The Merging Systems Identification (MeSsI) Algorithm.

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June 25, 2016

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   - Study dark matter particle properties.
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   - Application of the MeSsI Algorithm to spectroscopy catalogues
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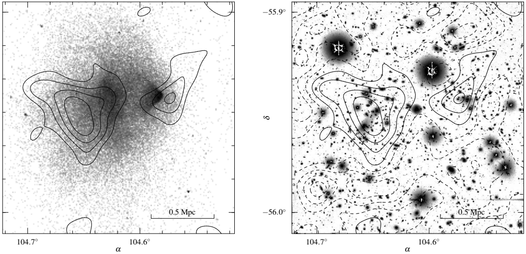
You can study dark matter particle properties



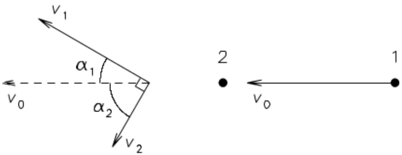
Markevitch et al. 2004

- Offset between Dark-Matter and gas.:

$\tau_s = \frac{\sigma}{m}\Sigma_s$ where σ is the cross-section, m is the particle mass and Σ_s is the superficial density of DM. The mean superficial density in $r = r_{tr}$ is $\Sigma \approx 0.2gcm^{-2}$, therefore, assuming spherical simetry and $\tau_s < 1$: $\frac{\sigma}{m} < 5cm^2g^{-1}$.

Cúmulo	$\frac{\sigma}{m}$
Bullet Cluster	$< 5cm^2/g$
Musket Ball	$< 7cm^2/g$
Baby Bullet	$< 4cm^2/g$

- The grat velocity of the secondary cluster:



$$
\begin{aligned}
\bar{p} &= m v_s \left[1 - 4 \int_{sen\alpha_c}^{1} x^2 \left(x^2 - \frac{V^2}{v^2}(1-x^2) \right)^{1/2} dx \right] \approx 0.1 m v_s && (1) \\
\frac{d(v - v_{ff})}{dt} &= \frac{\bar{p} n}{M_s} = \frac{\bar{p}}{m}\frac{\sigma}{m}\rho_m v && (2) \\
v - v_{ff} &= \frac{\bar{p}}{m}\frac{\sigma}{m}\Sigma_m && (3) \\
v - v_{ff} &< 1000 km/s && (4) \\
\frac{\sigma}{m} &< 7 cm^2/g && (5)
\end{aligned}
$$

- The survivor of the secondary cluster.

$$\chi = 1 - 2\frac{v_{esc}^2}{v_0^2} \quad (6)$$

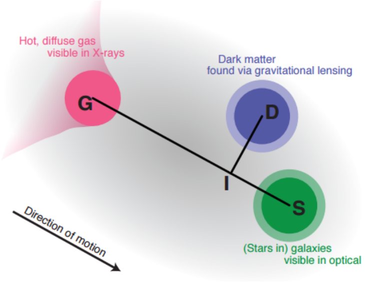
$$\tau_m = \frac{\sigma}{m}\Sigma_m \quad (7)$$

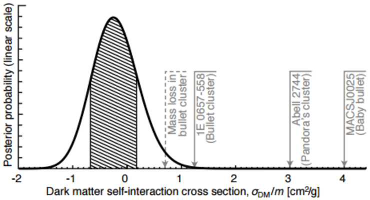
$$\chi\tau_m = \frac{\sigma}{m}\Sigma_m\left[1 - 2\frac{v_{esc}^2}{v_0^2}\right] \quad (8)$$

$$\chi\tau_m < 0.3 \quad (9)$$

$$\frac{\sigma}{m} < 1cm^2/g \quad (10)$$

Harvey et al. 2015





$$\frac{\sigma}{m} \leq 0.47 cm^2/g$$

You can test your favourite cosmological model.

- Studying the probability of finding a Bullet-like cluster.
  - Hayashi et al. 2006
  - Farrar y Rosen 2007
  - Lee y Komatsu 2010
  - Forero-Romero et al. 2010
  - Thompson y Nagamine 2011
  - Watson et al. 2013
- Hidrodynamical simulation studies.
  - Springel & Farrar. 2005
  - Milosavljevic et al. 2007
  - Mastropietro & Burket. 2008
  - Lage & Farrar 2014

The Rise and Fall of a challenger by Thompson (2014).

- They investigate the probability of finding such a high-velocity pair in large-volume N-body simulations, particularly focusing on differences between halo finding algorithms.
- When employing the Rockstart (Behroozi et al 1013) halo finder that considers particle velocities, they find numerous Bullet-like pair candidates that closely match not only the high pairwise velocity, but also the mass, mass ratio, separation distance, and collision angle that have been shown to produce the Bullet Cluster.
- The probability of finding a massive, high pairwise velocity pair among halos with $M_{\rm halo} \geq 10^{14} M_{\odot}$ is 4.6×10^{-4} using RS, while it is $\approx 45\times$ lower using a friends-of-friends (FOF) based approach as in previous studies.

High velocity tail of Bullet like pairs.

