Meet the amazing Elowen !

'Neutrinos in the Multi-Messenger Era' Workshop
Poster presented on the 29th of november, 2022

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Multimessenger ! Study of AGN !

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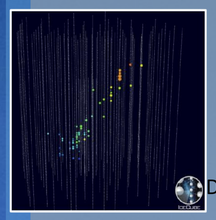
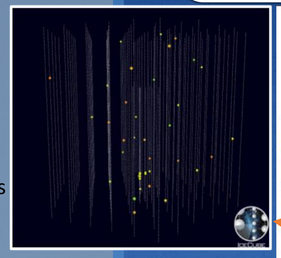
TeV



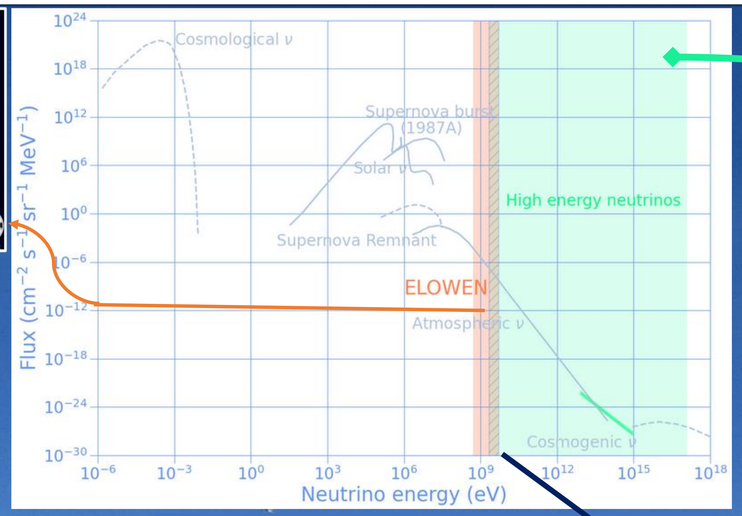
GeV

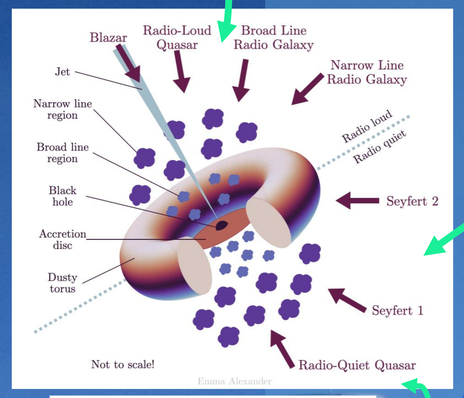


Coincidences w/o DeepCore
Coincidences in DeepCore
Causally connected hits
Hit timing & apparent velocity
Charge ratio
Depth first coincidence
Distance & delay between coincidences
Total charge

1. What kind of improvement ?

- The ELOWEN event selection targets neutrinos with an energy between 500 MeV and 5 GeV.
- The goal of this project is to optimize the passing conditions for each variable





https://emmaalexander.github.io/resources.html

«Cooperation zone»

1. Overview : AGN at the « multifrontier »

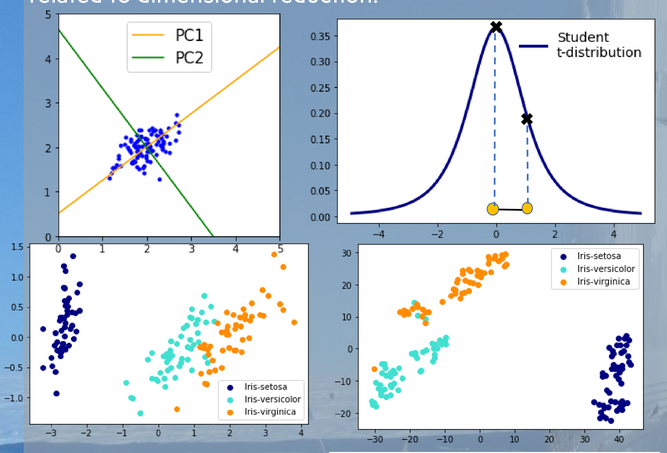
AGN = Active Galaxy Nuclei

- (Well-known) Wide **EM** spectrum (1)
- (Evidence) **Neutrino** sources (2)
- (Hypothesis) **GW** factories (3) → ~10% - 50% of GW (4)

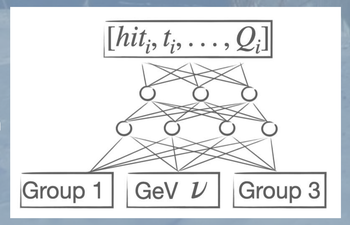
➔Perfect targets for multimessenger astronomers !
➔« **New physics** laboratories » candidates
➔Probing for unknown astroparticles **acceleration mechanisms**

2. How to optimize the passing conditions ?

-Data analysis : comparing the efficiency of supervised and unsupervised tools.
- Unsupervised tools : PCA and t-SNE related to dimensional reduction.

