

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

# Machine Learning techniques applied to cosmological problems.

Martín de los Ríos

Director: Dr. Mariano Domínguez

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

# Resumen

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

CosmoML:Machine Learning techniques applied to the CMB.

Construction of the data set.

Unsupervised methods.

Supervised methods.

Cosmological parameters Angular distributions.

Conclusions.

## Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

CosmoML:Machine Learning techniques applied to the CMB.

Construction of the data set.

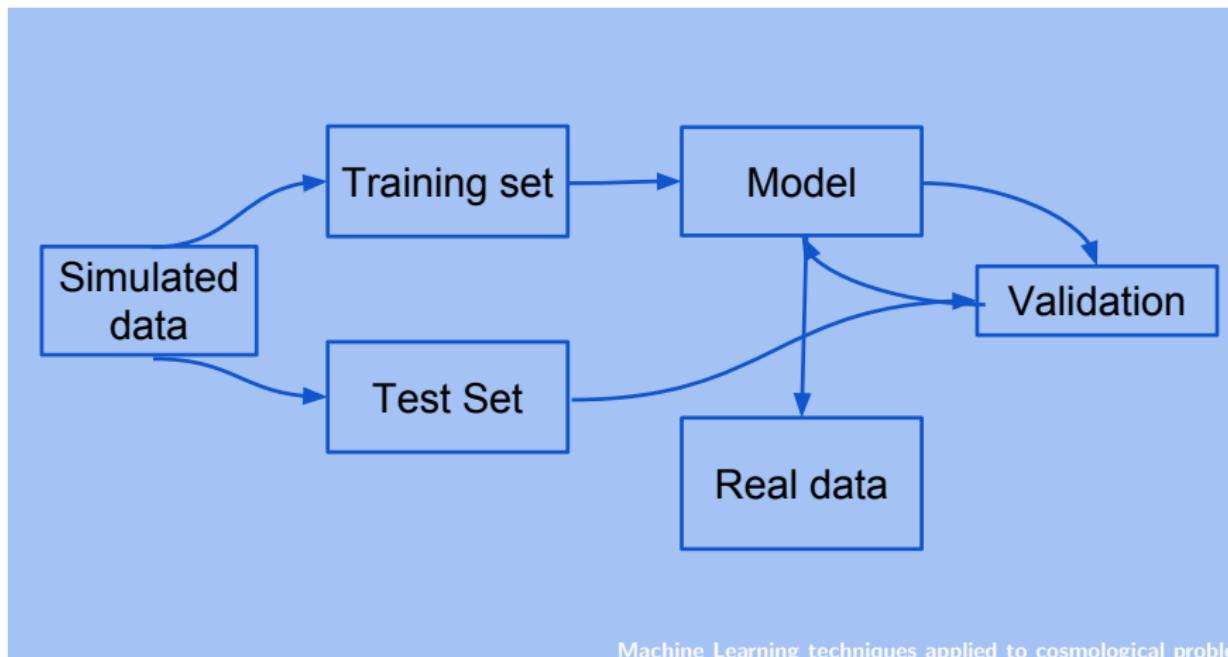
Unsupervised methods.

Supervised methods.

Cosmological parameters Angular distributions.

Conclusions.

# Supervised Learning.



**Introduction to Machine Learning techniques.**

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

# Random Forest

**Introduction to Machine Learning techniques.**

The MeSSI (Merging Systems Identification) Algorithm.

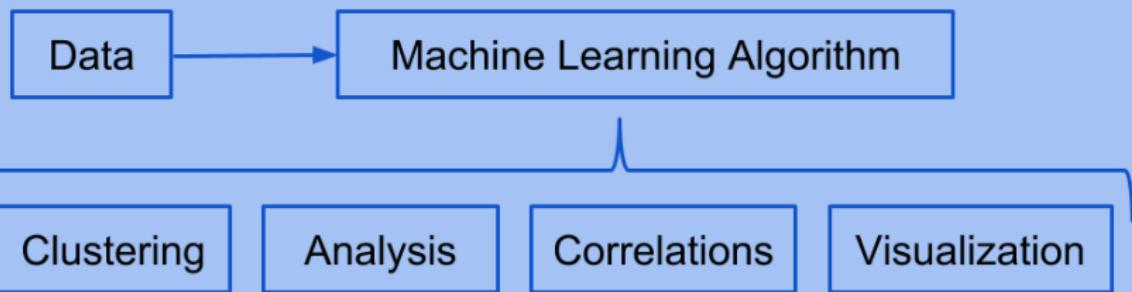
Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

# Support Vector Machines

# Unsupervised Learning.



**Introduction to Machine Learning techniques.**

The MeSSI (Merging Systems Identification) Algorithm.

