The daily life in particle physics

Presentation of phd project: dark matter, supersymmetry, ATLAS, data analysis and neural networks.

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My phd project

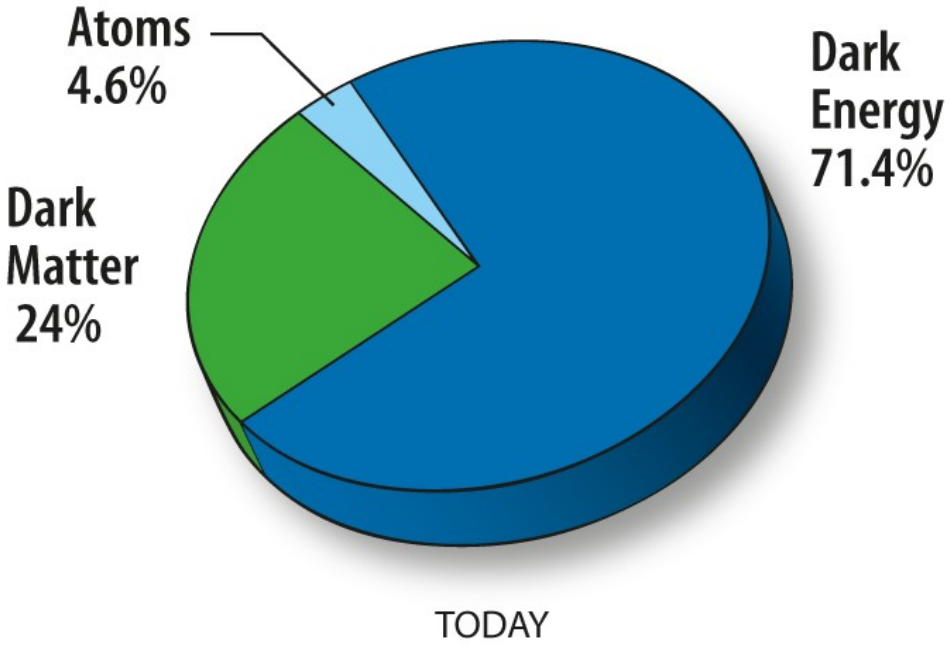
- Short summary: (try to) find out what dark matter is.
- Supersymmetry contains a very good candidate for dark matter.
- To find supersymmetry in ATLAS, we go through several petabytes of data.
- Data analysis is done with classical methods, and with machine learning techniques.
- No supersymmetry or dark matter found yet.

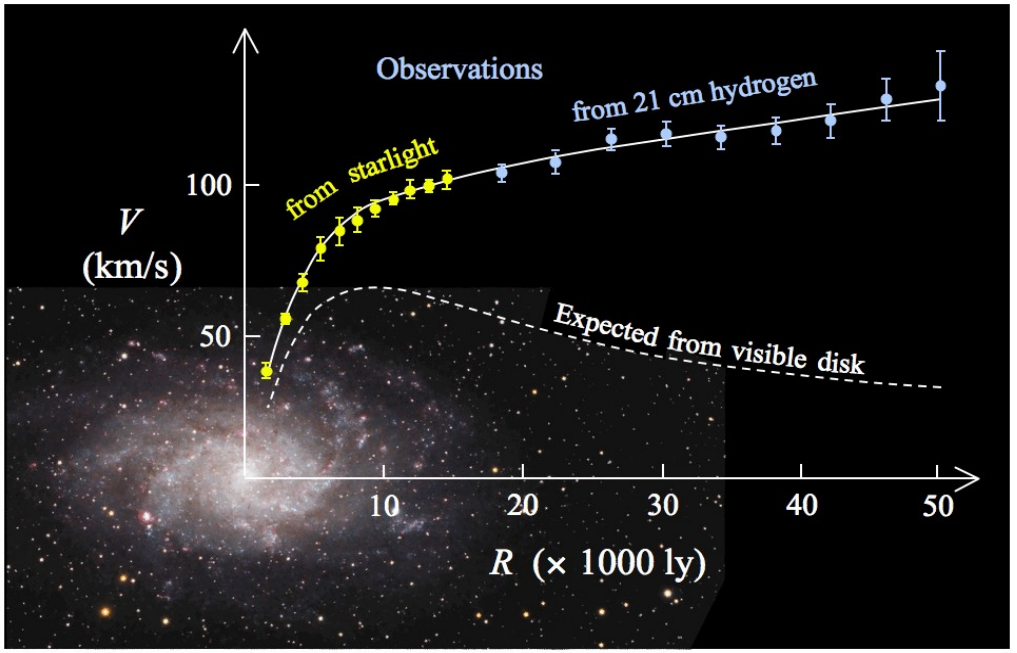
Dark matter

- Dark matter is a term for matter that clusters, and do not interact electromagnetically.
- In other words: stable, heavy, invisible matter.
- Mostly located in outer parts of galaxies, spherically distributed.
- The standard model contains no good candidates for dark matter.

