Towards a New Era in Galactic Gamma-Ray Astronomy

Henrike Fleischhack[1]

[1] hfleisch@mtu.edu

Abstract

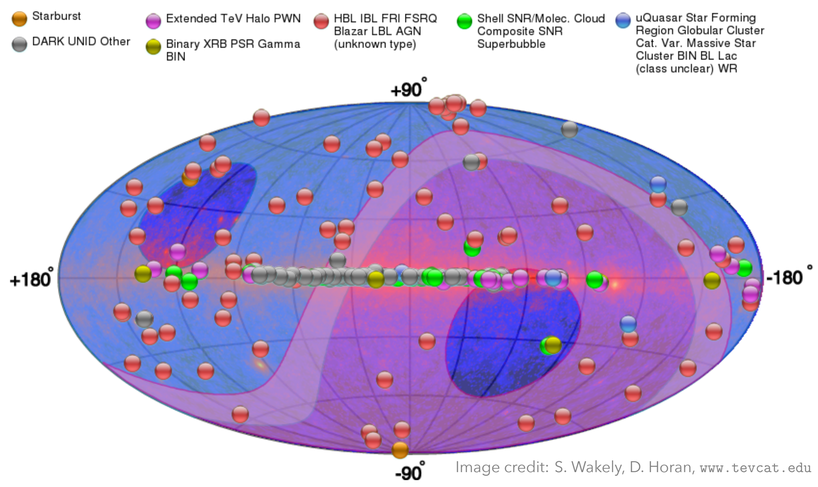
The field of Very-High-Energy (VHE, E>100 GeV) gamma-ray astronomy is entering an era of precision measurements. Over the last decade, innovations in instrumentation have led to a drastically improved understanding of the most energetic objects in the Universe. New results by the High Altitude Water Cherenkov Observatory (HAWC) have shown the unique insights that large-field-of-view survey instruments like HAWC can provide to the field. The recent 2HWC catalog and other publications have revealed gamma-ray emission from several large extended sources such as TeV halos surrounding pulsar-wind nebulae. Synergies between ground- and space-based survey and pointing instruments have already led to the identification of several new sources and source candidates.

In this poster, we will explore the potential of future improvements to the field: Upgrades to current instruments as well as the planned Southern Gamma Survey Observatory (SGSO) which will further improve our view of the VHE sky. These innovations will also open the door for further synergies between different instrument types. In particular, we will discuss future opportunities for Galactic astrophysics: Further study of TeV halos, the search for large extended structures such as possible counterparts of the Fermi bubbles at TeV energies, gamma-ray emission from Molecular clouds, and the search for Galactic transients.

Current and Future Ground-Based Instruments

	Latitude	*Field-of-View*	*Threshold*	*Collection Area* [m^2]
HAWC [1, 2]	19°N	2 sr	500 GeV	$5 \cdot 10^4$ ($1.6 \cdot 10^5$)
VERITAS [3]	31.7°N	0.003 sr	85 GeV	$2 \cdot 10^5$
MAGIC [4]	28.8°N	0.003 sr	50 GeV	$1 \cdot 10^5$
H.E.S.S. [5]	23.3°S	0.006 sr	30 GeV	$2 \cdot 10^5$
LHAASO [6]	29.3°N	2 sr	100 GeV	$8 \cdot 10^4$
CTA North [7]	28.8°N	0.016 sr	20 GeV	$1 \cdot 10^6$
CTA South [7]	24.7°S	0.020 sr	20 GeV	$5 \cdot 10^6$
SGSO [8]	15° to 25°S	∼2 sr	100 GeV	$\sim 2 \cdot 10^5$

The TeV γ-ray Sky



Southern Gamma Ray Observatory Concept

See also presentation by T. Weisgarber (Wednesday, 10:50 AM)

SGSO Detector

- Future γ-ray survey observatory [8, 9].
- Energy range: 100 GeV to 100 TeV.
- Wide-FoV water Cherenkov array.
- High-altitudes sites in South America under consideration.
- Complementary to HAWC & CTA.