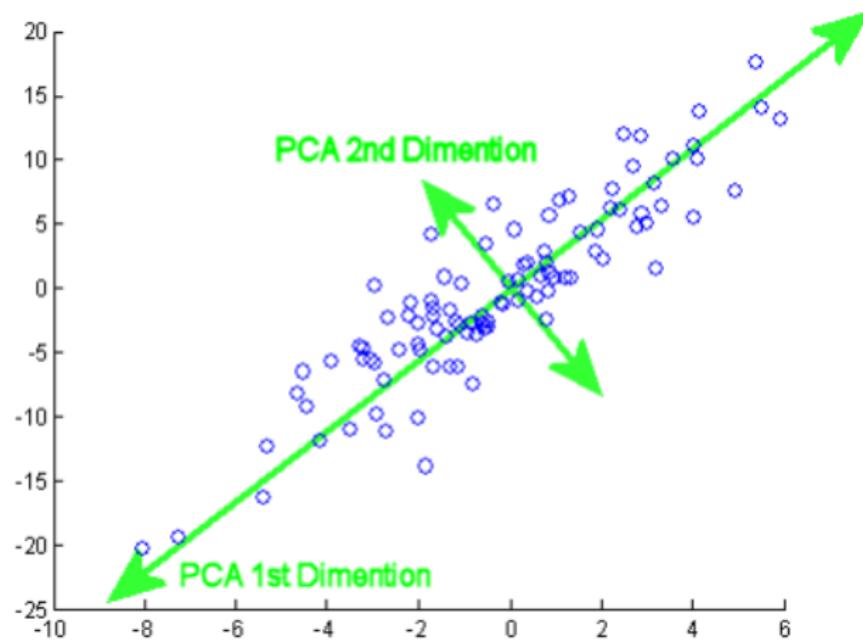
Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

# Mixture of Gaussians

# Principal Components Analysis.



Introduction to Machine Learning techniques.

## The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

Introduction to Machine Learning techniques.

## The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

CosmoML:Machine Learning techniques applied to the CMB.

Construction of the data set.

Unsupervised methods.

Supervised methods.

Cosmological parameters Angular distributions.

Conclusions.

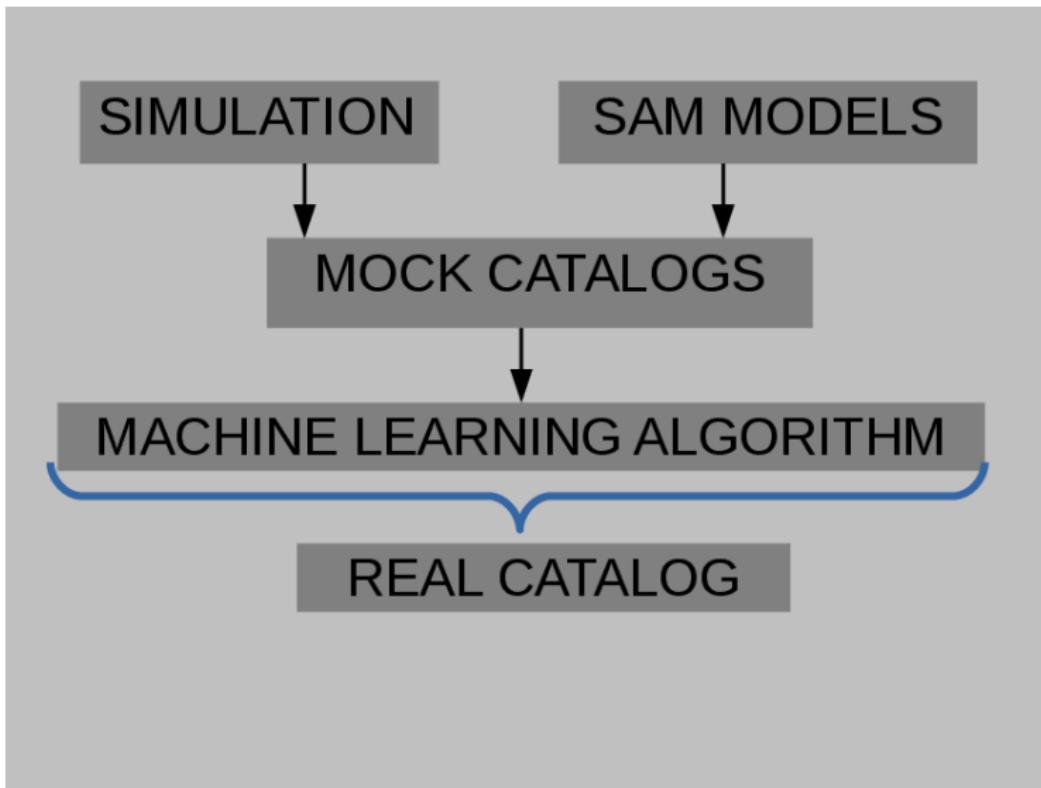
## **The MeSSI (Merging Systems Identification) Algorithm & Catalogue.**

Martín de los Ríos<sup>\*</sup>, Mariano J. Domínguez R.<sup>†</sup>, Dante Paz, Manuel Merchán<sup>‡,3</sup>.

<sup>1</sup> Instituto de Astronomía Teórica y Experimental (CCT-Córdoba - CONICET, UNC), Laprida 854, X5000BGR, Córdoba, Argentina.

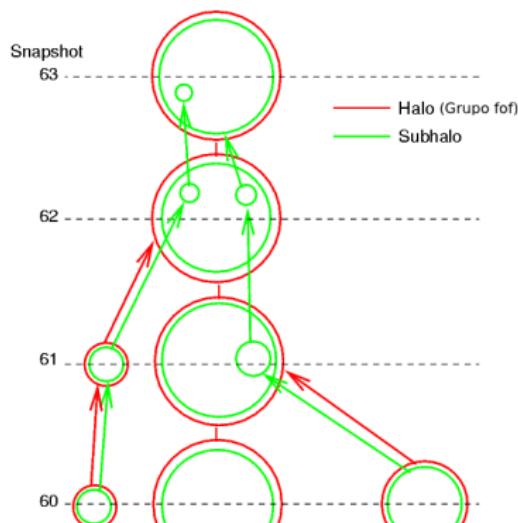
<sup>2</sup> Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina.

