Diffuse neutrinos from extragalactic supernova remnants

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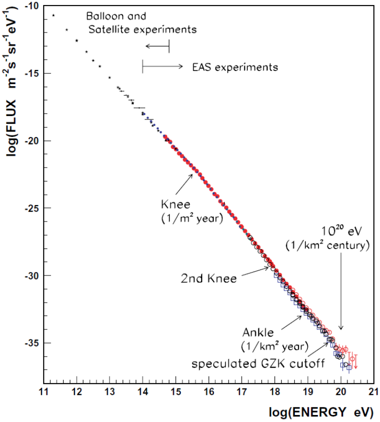
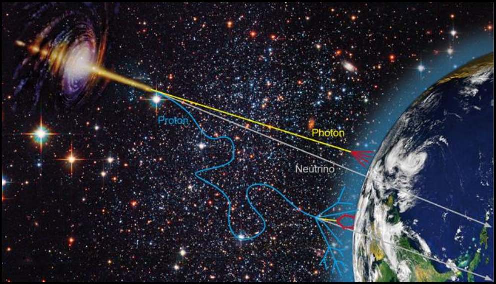
MAX-PLANCK-GESELLSCHAFT

Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

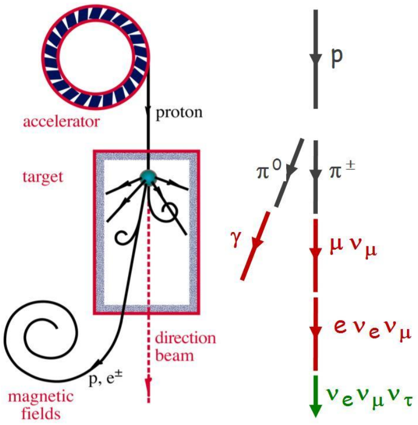
CR Spectrum


Balloon and
Satellite experiments
EAS experiments
Knee
(1/m² year)
2nd Knee
Ankle
(1/km² year)
speculated GZK cutoff
10^20 eV
(1/km² century)
log(FLUX m^-2 s^-1 sr^-1 eV^-1)
log(ENERGY eV)
-10
-15
-20
-25
-30
-35
11
12
13
14
15
16
17
18
19
20
21

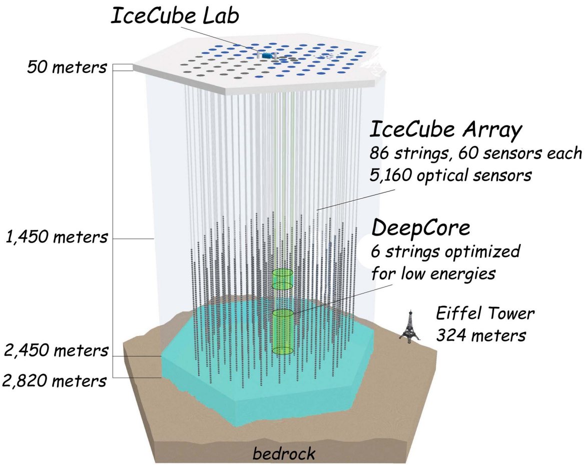
CR Spectrum



Cosmic Rays (CR)

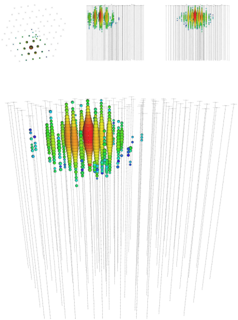


IceCube Experiment

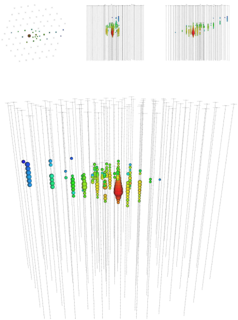


IceCube Experiment: Optical modules

IceCube results

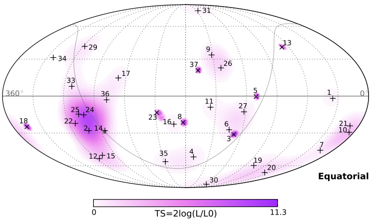


(a) Shower event

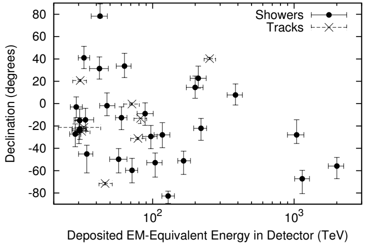


(b) Track event

IceCube results(arXiv:1405.5303)



(c)



(d)

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  - **Hypernova remnants (HNRs)**
    - Small fraction of SNRs ($1 \simeq$ %) with extreme energetic ejecta
    - Stars with $M > (50 - 80)M_{\odot}$, low metallicity (population II)
    - Capable of generating ν flux up to 1−10 PeV

