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IUSS

Scuola Universitaria Superiore Pavia



PhD SST

Space Science
and Technology



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ISTITUTO UNIVERSITARIO DI STUDI SUPERIORI DI PAVIA
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INAF/IASF - MILAN

Morphology Analysis of Young and Massive Star Clusters as Galactic PeVatrons

A. Bonollo

A. Giuliani, P. Esposito, S. Crestan,
G. Galanti, S. Mereghetti, M. Rigoselli

TOSCA Meeting
October 29th, 2024

Next-Generation IACT Telescopes

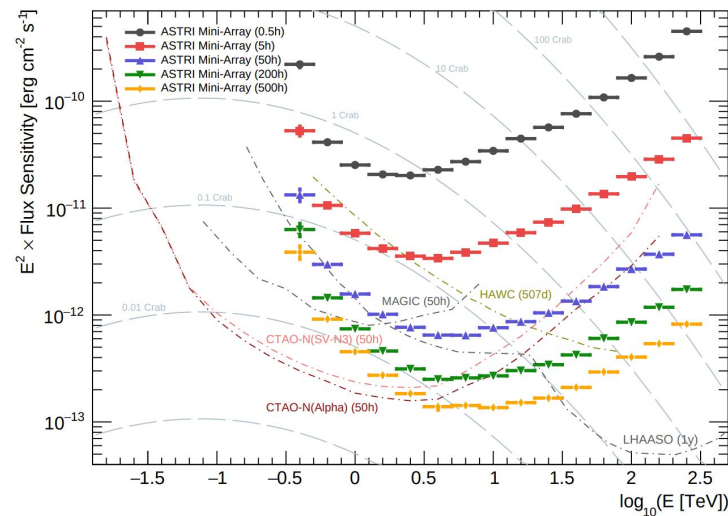


The **CTAO** (alpha configuration):

- LSTs and MSTs in the north (20 GeV - 5 TeV).
- MSTs and **SSTs** in the south (150 GeV - 300 TeV).

More than **60 telescopes** across the two hemispheres.

- ~ 5 – 10% energy resolutions.
- ~ few arcmin angular resolution.



The **ASTRI Mini-Array**:

- 9 SSTs in the north (Teide Observatory - Tenerife).

Vast discovery space **up to 100s of TeV**.

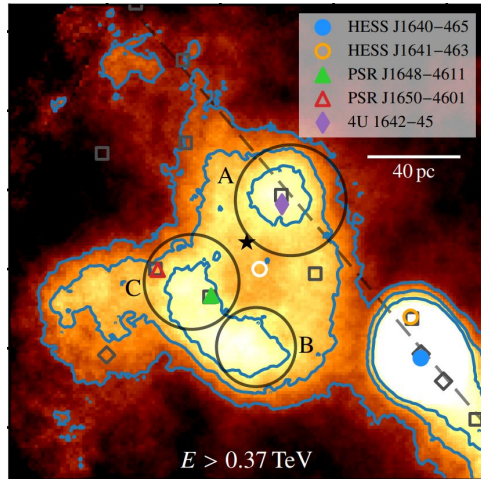
- Wide FoV.
- 3' angular resolution.



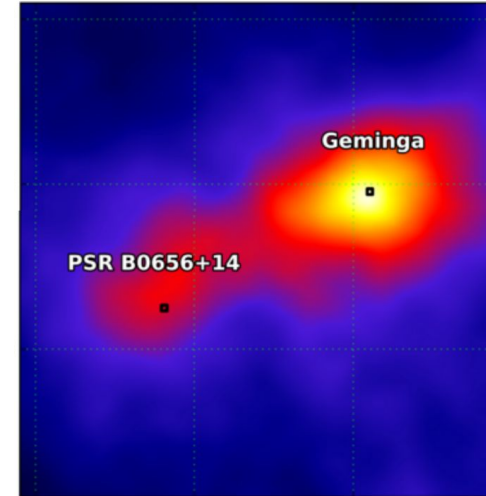
Analysis Outline



We study the morphology of known diffuse sources to define classification methodologies for unidentified sources.



- CR distribution and **gamma-ray** emission around YMSCs with model by Morlino et al. (2021).
- Gas distribution modelization
- Gamma-ray emission **simulations** with the ASTRI and CTAO IRFs.
- Morphology studies and radial **excess profile** modellization.