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

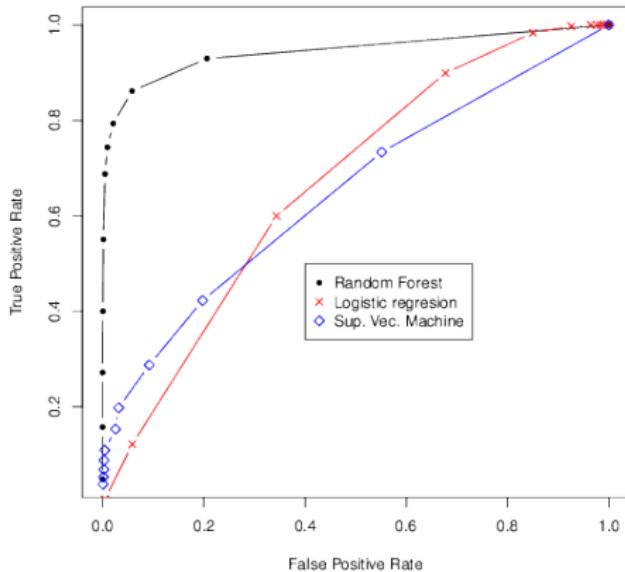


## Study of the merger trees.

- ▶ 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	$M_1 [10^{14} M_\odot]$	$RA_1 [\text{h}]$	$DEC_1 [\text{d}]$	$z_1$	$M_2 [10^{14} M_\odot]$	$RA_2 [\text{h}]$	$DEC_2 [\text{d}]$	$z_2$
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 ±0.0001	13.3 ±1.3	255.76 ±0.05	33.90 ±0.005	0.0989 ±0.0005
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 ±1.0	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 ±0.0001	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 ±40.4	176.1 ±0.1	-34.39 ±0.1	0.0727 ±0.001
Abell 2382	77.7	327.90	-15.66	0.0676	6.12	328.167	-15.62	0.0642

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

**Analysis of individual merging clusters candidates.**

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

**Analysis of individual merging clusters candidates.**

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

CosmoML:Machine Learning techniques applied to the CMB.

Construction of the data set.

Unsupervised methods.

Supervised methods.

Cosmological parameters Angular distributions.

Conclusions.

Astronomy & Astrophysics manuscript no. merger1\_v3  
December 4, 2017

# I. Analysis of candidates for interacting galaxies

**A1204 and A2029/A2033**

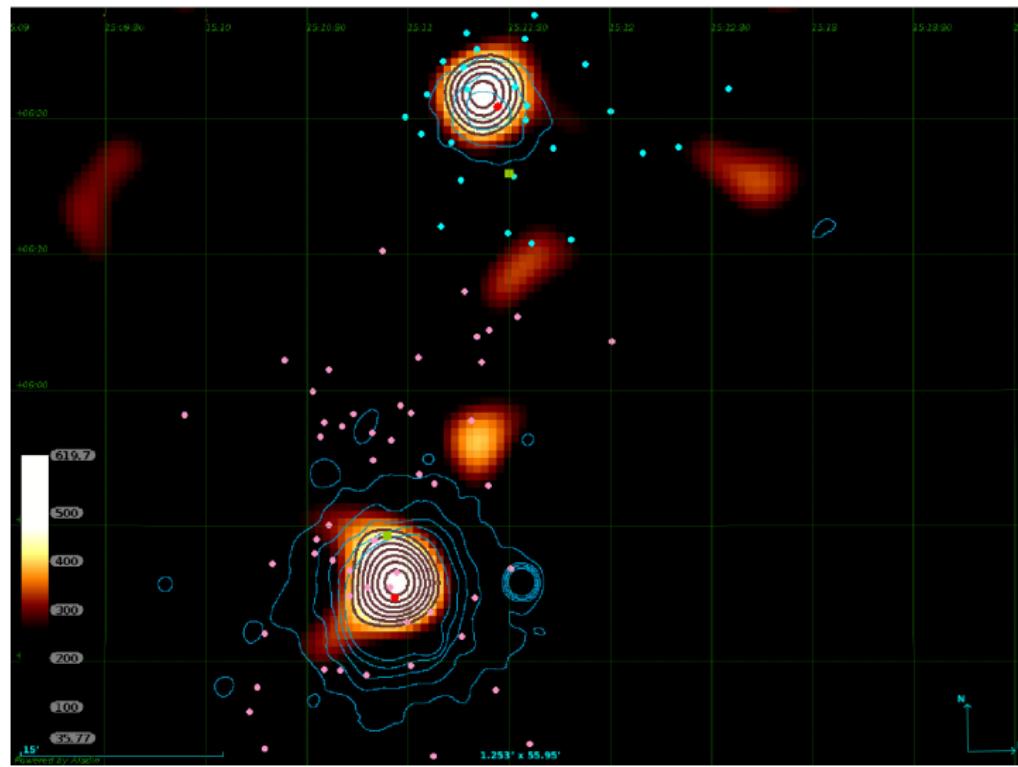
Elizabeth Johana Gonzalez <sup>★1,2</sup>, Martín de los Ríos<sup>1,2</sup>, Gabriel A. Oio<sup>1,2</sup>, Daniel Hernández<sup>1,2</sup>,  
Tagliaferro<sup>1,2</sup>, Mariano J. Domínguez R.<sup>1,2</sup>, José Luis Nilo Castellón<sup>3,4</sup>, Héctor Cuevas<sup>1,2</sup>

