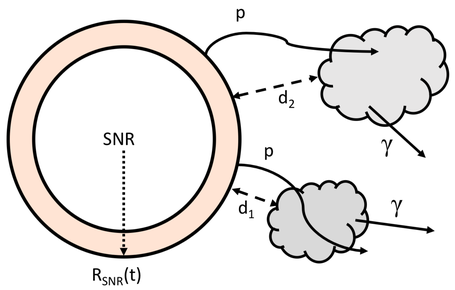
Predictions for gamma-rays from clouds associated with supernova remnant PeVatrons

A.M.W. Mitchell[1], G. Rowell[2], S. Celli[3,4], S. Einecke[2]

1 - Department of Physics, ETH Zurich, CH-8093 Zurich, Switzerland
2 - University of Adelaide, School of Physical Sciences, Adelaide SA 5005, Australia
3 - Dipartimento di Fisica dell'Università La Sapienza, P. le Aldo Moro 2, I-00185 Rome, Italy
4 - Istituto Nazionale di Fisica Nucleare, Sezione di Roma, P. le Aldo Moro 2, I-00185 Rome, Italy

14th July, 12:00-13:30 CEST, session 55, GAI



We use catalogues of SNRs, clouds and known TeV sources to predict which clouds may be gamma-ray bright due to illumination by cosmic rays. [1,4,5,6]

Model:

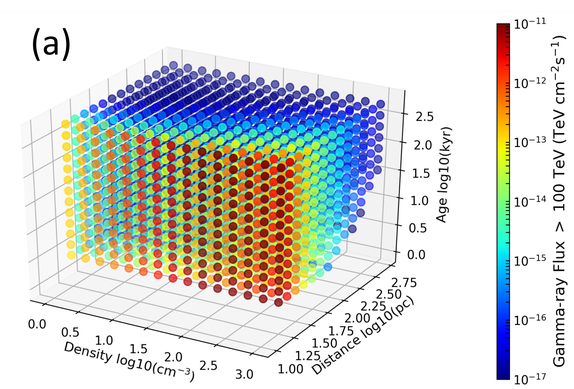
- Proton spectrum injected by impulsive accelerator [2]

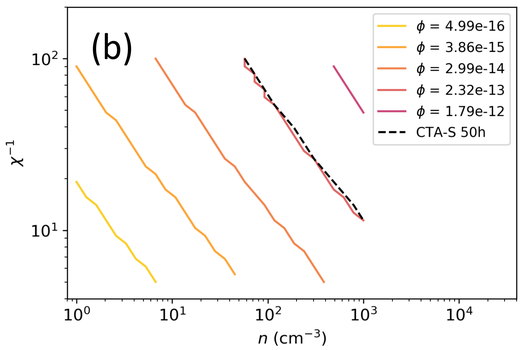
$$f(E,r,t) \approx \frac{f_0 N_0 E^{-\alpha}}{\pi^{3/2} R_d^3} \exp\left[-\frac{(\alpha-1)t}{\tau_{pp}} - \frac{(R-R_{\rm esc})^2}{R_d^2}\right]$$

- Particle escape from SNR at Resc
- Particle propagation through the ISM
- Interaction with interstellar clouds to produce gamma-ray flux [3]

$$\Phi_\gamma(E_\gamma) = c n_H \int_{E_\gamma}^{\infty} \sigma_{\rm inel}(E_p) f(E_p,r,t) F_\gamma\left(\frac{E_\gamma}{E_p}, E_p\right) \frac{dE_p}{E_p}$$

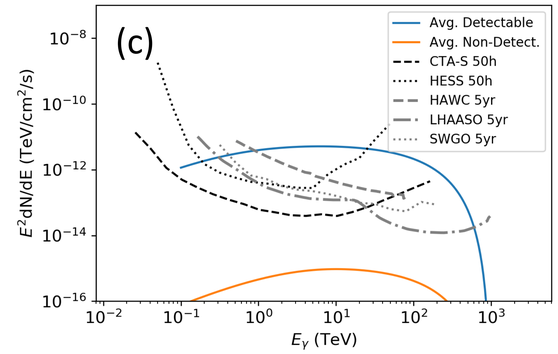
- Resulting flux depends on system properties

