

PROSPECTS FOR THE DETECTION OF ELECTRON HALOS OF MIDDLE-AGE PULSARS

Rubén López-Coto SGSO Workshop - Buenos Aires - 11/12/17

PULSAR WIND NEBULAE

PWN Evolution in a Nutshell



- Easy & independent
- R ~ t^{6/5}
- All the Crab wisdom, e.g.
 - Kennel & Coroniti 1984
 - Martín++, 2012
 - ...



- Messy & depending on SNR development
- Oscillative reverbations
- Analytically R ~ t^{0.3}
- Only over-idealized and/or numerical wisdom
 - Swaluw++ 2001,2004

 More messy & more depending on SNR dev. & surroundings

Relic stage

- R ~ undefined
- Only case-by-case wisdom

From S. Klepser

PULSAR WIND NEBULAE

PWN Evolution in a Nutshell

Free expansion				Reverse shock			Relic stage		
	2-6 SNR			kyr interaction 20-1			00 kyr?		
-	Crab Nebula 3C 58		-	HESS . HESS .	J1825 J1813-12	26	-	Geminga ???	
-			-				Mo to	ost interes study	ting
	Easy & independent R ~ t ^{6/5} All the Crab wisdom, e.g. Kennel & Coroniti 1984 Martin++, 2012	Easy & independent R ~ t ^{6/5} All the Crab wisdom, e.g. Kennel & Coroniti 1984 Martin++, 2012		 Messy & depending on SNR development Oscillative reverbations Analytically R ~ t^{0.3} Only over-idealized and/or numerical wisdom Swaluw++ 2001,2004 			 More messy & more depending on SNR dev. & surroundings R ~ undefined Only case-by-case wisdom From S. Klepse 		

"RELIC" PWNe

- Geminga is a middle-age (~300 kyr) and near (~250 pc) pulsar
- First pulsar discovered in GeV gamma rays and second strongest persistent source at GeV energies.
- In X-rays, the PWN has a bow-shock shape with an ~arcmin size

- At TeV gamma rays, Milagro reported excesses from the region.
- HAWC detected it with a ~5 deg extension, together



The PWN? in Geminga



Geminga

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The PWN? in Geminga

 ϵ_{ISM} ~2-3 eV/cm³



The PWN? in Geminga

 ϵ_{ISM} ~2-3 eV/cm³



The "Electron halo" in Geminga



Geminga by HAWC

- Detection of two very extended gammaray sources coincident with Geminga and PSR B0656+14 with ~5 deg extension
- Measured the gamma-ray spectrum between 8 and 40 TeV
- Constraint on the diffusion coefficient of the ISM
- Constraint on the contribution of these two pulsars to the positron flux at the Earth.
- Not done by HAWC: energy dependent morphology
- Paper published in Science



All-electron and positron fraction

- The positron fraction is expected to decrease with Energy
 - This is the case for energies below a few GeV

They have to be local!

- At higher energies the positron fraction increases -> There has to be a source injecting them
- The all-electron spectrum recently measured by HESS reaches ~15 TeV



Sensitivity HAWC



Sensitivity SGSO

Located at the San Antonio de los Cobres latitude

Sensitivity SGSO (<10⁶ yr pulsars)

Geminga-like candidates

Pulsars located at a similar distance as Geminga and PSR B0656.

Search for:

- Extended emission
- or Upper Limits on the electrons accelerated

Local All-electron flux

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Local All-electron flux

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Summary

- Prospects for the detection of halos of middle age pulsars with SGSO very promising.
 - All nearby pulsars with an age < 10⁶ yr would be in the reach of such observatory
- We will be able to measure the contribution of all known nearby pulsars to the local all-electron spectrum
- We can also put constrains in the emission of unknown nearby pulsars (or discover them by the gamma-ray emission of their halos).