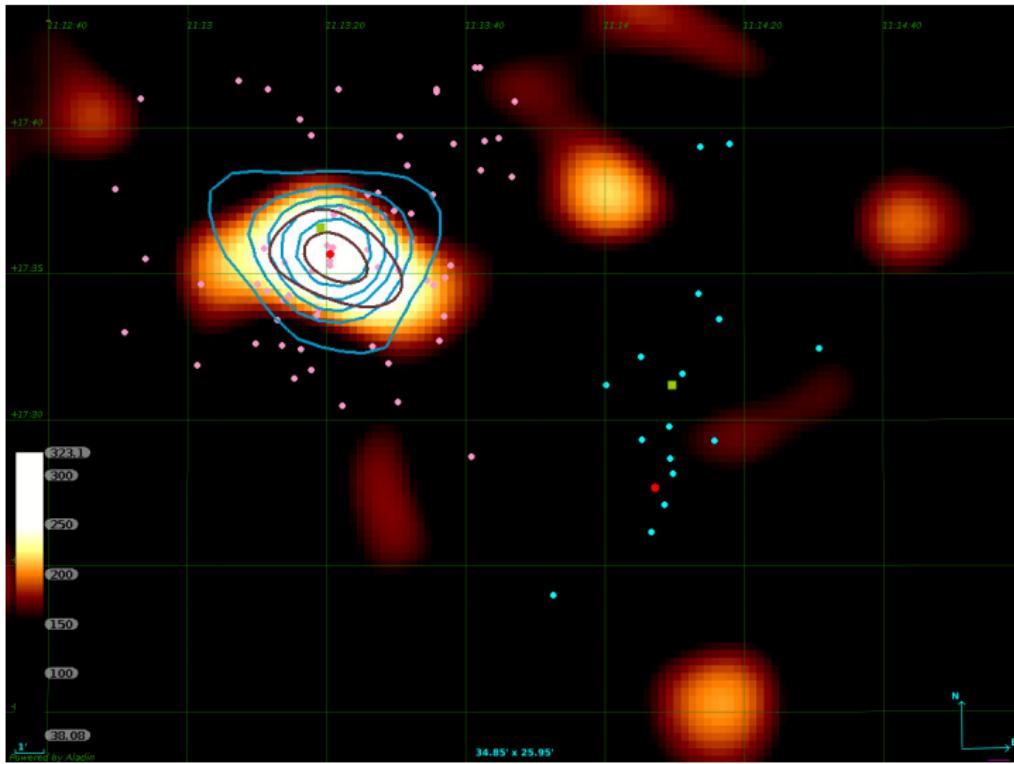
<sup>1</sup> Instituto de Astronomía Teórica y Experimental, (IATE-CONICET), Laprida 854, X5000BGR, Córdoba, Argentina

<sup>2</sup> Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina

<sup>3</sup> Instituto de Investigación Multidisciplinario en Ciencia y Tecnología, Universidad de La Serena, Bío-Bío, Chile

<sup>4</sup> Departamento de Física y Astronomía, Facultad de Ciencias, Universidad de La Serena, Av. Juan Domingo Perón 340, Casilla 196, La Serena, Chile





## II. Analysis of candidates for interacting galaxy clusters

### A267, a merging fossil group.

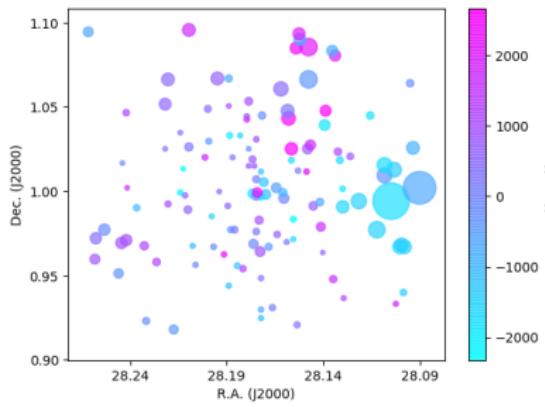
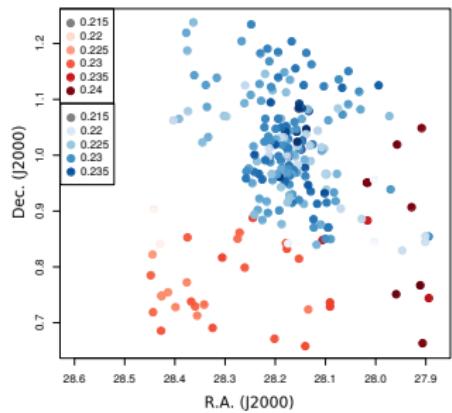
Elizabeth Johana Gonzalez <sup>★1,2</sup>, Martín de los Ríos<sup>1,2</sup>, Gabriel A. Oio<sup>1,2</sup>, Daniel Hernández Lang<sup>4</sup>, Tomás Tagliaferro<sup>1,2</sup>, Mariano J. Domínguez R.<sup>1,2</sup>, José Luis Nilo Castellón<sup>3,4</sup>, Héctor Cuevas L.<sup>4</sup>, and Carlos