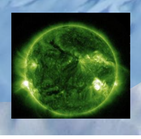


- Supervised tools: linear models, decision trees and boosted decision trees as well as networks



3. Outcomes and prospects

- Reject most of the detector noise while keeping as many GeV neutrinos as possible
- Use the new event selection to probe neutrino emission from solar flares, compact binary mergers and gamma ray bursts



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Improving

Working with IceCube Neutrino Observatory at UCLouvain

Exploring

2. Data sets : A question of diversity

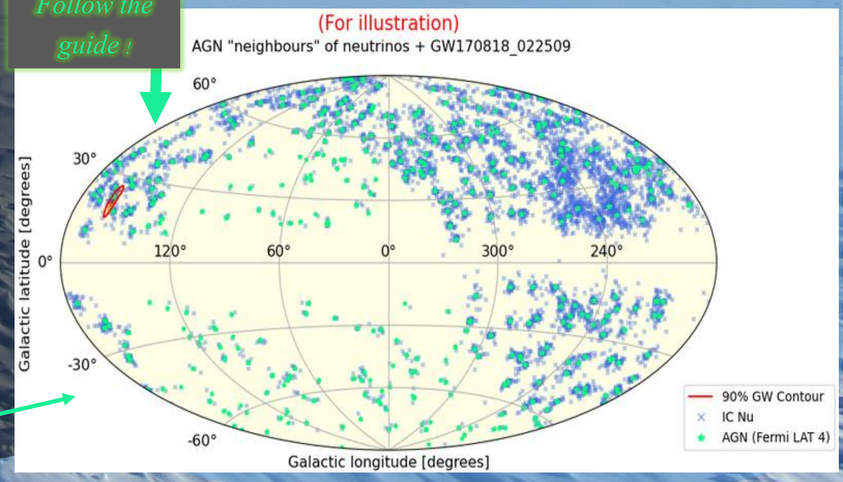
- **Fermi LAT** 4th AGN catalog (5)
- **IceCube** « 2008-2018 point sources catalog » (6)
- **ANTARES** « 2007-2017 point sources catalog »
- GWTC 3 & 2.1 (**LIGO + Virgo**) (7)

+ (Potentially) WISE, eRosita, ...

⚠ Diversity is essential for MM studies : Energy scales, events hidden to some detectors, resolution, ...
+ Statistical confidence requirements

3. A very first glimpse at the AGN Multi-verse !

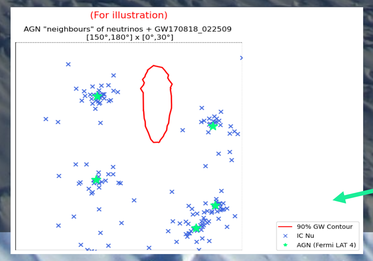
Follow the guide !



4. Forecasts & Expectations

- Searching for **correlations** (mainly : space-time & energies) at local and « overall » levels
- Biggest **hope** : Such correlations exist

➔ Quality improvements following detectors, pipelines & software upgrades + launching of new ones (KAGRA, LISA, Hyper-K, ...)
➔ Beginning of **deeper searches** :
- Origin of these correlations ?
- Enlarging knowledge about AGN
- Other candidates for MM ?
- Gravitational-based acceleration mechanism(s) ?



Refs about ELOWEN :

(1) Phys. Rev. D 103, 102001 (2021) : https://arxiv.org/abs/2101.00610

(2) Scikitlearn PCA : https://scikit-learn.org/stable/modules/decomposition.html#principal-component-analysis-pca

Multi-ref about multimessenger :

(1) Padovani, P. et al (2017). Active Galactic Nuclei: what's in a name? *Astronomy and Astrophysics Review*, *25*(1). https://doi.org/10.1007/s00159-017-0102-9

(2) The IceCube Collaboration*†, (2022). Evidence for neutrino emission from the nearby active galaxy NGC 1068. *Science*, *378*(6619), 538–543. https://doi.org/10.1126/SCIENCE.ABG3395

(3) Gröbner, M. et al (2020). Binary black hole mergers in AGN accretion discs: gravitational wave rate density estimates. *Astronomy & Astrophysics*, *638*, A119. https://doi.org/10.1051/0004-6361/202037681

(4) Yang, Y. et al (2019). AGN Disks Harden the Mass Distribution of Stellar-mass Binary Black Hole Mergers. *The Astrophysical Journal*, *876*(2), 122. https://doi.org/10.3847/1538-4357/AB16E3

(5) The Fermi LAT collaboration. The Fourth Catalog of Active Galactic Nuclei Detected by the Fermi Large Area Telescope. *The Astrophysical Journal*, *892*(2), 105. https://doi.org/10.3847/1538-4357/ab791e

(6) IceCube Collaboration (2021). *IceCube Data for Neutrino Point-Source Searches Years 2008-2018*. 51. https://doi.org/10.21234/CPKQ-K003

(7) The LIGO Scientific collaboration, The Virgo Collaboration, The KAGRA Collaboration., (2021). *GWTC-3: Compact Binary Coalescences Observed by LIGO and Virgo During the Second Part of the Third Observing Run*. *48*, 147. https://doi.org/10.48550/arxiv.2111.03606