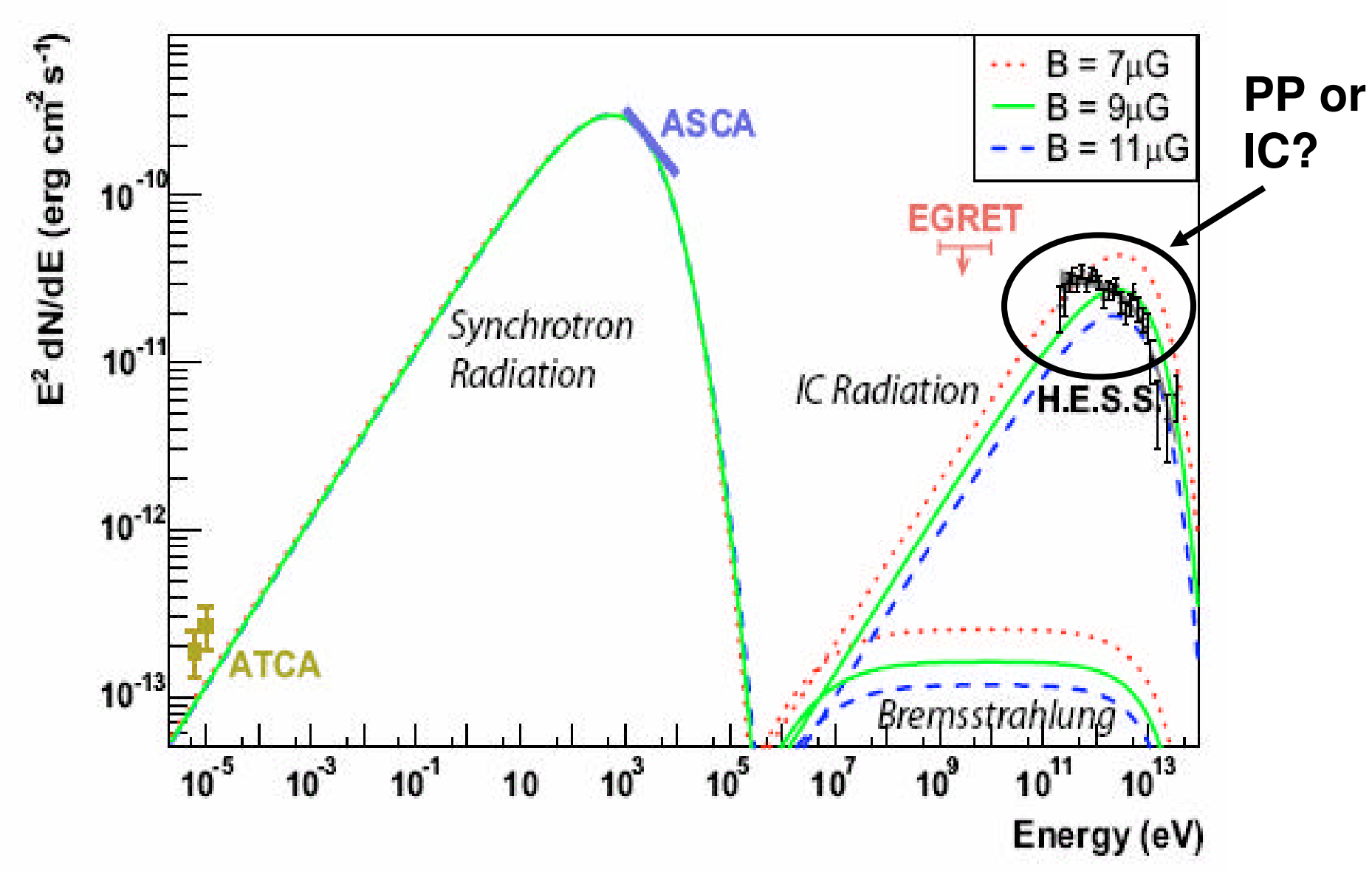
In which shell-type SNRs should we look for gamma-rays and neutrinos from p-p collisions?