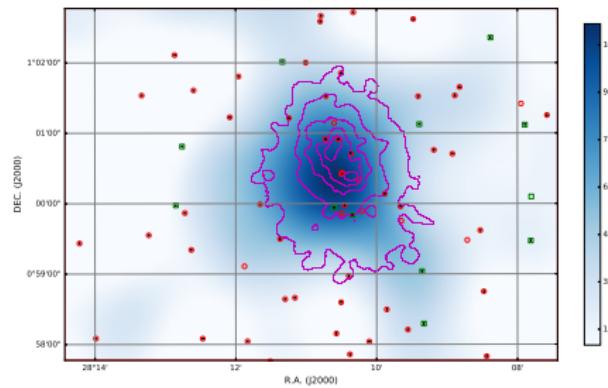
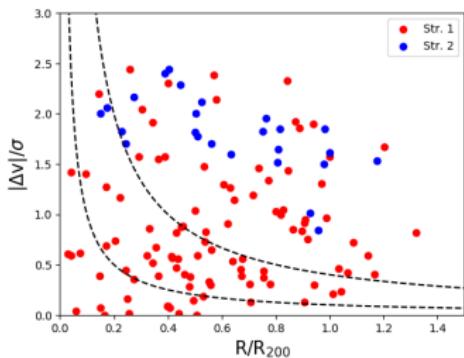
<sup>1</sup> Instituto de Astronomía Teórica y Experimental, (IATE-CONICET), Laprida 854, X5000BGR, Córdoba, Argentina.

<sup>2</sup> Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina.

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

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





MNRAS **000**, 000–000 (0000)

Preprint March 8, 2019

Compiled using MNRAS L<sup>A</sup>T<sub>E</sub>X style file v3.0

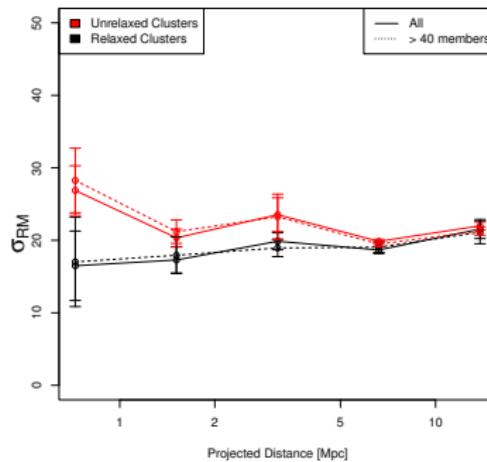
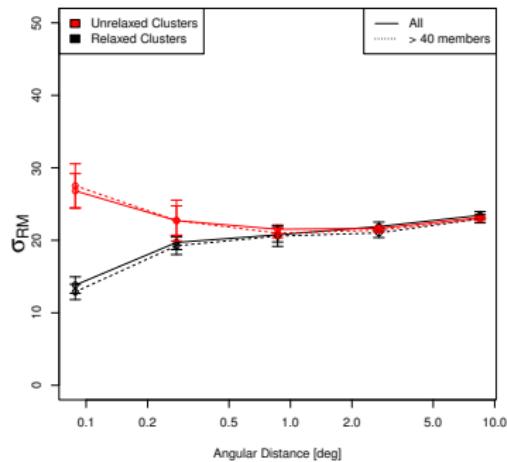
# Faraday Rotation Measure dependence with galaxy clusters dynamics

F.A. Stasyszyn<sup>1,2</sup> & M. de los Rios<sup>1,2,3</sup>

<sup>1</sup> *Instituto de Astrofísica Teórica y Experimental (IATE), Laprida 854, Córdoba, Argentina*

<sup>2</sup> *Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina.*

<sup>3</sup> *Consejo Nacional de Investigaciones Científicas y Técnicas, Rivadavia 1917, C1033AAJ Buenos Aires, Argentina.*



Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

**CosmoML:Machine Learning techniques applied to the CMB.**

Conclusions.

Construction of the data set.

Supervised methods.

Cosmological parameters Angular distributions.

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

**CosmoML:Machine Learning techniques applied to the CMB.**

Construction of the data set.

Unsupervised methods.

Supervised methods.

Cosmological parameters Angular distributions.

Conclusions.

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

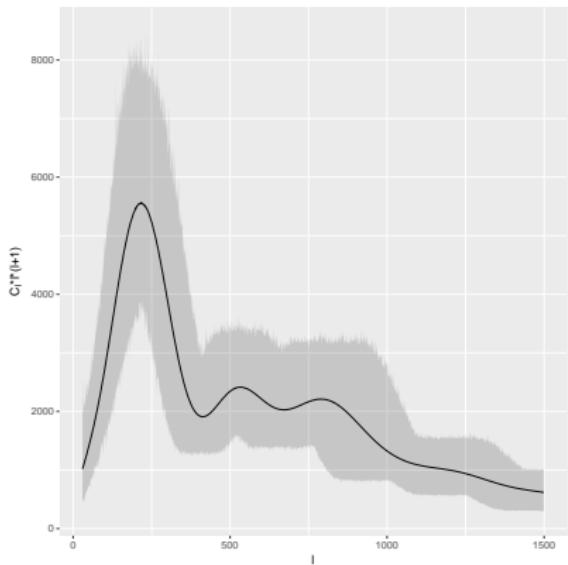
Martín de los Ríos<sup>★</sup>, Mariano J. Domínguez R.<sup>★ 1,2,3</sup>.

