Evidence for recent GeV brightening of the SN 1987A region

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Introduction

- Type II SN occurred 23rd Feb. 1987 in LMC (∼50 kpc)
- peak optical magnitude ∼ 3
- progenitor – a blue supergiant Sanduleak -69 202

Explosion detected in

- Neutrinos (Kamiokande II: 12 antineutrinos; IMB: 8; Baksan: 5) in ∼10 s burst (core collapse)
- 2–3 h later in optics (blast wave reached the surface)
- NO detection in hard X-rays (0.3–9 MeV, SMM/GRS, effective area ∼ 100 cm$^2$)
Introduction

Now the remnant develops in a complex hour-glass shape cavity bounded by a dense ring in equatorial plane. The evolution of the central ring is clearly traced in optics(HST) and X-rays(Chandra)
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SN explosion event and SNR evolution become a laboratory for

- SN explosion modelling
- SNR expansion modelling
- particle acceleration on the shock (DSA) modelling
- Axion and sterile neutrino studies

2 - 10 keV

| 5978 | 7445 | 8796 | 10433 |

(c) : 1608.02160
Predictions from DSA models

Within DSA models GeV-TeV emission from SNR 1987A is expected:

- The emission is hadronic (cosmic ray protons are accelerated on the shock)
- Emission is variable (variable density of the medium + acceleration timescale)
Predictions from DSA models

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- Maximum of the emission expected 2007 – 2017

No GeV-TeV emission detected in GeV (1509.06903) and TeV (1501.06578) till \( \sim 2015 \ldots \)
During last 2–4 years Fermi/LAT data indicate gradual brightening of SN 1987A region

- Brightening is more significant if analysis is performed with P8R3 data calibration released few months ago
- The signal is seen only at $\gtrsim 1$ GeV energies and is comparable to predicted by DSA models
Possible counterparts

The region is crowded and includes several potential counterparts:

- SN 1987 A
- 30 Dor C
- Honeycomb nebula
- RX J0536.9-6913/Transient
Possible counterparts

None of these sources demonstrate a clear increase of X-ray flux.

Potential origin of GeV emission:
Possible counterparts

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- **SN 1987A**: GeV-TeV brightening is expected; hints of X-ray flux increase
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- **RX J0536.9-6913/Extragalactic transient...**
Conclusions

- $\sim 4\sigma$ excess seen by Fermi/LAT from SN 1987A position during last 2–4 years
- Flux increase is long-expected by DSA models but not seen previously in GeV/TeV
- Poor localization allows several other counterparts (30 Dor C; Honeycomb nebula; transient)
- No clear variability in X-rays – a hint for hadronic emission from SN 1987A?
- Joint HESS/XMM proposal accepted. More results by the end of 2019.
- MeerKAT (radio) observations may take place (under discussion)
- Stay tuned!
Danke.

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