Boaz Katz and Eli Waxman

astro-ph/0706.3485

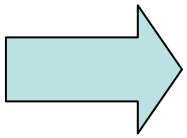
H.E.S.S. RX 1713.7-3946



Aharonian et al.(2006) A&A 449, 223

Luminosity (νL_ν) ratios

$$\frac{dN_e}{d\varepsilon_e}\Big|_{\varepsilon_e=\varepsilon_p} = K_{ep}\frac{dN_p}{d\varepsilon_p} \propto \varepsilon_p^{-p}$$



$$\text{Inverse Compton/PP} \approx 10\left(\frac{K_{ep}}{10^{-2}}\right)\left(\frac{h\nu}{\text{TeV}}\right)^{(p-1)/2}\left(\frac{n}{1\ \text{cm}^{-3}}\right)^{-1}$$

$$\text{PP/Thermal Bremsstrahlung} \lesssim 3\times 10^{-3}\left(\frac{\epsilon_p}{0.1}\right)\left(\frac{T_e}{T_p}\right)^{-1/2}\left(\frac{T_p}{\text{keV}}\right)^{1/2}$$

$$\text{PP/Syn} \lesssim 50\left(\frac{K_{ep}}{10^{-2}}\right)^{-1}\left(\frac{B}{10\mu G}\right)^{-3/2}\left(\frac{n}{1\ \text{cm}^{-3}}\right)\left(\frac{\nu}{\text{GHz}}\right)^{-1/2}$$

