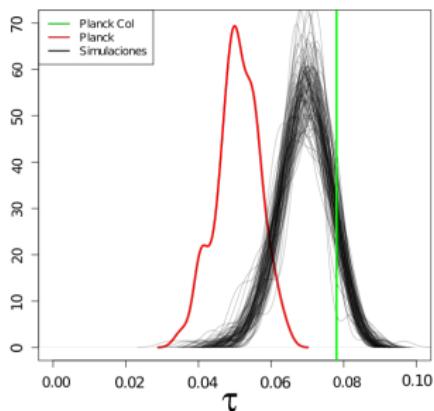
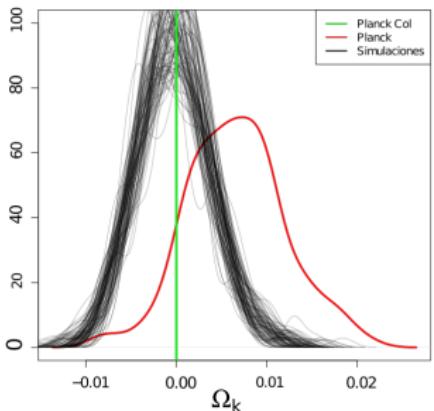












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- We studied the angular distributions of the cosmological parameters without finding anything unexpected in the standard cosmological model, with the possible exception of the parameter $10^9 A_s e^{-2\tau}$.

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- They can be very useful for classification and regression problems, achieving, in most of the problems, better results than the traditional methods in lower computational time.
- Taking into account the large amount of data that will be recorded by the future surveys, this technique will be essential for their analysis.



THANK YOU