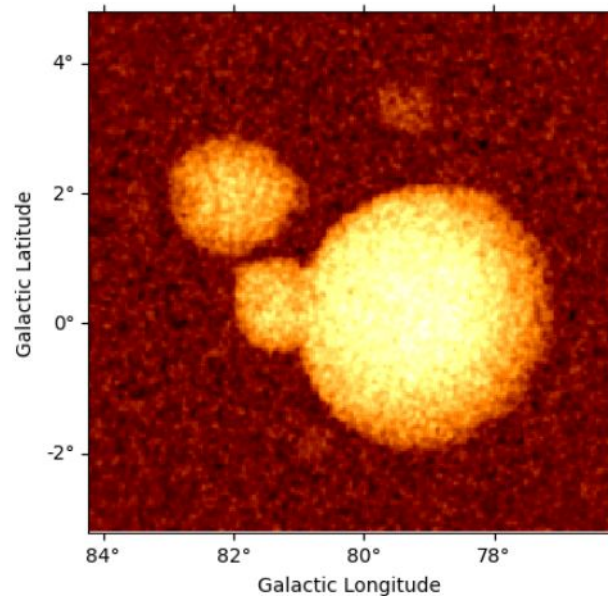
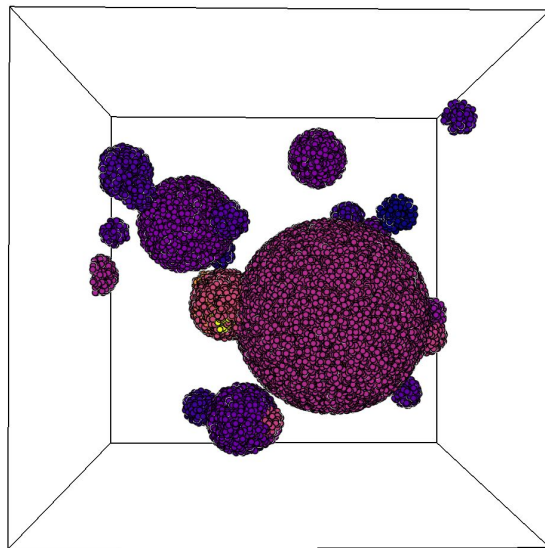
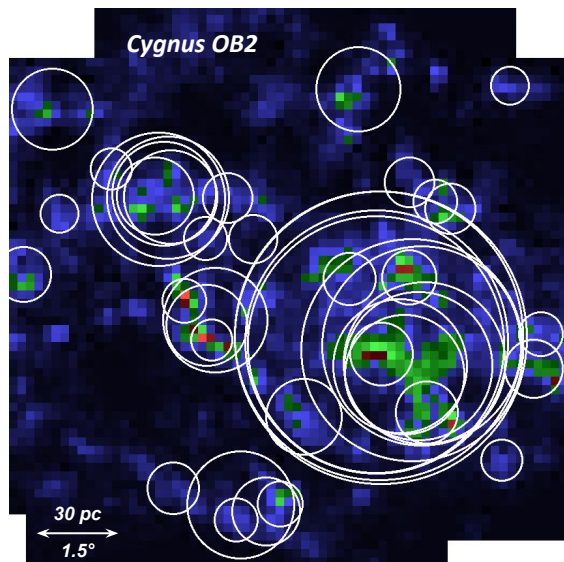
Gas Modelization



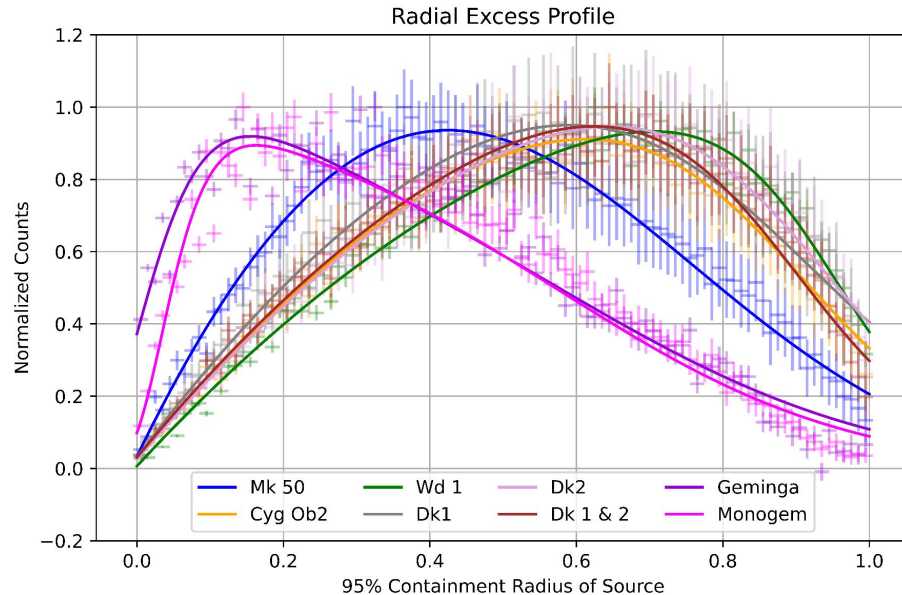
We used 3d maps to compute **density and position** of clouds.