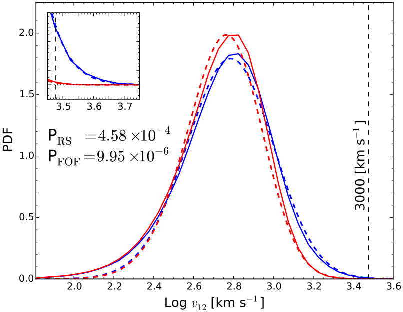
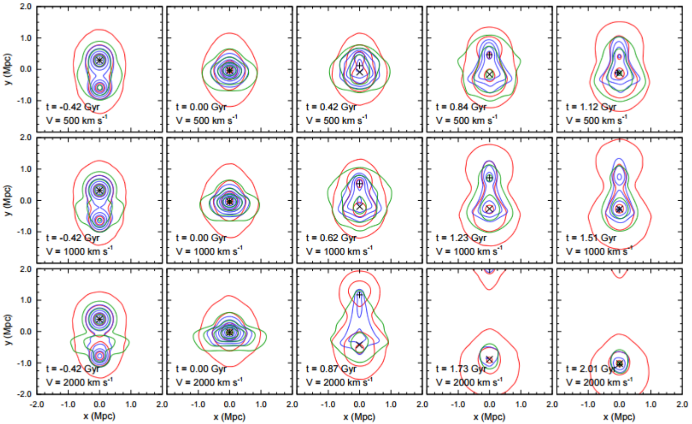


Figure : Probability distribution function of massive halo pairs in largest simulation (L4500) identified by FOF (Red solid line) and RS (Blue solid line).

You can study the ICM properties (Zhang et al. 2014).



Mass contours. SZ Emission. X-ray Emission.

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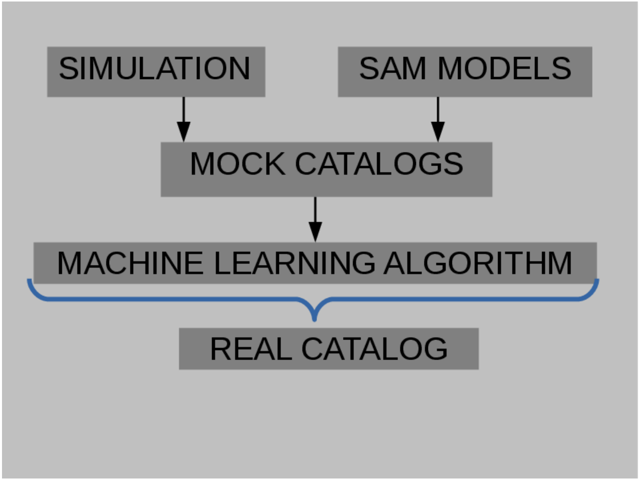
SIMULATION
SAM MODELS
MOCK CATALOGS
MACHINE LEARNING ALGORITHM
REAL CATALOG

Clusters identification.

- We construct a mock catalogue based on the results of the application of the SAM Model of Guo et al. 2010 to the Millenium simulation.

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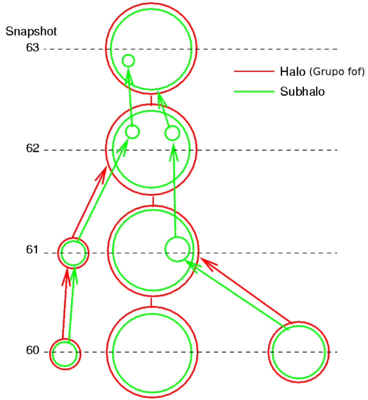
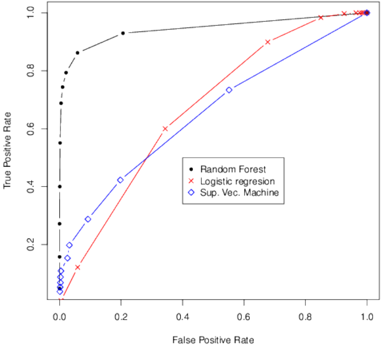
- We construct a mock catalogue based on the results of the application of the SAM Model of Guo et al. 2010 to the Millenium simulation.
- We Perform a friend-of-friend algorithm (*Merchan & Zandivares 2002*) to the mock catalog in order to identify the clusters.
- We assign each identified cluster with a fof-group in the simulation.

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.



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- After that, we estimate the velocity dispersion and the virial radius.

$$
\begin{aligned}
R_{vir} &= \frac{\pi}{2} \frac{ngal(ngal-1)}{\sum_{i>j}^{ngal} R_{ij}^{-1}} \\
\sigma &= \frac{\sqrt{\pi}}{ngal(ngal-1)} \sum_{i=1}^{ngal-1} \omega_i g_i \\
\omega_i &= i(ngal-i) \\
g_i &= v_{i+1} - v_i
\end{aligned}
\tag{11}
$$

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- We compare the virial radius of the identified substructures with the virial radius of the subhalos, finding that we are overestimating the real values.
- We compare the velocity dispersion of the identified substructures with the velocity dispersion of the associated subhalos, finding that our values are in good concordance with the real values.