<sup>1</sup> Instituto de Astronomía Teórica y Experimental (CCT Córdoba, CONICET, UNC), Laprida 854, X5000BGR, Córdoba, Argentina.

<sup>2</sup> Observatorio Astronómico de Córdoba, Universidad Nacional de Córdoba, Laprida 854, X5000BGR, Córdoba, Argentina.

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

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



# Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

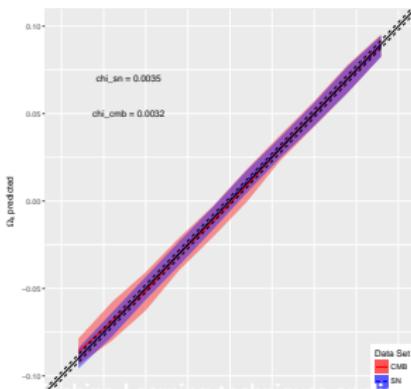
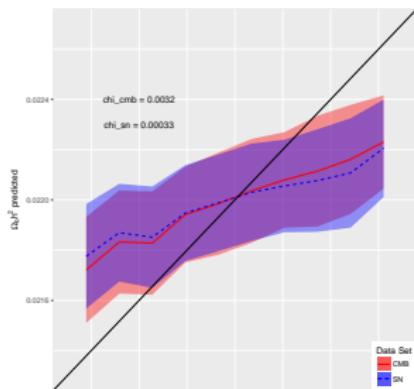
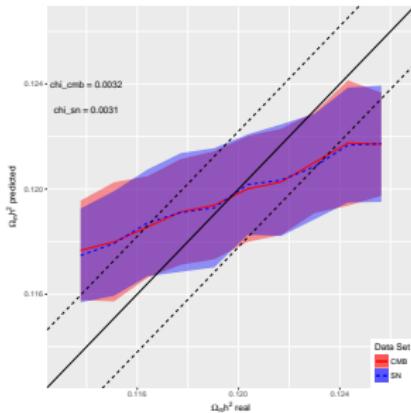
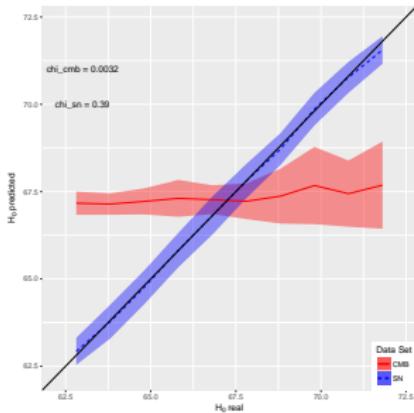
CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

Construction of the data set.

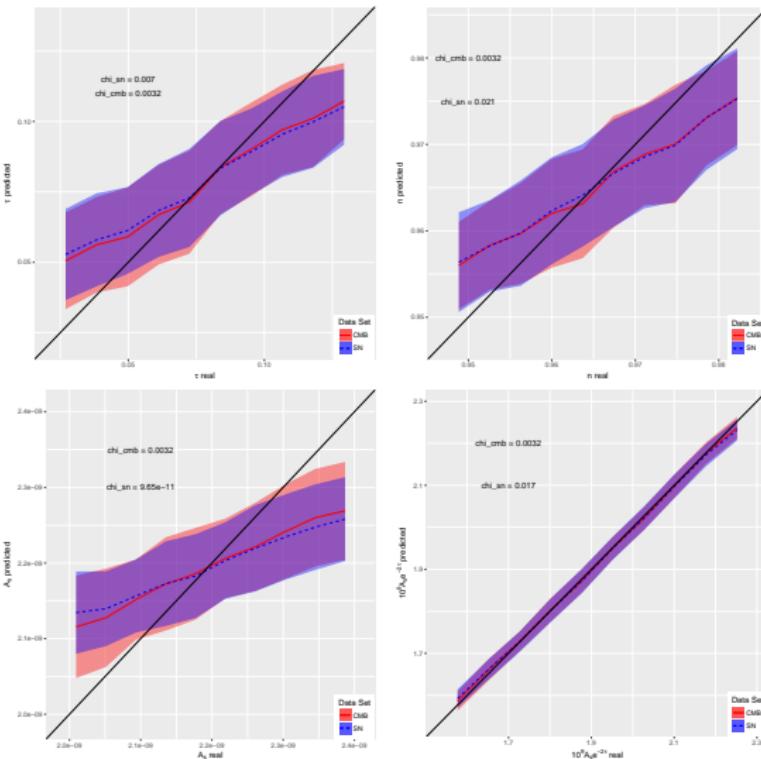
Supervised methods.