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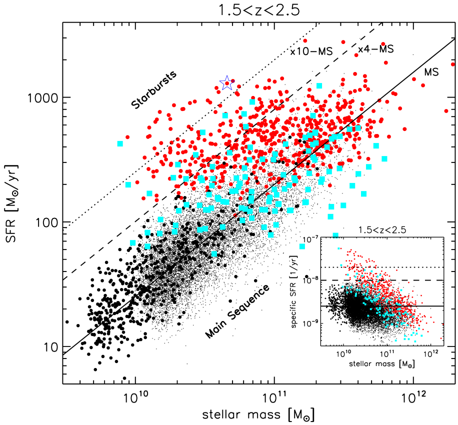
2. Star burst galaxies (SBGs)
   - Old, Metal poor galaxies (z$\backsimeq$1-2)
   - Galaxies with a high SFR
   - Relative rate of SBGs $\rightarrow$ (10-20)% of the NSFGs
   - High $n_p(n = 10^2\text{cm}^3) \rightarrow$ high efficiency for ν production

R_{SF}: Different types of galaxies



η_π:SBGs vs NSFGs

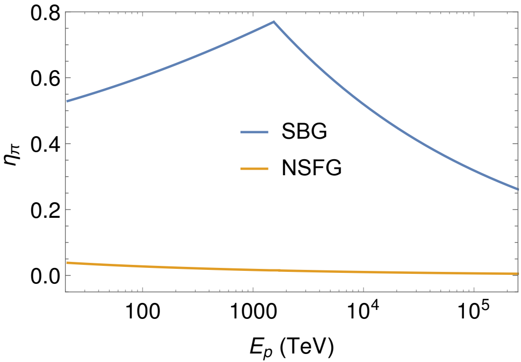
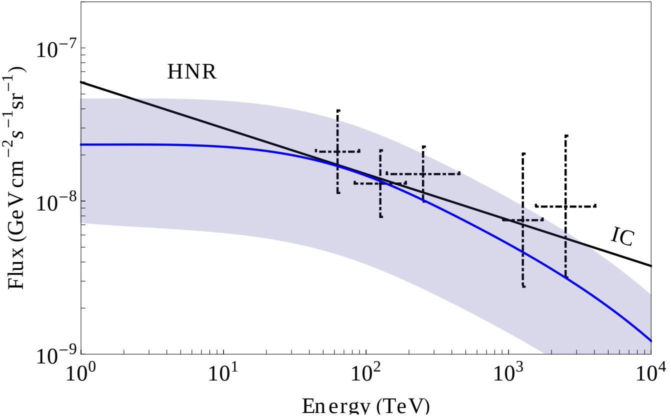


Figure: ν's production efficiency (η_π) as a function of the proton energy

SNR and HNR in NSFG's+SBG's neutrino flux



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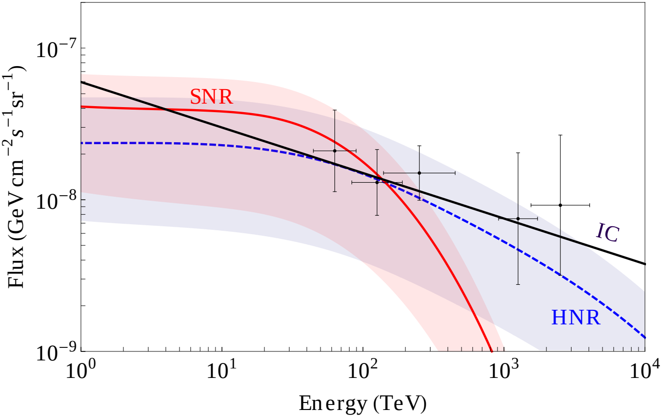

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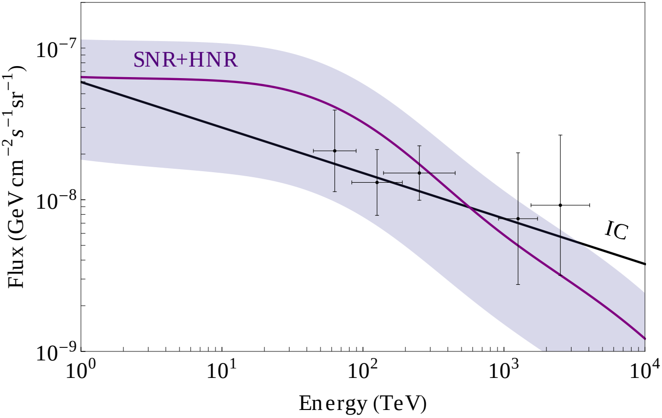

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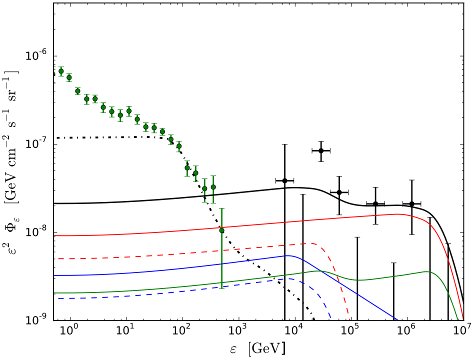
- This will introduce even more uncertainties to the resulting γ flux

γ ray background (arXiv:1501.04934)



