Exploring multiwavelength information for DM and astrophysics

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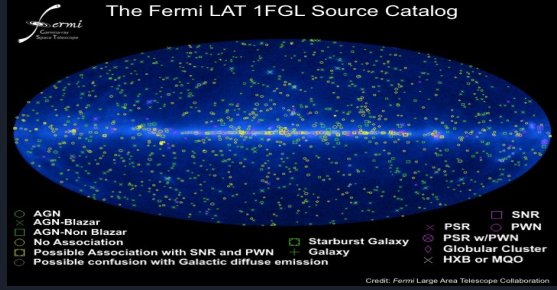
Fermi source classification with probabilistic programming



Idea and goal: Source classification with posterior predictive distributions & model selection (dark matter subhalos, millisecond pulsars in Galactic bulge). Taking into account multiwavelength information in a flexible and statistically clean way.

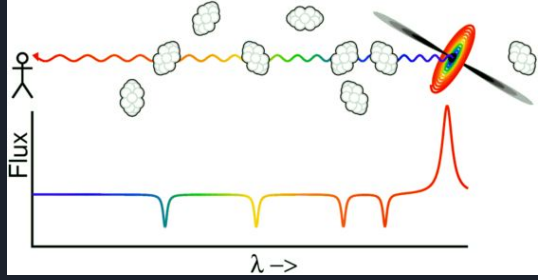
Machine learning methods: Bayesian network using `Edwardlib/tensorflow`. Variational inference (ELBO maximization). **Challenge**: Lots of observables. Requires extension of `Edwardlib` & ELBO approach to account for detection thresholds (only biased subset of sources is observed). **Method development opportunity.**

Availability of data: 4FGL Fermi source catalog (several thousand sources) + ATNF pulsar catalog.

When does it start: July. From September on MSc student will be involved, later also PhD student.

How to communicate? Slack channel (`#fermiprobprog`). Technical details on `notion.so` wiki (soon). Kick-off meeting in July.

Optimized analyses of 1-dimensional fields: Ending the reign of cold dark matter



Idea and goal: Explore new methods to analyse simple 1-dim data sets and compare with traditional power spectrum approach. Application to Lyman-alpha spectra and stellar streams.

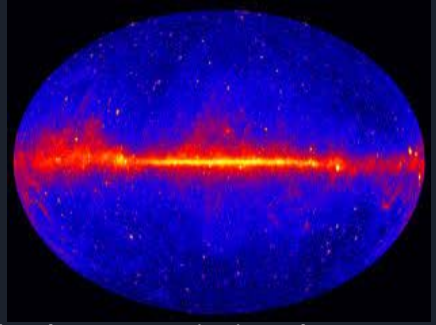
Machine learning methods: (A) Convolutional/dense neural network. (B) Transdimensional Bayesian modeling with probabilistic catalogs, generated by MCMC.

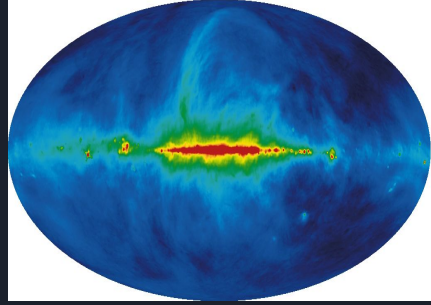
Availability of data: Training data generated based on simulations. GADGET-2 for Lyman-alpha, halo simulations for stellar streams. Start with toy models, if promising proceed to real data. **Data challenge opportunity.**

When does it start: Ly-alpha part already started (PD & PhD students). Stellar streams later this year (MSc student).

How to communicate? Slack channel (`#1dimCDM`). Technical details on `notion.so` wiki (soon). Kick-off meeting in July.

Annihilation/decay signals from DM in multiwavelength data





Idea and goal: Explore the possibility to identify whether an emission due to DM annihilation (or decay) is present in the sky maps observed at different frequencies (radio, gamma) and compare with traditional methods

Machine learning methods: Techniques inspired by hyperspectral analyses for component separation (parametric DM models, non-parametric background modeling). **Data challenge opportunity.**

Availability of data: Full-sky gamma rays maps (Fermi) at different energies; radio maps at different frequencies. Template DM signals.

When does it start: Kick-off meeting in October.

How to communicate? Slack channel (`#multiwaveDM`).