SGSO Alliance

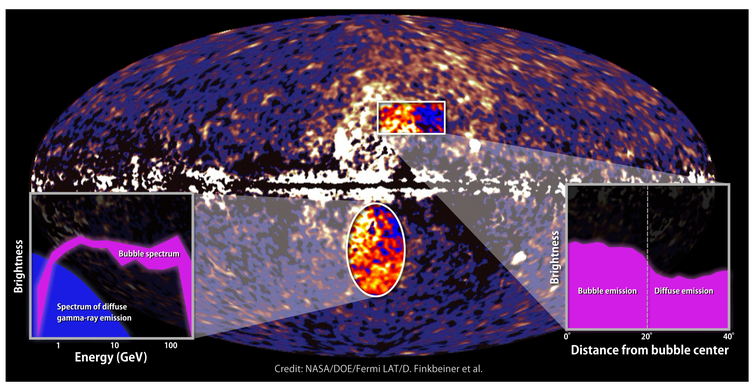
- www.sgso-alliance.org/SGSOWiki/
- Group of scientists expressing interest in designing/building a southern gamma-ray survey observatory.
- Please join if you are interested!
- No commitment necessary.

SGSO Science

Science topics include [9]:

- TeV Galactic diffuse emission.
- (Extended) Galactic sources.
- Monitoring of Galactic and Extragalactic transient sources.
- Dark matter searches.

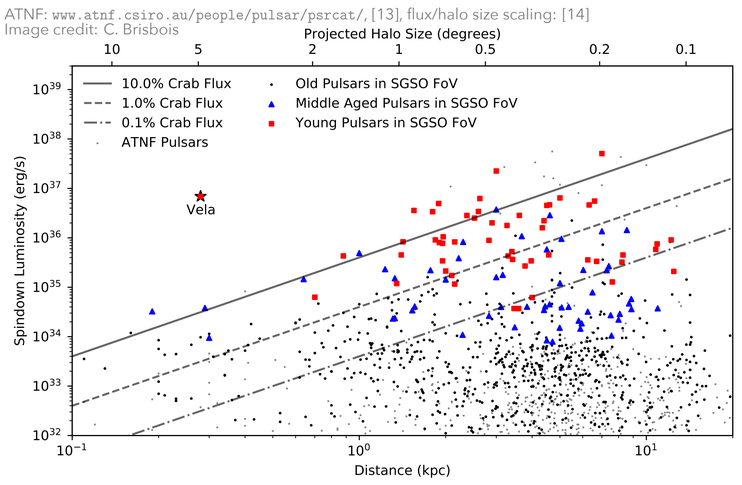
Fermi Bubbles



- Large-scale structure in diffuse γ-ray emission.
- Discovered by Fermi-LAT, hard spectrum at GeV energies [10, 11].
- Northern and southern bubble.
- Active past of the Galactic center?
- No TeV counterpart for northern bubble detected yet [12].
- SGSO will be able to observe the southern bubble.
- Detection or non-detection will constrain origin of emission.

TeV Halos

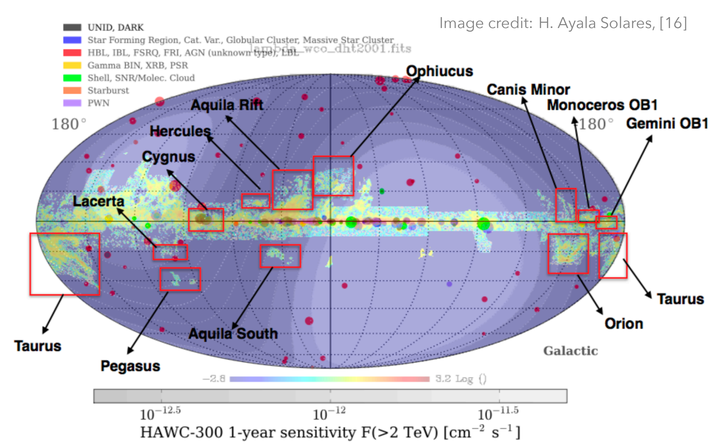
ATNF: www.atnf.csiro.au/people/pulsar/psrcat/, [13], flux/halo size scaling: [14]
Image credit: C. Brisbois



- HAWC discovered extended emission around Geminga pulsar [15].
- TeV halos more extended than the PWNe seen in X-rays.
- Prototype for new source class [14].
- SGSO will see southern pulsars.
- Evolution of pulsar halos.
- Energy-dependent profiles?
- Pulsations and TeV halo around Vela?
- Discovery of misaligned pulsars?

Molecular Clouds

Image credit: H. Ayala Solares, [16]



- Extended region of cold, molecular gas.
- Up to tens of degrees apparent size.
- Concentrated along Galactic plane.
- Passive clouds: γ-ray emission due to interactions with CR 'sea'.
- γ-ray emissivity proportional to CR flux; important tracer of CR distribution throughout the Galaxy [17].
- SGSO will have access to molecular clouds on the southern sky.

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SOUTHERN GAMMA-RAY SURVEY OBSERVATORY

Michigan Technological University