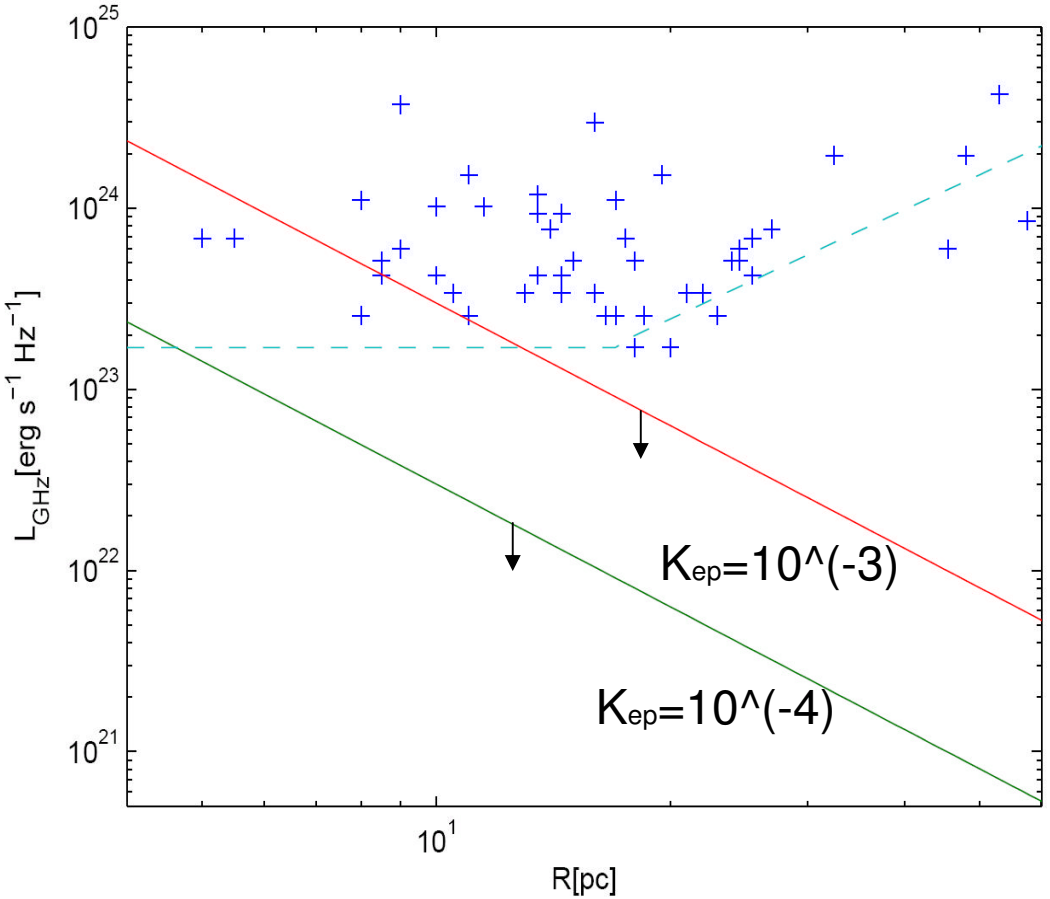
Ratio of PP to Synchrotron Emission

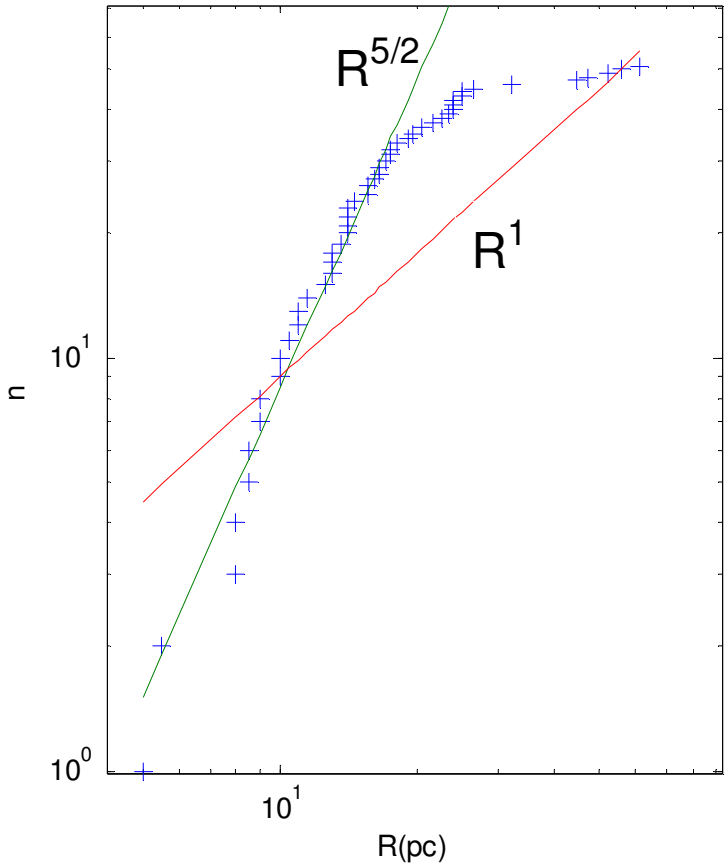
Ref.	Model	K_{ep}	n[cm^{-3}]	B[μG]	p	PP/Syn in ref	PP/Syn power-law model
1		$\approx 10^{-4}$	1	130		≈ 200	100 (for p=2)
2	PP	$\approx 5 \times 10^{-4}$	1	15	2.07	≈ 250	300
3		2.4×10^{-6}	0.2	120	2.1	≈ 300	400
3		4.5×10^{-4}	2	85	2	≈ 70	100
3		1.7×10^{-3}	0.008	6	2.4	≈ 0.5	0.3
3	IC	3.5×10^{-2}	0.01	6.5	2.4	≈ 0.3	0.15
4		10^{-2}	0.2	≈ 6	2.1	≈ 2	10

References:
(1) Berezhko & Völk (2006)
(2) Moraitis & Mastichiadis (2006)
(3) Aharonian et al. (2007)
(4) Enomoto et al. (2006)