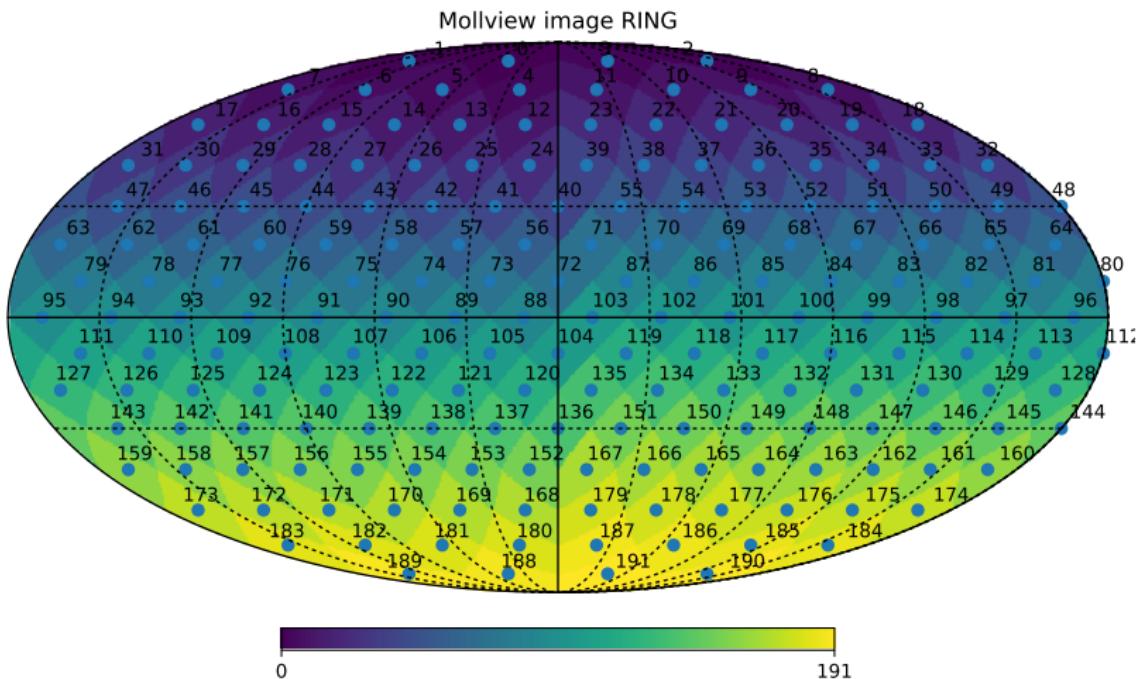
Cosmological parameters Angular distributions.



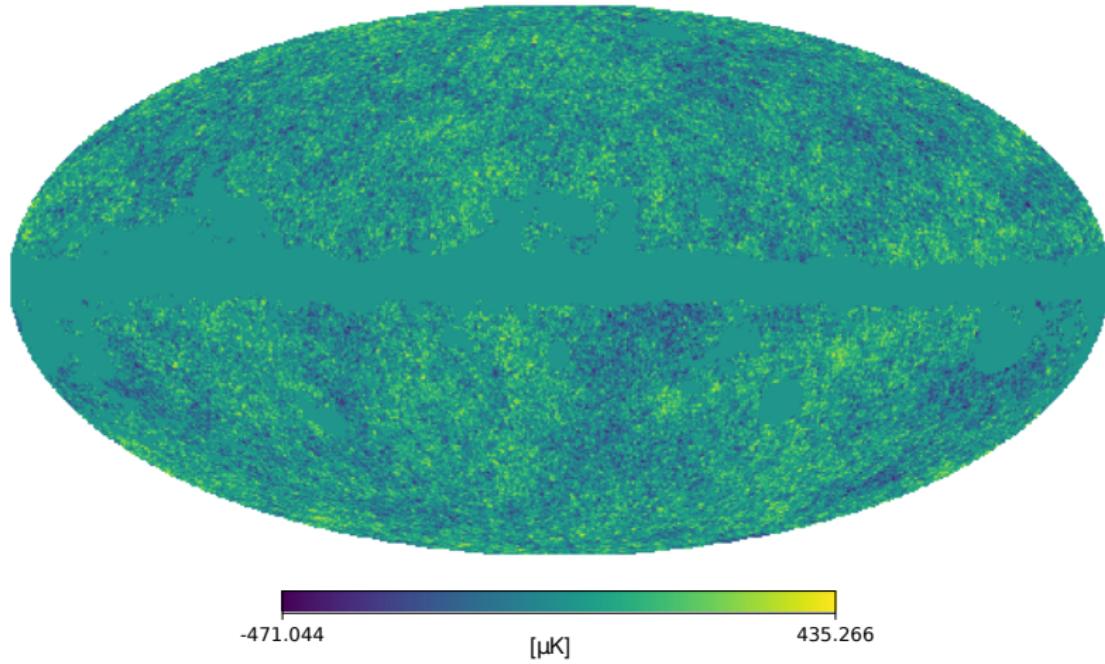
Introduction to Machine Learning techniques.  
The MeSSI (Merging Systems Identification) Algorithm.  
Analysis of individual merging clusters candidates.  
**CosmoML:Machine Learning techniques applied to the CMB.**  
Conclusions.