Dark matter

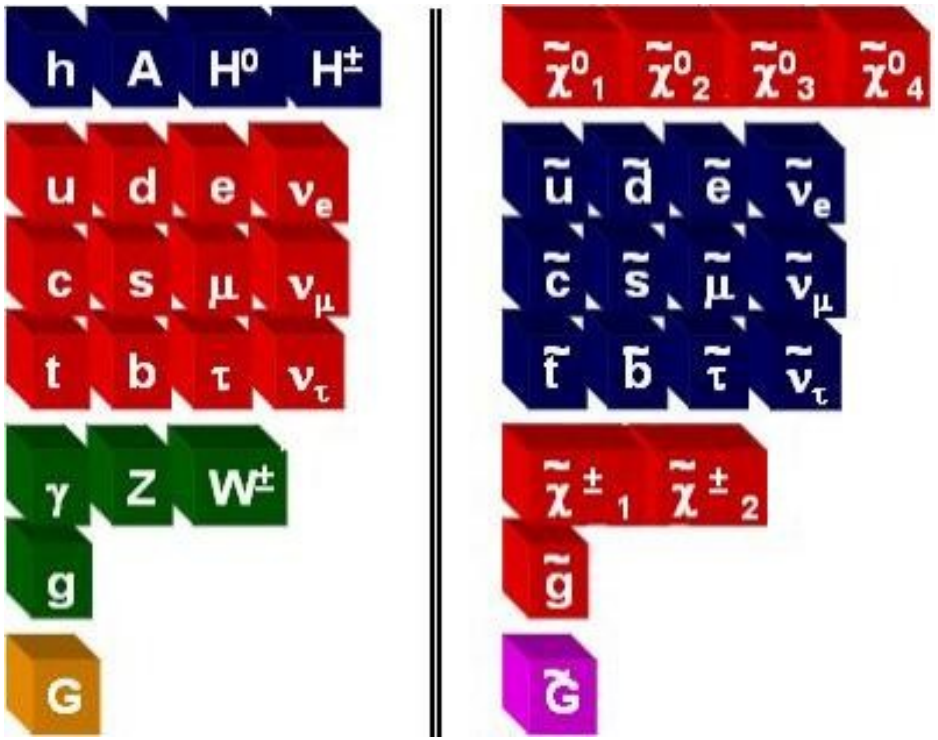
- Dark matter makes up around 24% of the total energy content of the universe today.
- Multiple evidences for the existence of dark matter, for example rotation curves of galaxies





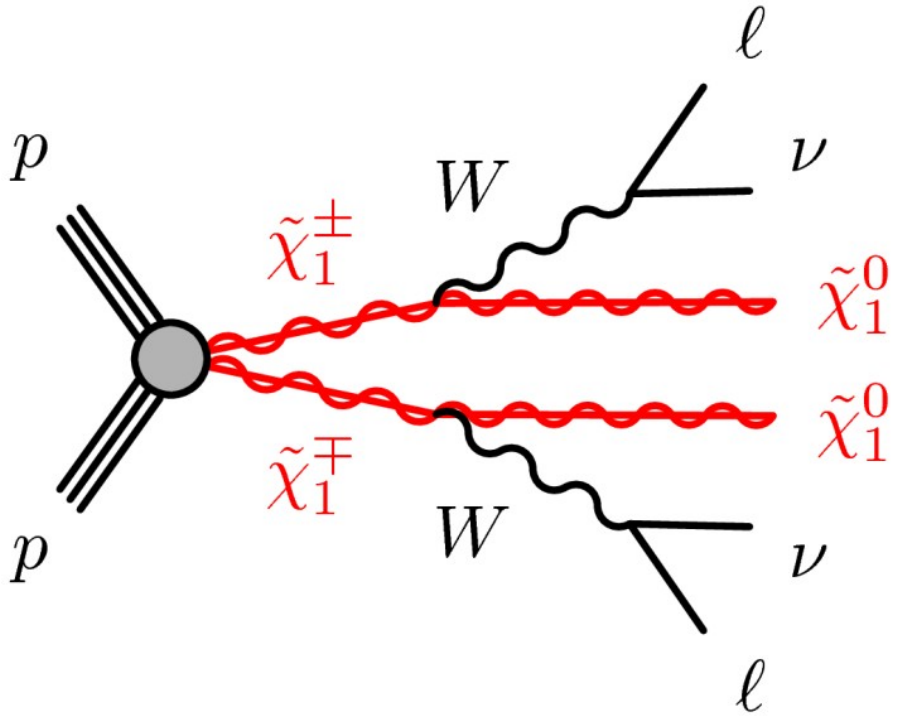
Supersymmetry

- A concept providing a symmetry between fermions and bosons.
- All standard model particles have superpartners.
- Solves the hierarchy problem.



Search for SUSY in ATLAS

- When preforming searches in ATLAS, we look for specific signatures (final states) of the processes we study.
- I am studying a model independent search of charginos decaying via W to two leptons (electrons and muons).
- The neutralinos (and the neutrinos) will escape undetected, but we can see it as missing transverse energy.



Machine learning techniques

- Machine learning techniques are used to take actions based on statistical features of the input data, without these actions being explicitly programmed.
- Also used for artificial intelligence, like in algorithms for the game Go, customer recommendations and facial recognition.
- In ATLAS, we use ML to improve our data analysis.

Neural networks

- Neural networks are grids of neurons divided into three parts: input layer, hidden layers and output layers.
- Each neuron in a layer feeds weighted inputs into all neurons in the next layer.
- These weights are adjusted by training.
- NN are slow to train, but fast to run.
- I plan to use neural network to improve my analysis in the future.