We modelled the gas clouds as **spheres of homogeneous density**.

We used the 3d maps to generate **new source models** for the YMSC simulations.



Radial Profile Models - I



Modified Gaussian Function

$$f(x; N, x_0, a, w) = N e^{-\left[\left(1 + e^{a(x-x_0)}\right) \frac{x-x_0}{w} \right]^2}$$

Polynomial-Asymmetric Function

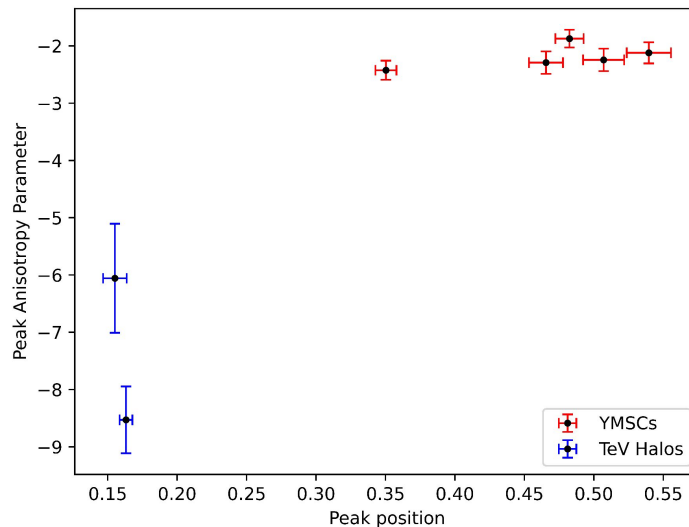
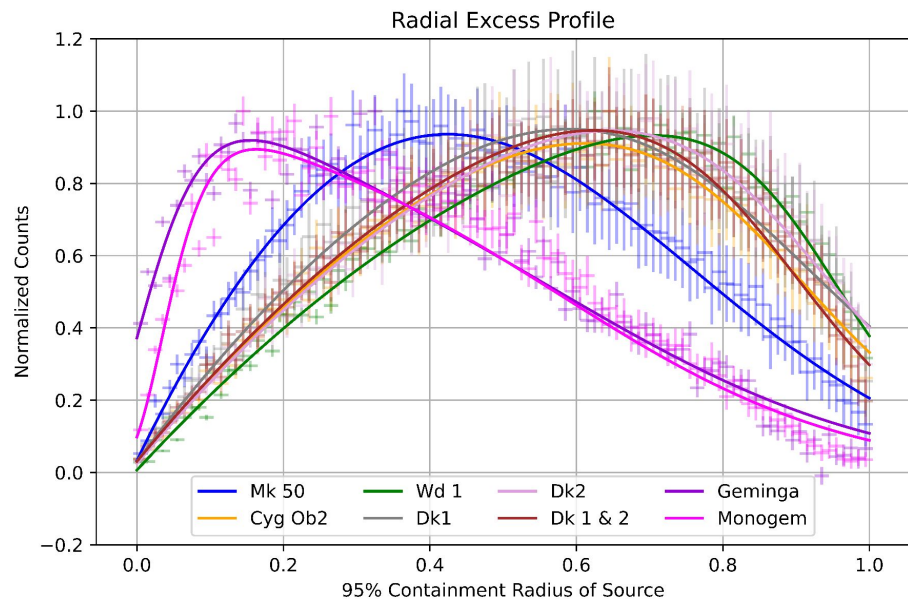
$$f(x; N, x_0, s, w) = N \left(1 - \left(\frac{x - x_0}{w} \right)^2 \right) \frac{1}{1 + e^{\frac{x-x_0}{s}}}$$

Parabola
Sigmoid

The relevant parameters include:

- Peak position x_0
- Curve symmetry s or a .

Radial Profile Models - II



Final Remarks



- More advanced morphology studies with **next-generation SSTs**.
- Radial emission profile fits characterize the morphology.
- YMSC models predict peculiar morphological features that can help **source classification**.

For a more complete view of the results see our poster!