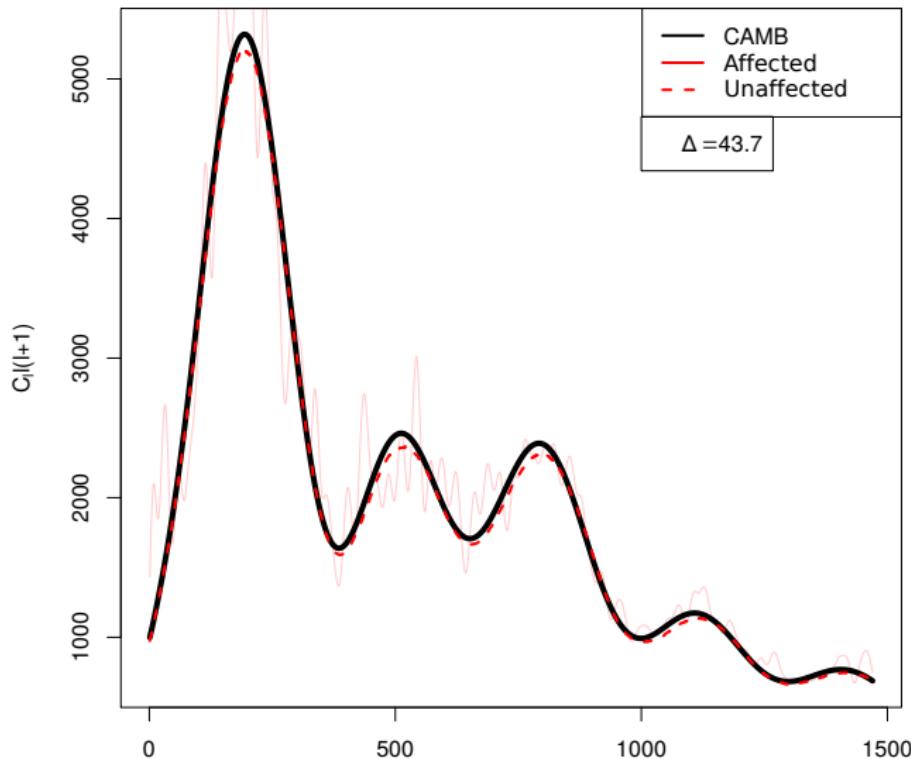
Construction of the data set.  
Supervised methods.  
Cosmological parameters Angular distributions.





Mollweide view





# Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

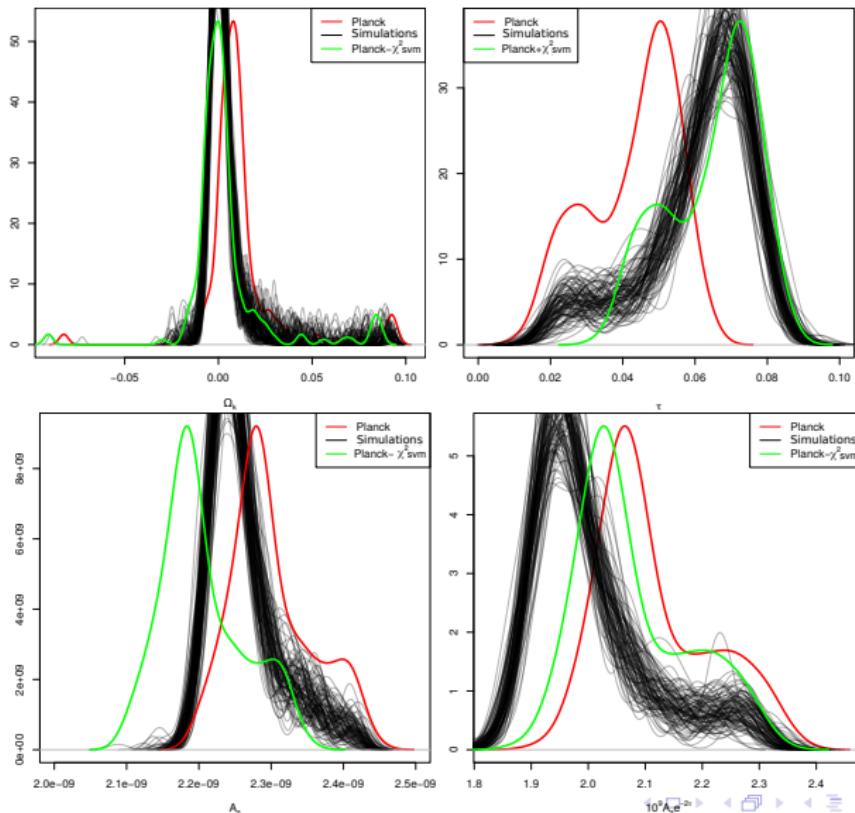
CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

Construction of the data set.

Supervised methods.

Cosmological parameters Angular distributions.



Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

A2029/2033.

A1204.

A267.

Statistical analysis of the magnetic fields in merging clusters.

CosmoML:Machine Learning techniques applied to the CMB.

Construction of the data set.

Unsupervised methods.

Supervised methods.

Cosmological parameters Angular distributions.

Conclusions.

Introduction to Machine Learning techniques.

The MeSSI (Merging Systems Identification) Algorithm.

Analysis of individual merging clusters candidates.

CosmoML:Machine Learning techniques applied to the CMB.

Conclusions.

# Muchas

# Gracias