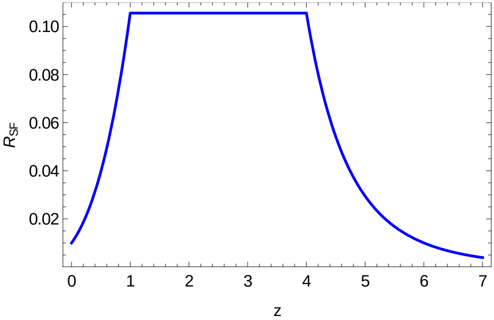
Conclusions

- Cosmic ν's are very useful to study the CR's accelerators in the *multimessenger approach*
- Diffuse neutrino flux might have a (dominant) stellar remnant origin
- The η_π will depend on the galactic environment
  - SBG's are very efficient ν producers
  - SNRs-HNRs in NSFGs-SBGs are plausible candidates
    - **The SNR-HNR in NSFGs-SBGs ν dominated flux scenario will result in a break on the spectrum**
- We (desperately) need more events!

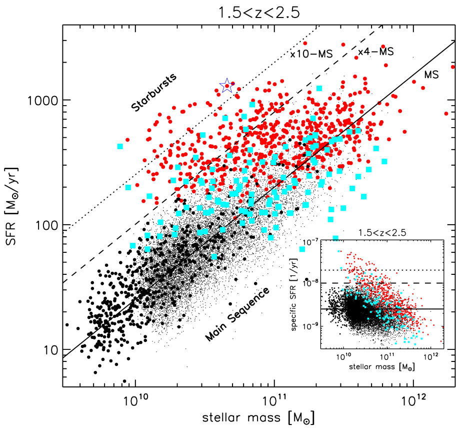
Thank you for your attention

Back up slides

R_{SF} as a function of z

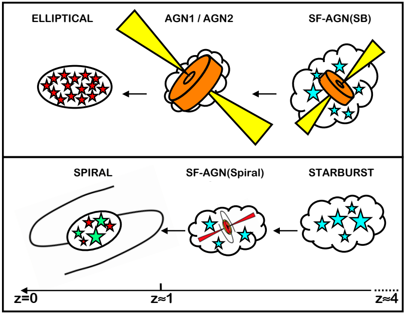


SBGs

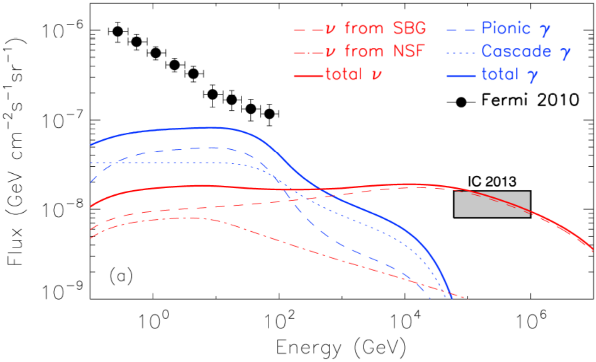


1.5<z<2.5
x10−MS
x4−MS
MS
Starbursts
Main Sequence
1000
100
10
SFR [M⊙/yr]
10^10
10^11
10^12
stellar mass [M⊙]
1.5<z<2.5
specific SFR [1/yr]
10^-7
10^-8
10^-9
stellar mass [M⊙]

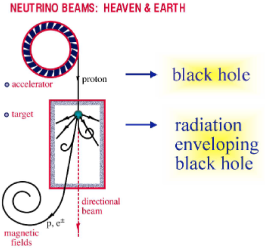
SBGs


ELLIPTICAL
AGN1 / AGN2
SF-AGN(SB)
SPIRAL
SF-AGN(Spiral)
STARBURST
z=0
z≈1
z≈4

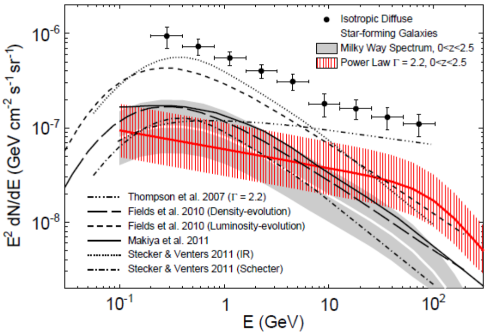
HNRs in SBG neutrino flux (arXiv: 1310.1362)



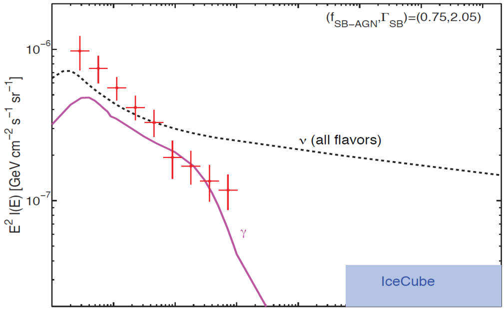
SBGs


NEUTRINO BEAMS: HEAVEN & EARTH
accelerator
proton
target
directional
beam
magnetic
fields
p, e±
black hole
radiation
enveloping
black hole

Fermi γ ray flux



Fermi γ ray flux



SN ν at IceCube