With this association between substructure and subhalos in the mock, we find 3 cases:

1. Clusters where we identify the type 0 subhalo (the principal subhalo of the fof group) and a type 1 subhalo.

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2. Clusters where we identify two type 1 subhalos.
3. Clusters where Mclust find two substructures that are associated to the same type 0 subhalo.

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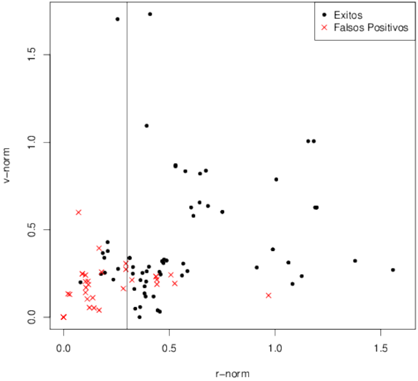
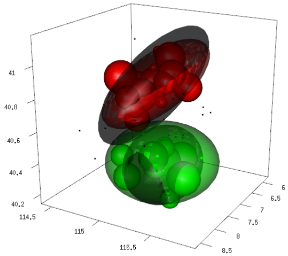
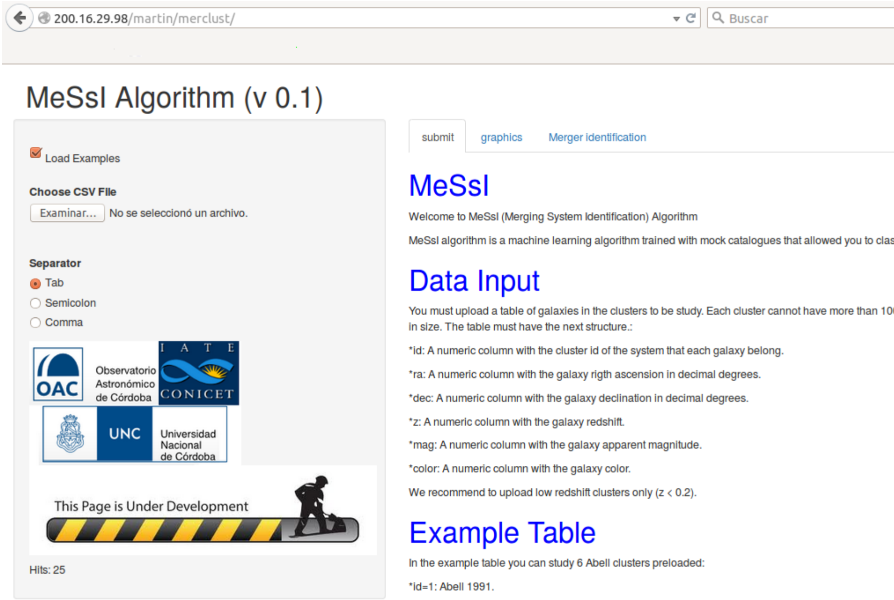


Mock Clusters



Application of the MeSsI Algorithm to spectroscopy catalogues

- We find 12 Clusters with high probability of been in a merger in the SDSS DR7.
- We find 4 Clusters with high probability of been in a merger in the WINGS Clusters.
- We find 16 Clusters with high probability of been in a merger in the HECs Clusters.


200.16.29.98/martin/merclust/
Buscar
MeSsI Algorithm (v 0.1)
Load Examples
Choose CSV File
Examinar... No se seleccionó un archivo.
Separator
Tab
Semicolon
Comma
Observatorio Astronómico de Córdoba
OAC
I A T E
CONICET
UNC
Universidad Nacional de Córdoba
This Page is Under Development
Hits: 25
submit
graphics
Merger identification
MeSsI
Welcome to MeSsI (Merging System Identification) Algorithm
MeSsI algorithm is a machine learning algorithm trained with mock catalogues that allowed you to clas
Data Input
You must upload a table of galaxies in the clusters to be study. Each cluster cannot have more than 10
in size. The table must have the next structure.:
*id: A numeric column with the cluster id of the system that each galaxy belong.
*ra: A numeric column with the galaxy rigth ascension in decimal degrees.
*dec: A numeric column with the galaxy declination in decimal degrees.
*z: A numeric column with the galaxy redshift.
*mag: A numeric column with the galaxy apparent magnitude.
*color: A numeric column with the galaxy color.
We recommend to upload low redshift clusters only (z < 0.2).
Example Table
In the example table you can study 6 Abell clusters preloaded:
*id=1: Abell 1991.

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Future Work

- Perform astrophysical test over our sample of colliding cluster candidates looking for impose some constraints on dark matter particle properties.

Future work.

- Apply the detection method to more deep real catalogs.

We will make a ligth-cone mock and re-calibrate our machine learning algorithm for high-redshift clusters.

Future Work

- Reconstruct the 3d merger with the Bayesian techniques presented by *Dawson et al. 2012*.

Future Work

- Study the physical properties of the galaxies that belong to the identified coliding substructures, ordering them in a temporal line.

Future Work

- Construct a catalog of relaxed clusters in order to study the dark matter equation of state (Serra & Dominguez 2011).


THANK YOU