M33 SNRs

Gordon et al. 1999,
ApJ. Supp. 120, 247

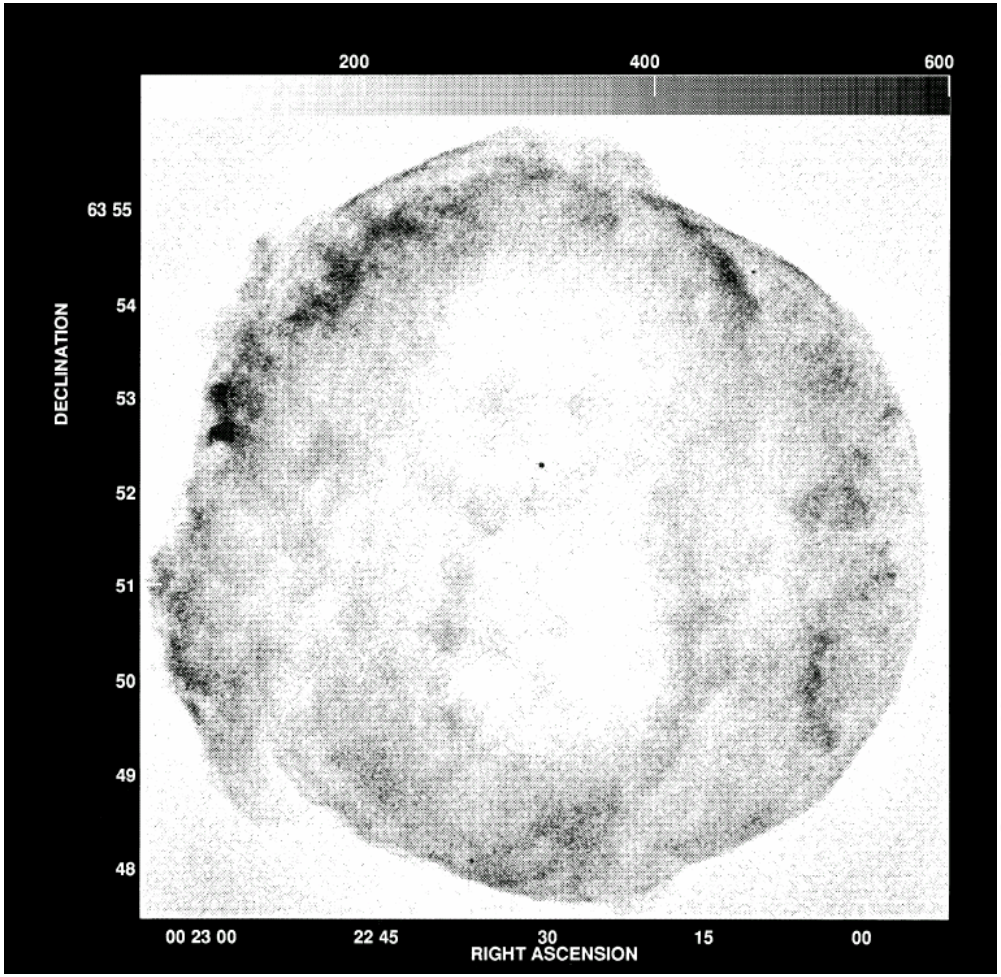




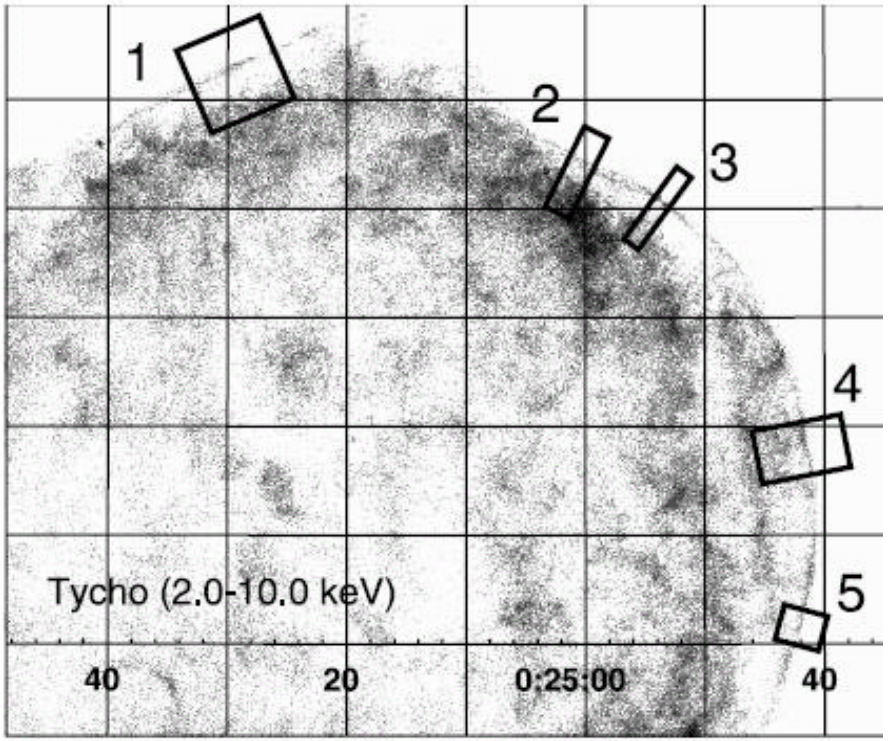
$$L_{\nu,\mathrm{Syn}}(\mathrm{GHz}) \approx 3\times 10^{24}\left(\frac{K_{ep}}{10^{-2}}\right)\left(\frac{\eta_p}{0.1}\right)\left(\frac{E}{10^{51}\ \mathrm{erg}}\right)^{7/4}\left(\frac{\epsilon_B}{0.1}\right)^{3/4}\left(\frac{R}{10\ \mathrm{pc}}\right)^{-9/4}\ \mathrm{erg\ s^{-1}\ Hz^{-1}}$$

Filaments → Large B?

Tycho SNR



Radio: Dickel et al.(1991). 101, 2151



X-ray: Bamba et al. ApJ, 621, 793

Conclusions

- **The TeV gamma-rays from RX 1713.7-3946 and RX J0852.0-4662 are not from PP collisions.**
- **Neutrino flux probably non detectable,**

$$\varepsilon_\nu f_{\varepsilon_\nu} \lesssim 10^{-12}\ \mathrm{erg\ cm^{-2}\ s^{-1}}$$

- **For finding Neutrinos and Gamma rays from PP collisions, look at SNRs with strong thermal X-ray emission.**