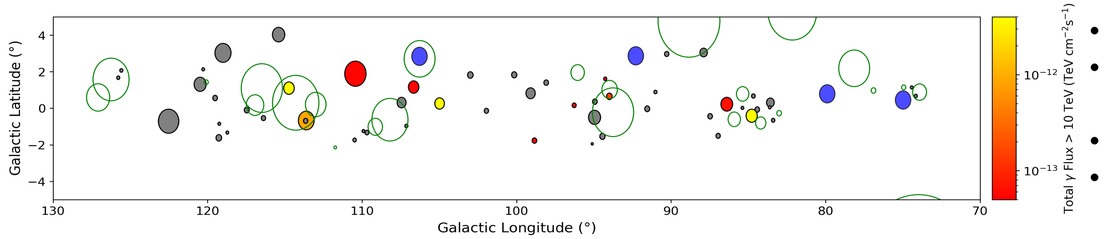




$$D(E) = \chi D_0 \left(\frac{E_p({\rm GeV})}{B(n)/3\mu{\rm G}}\right)^{\delta} {\rm cm}^2/{\rm s},$$

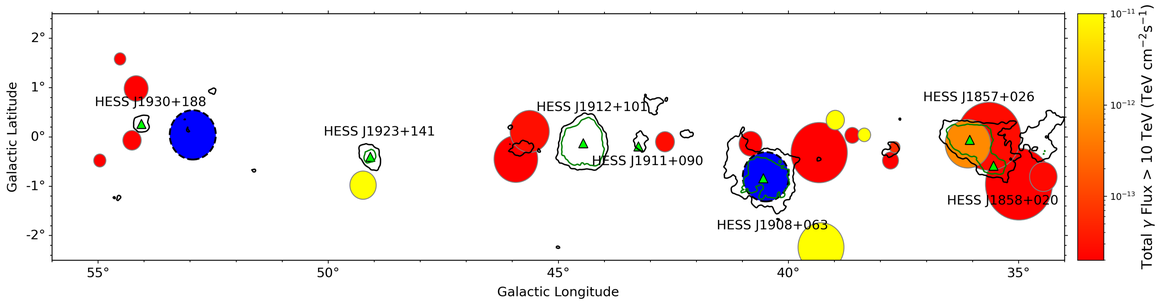
(a) Gamma-ray flux with cloud density, SNR age and cloud-SNR distance
(b) Lines of constant gamma-ray flux with cloud density *n* and diffusion properties χ
(c) Gamma-ray spectra from clouds with average properties of detectable (& non-detectable) systems

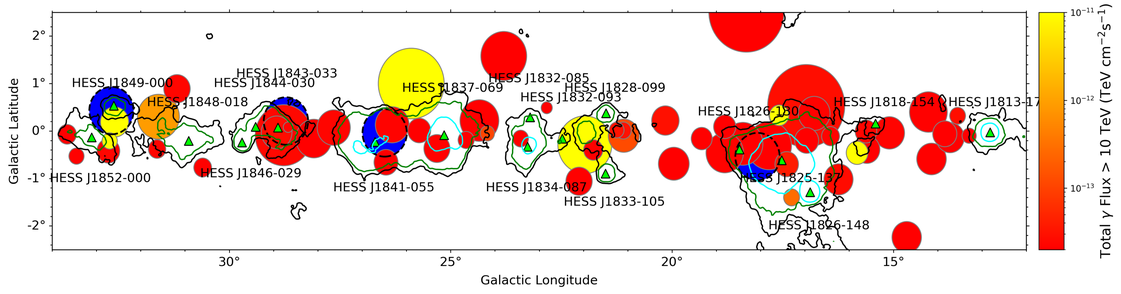




- LHAASO sources > 100 TeV in blue
- Flux prediction for clouds from our model in colour
- Contours from HGPS [4]
- Clouds overlapping with LHAASO sources are listed in the table [7]

Cloud coordinates (l, b) deg	Size deg	Distance kpc	$F_\gamma^{\rm total} > 100$ TeV TeV cm^{-2} s^{-1}	SNR	LHAASO
(17.81,-0.31)	0.3458	6.3	2.14e-16	G017.0-00.0	J1825-1326
(26.69,-0.07)	0.2018	4.01	6.96e-17	G027.8+00.6	J1839-0545
(28.67,0.08)	0.1400	6.77	1.51e-14	G028.6-00.1	J1843-0338
(32.59,0.59)	0.1722	6.23	1.09e-17	G031.9+00.0	J1849-0003





References: [1] Mitchell et al. MNRAS **503**, 3522-3539 (2021); [2] Aharonian & Atoyan A&A **309**, 917 (1996); [3] Kelner, Aharonian & Bugayov PRD **74**, 034018 (2006); [4] H.E.S.S. collaboration A&A **612**, A1 (2018); [5] Green JA&A **40,** 36 (2019); [6] Rice et al. ApJ 822, 52 (2016); [7] LHAASO collaboration, Nature **594**, 33 (2021)