Evidence for an 8 MeV line in the SN 1987A neutrino Spectrum

and five reasons to expect one

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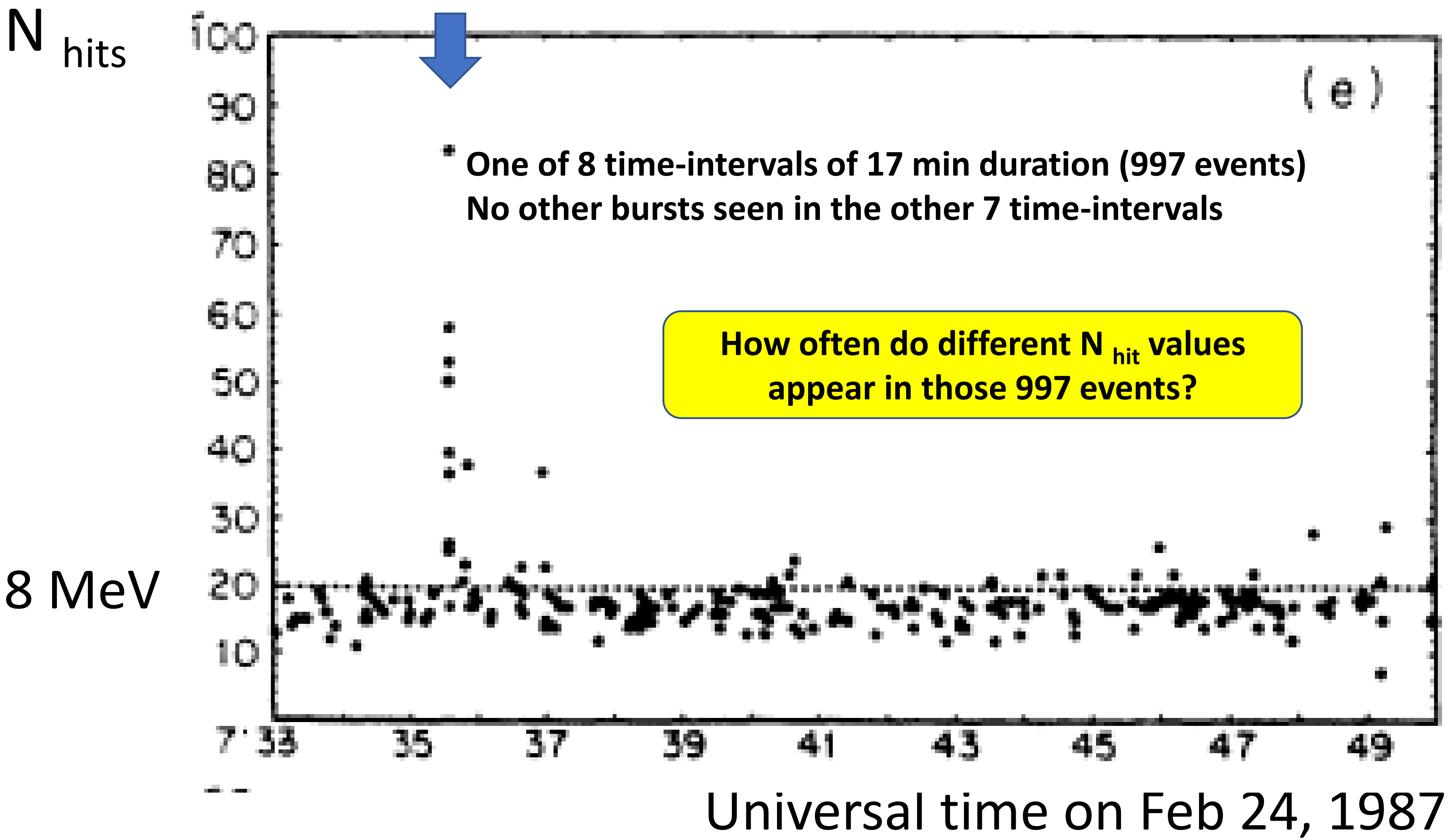
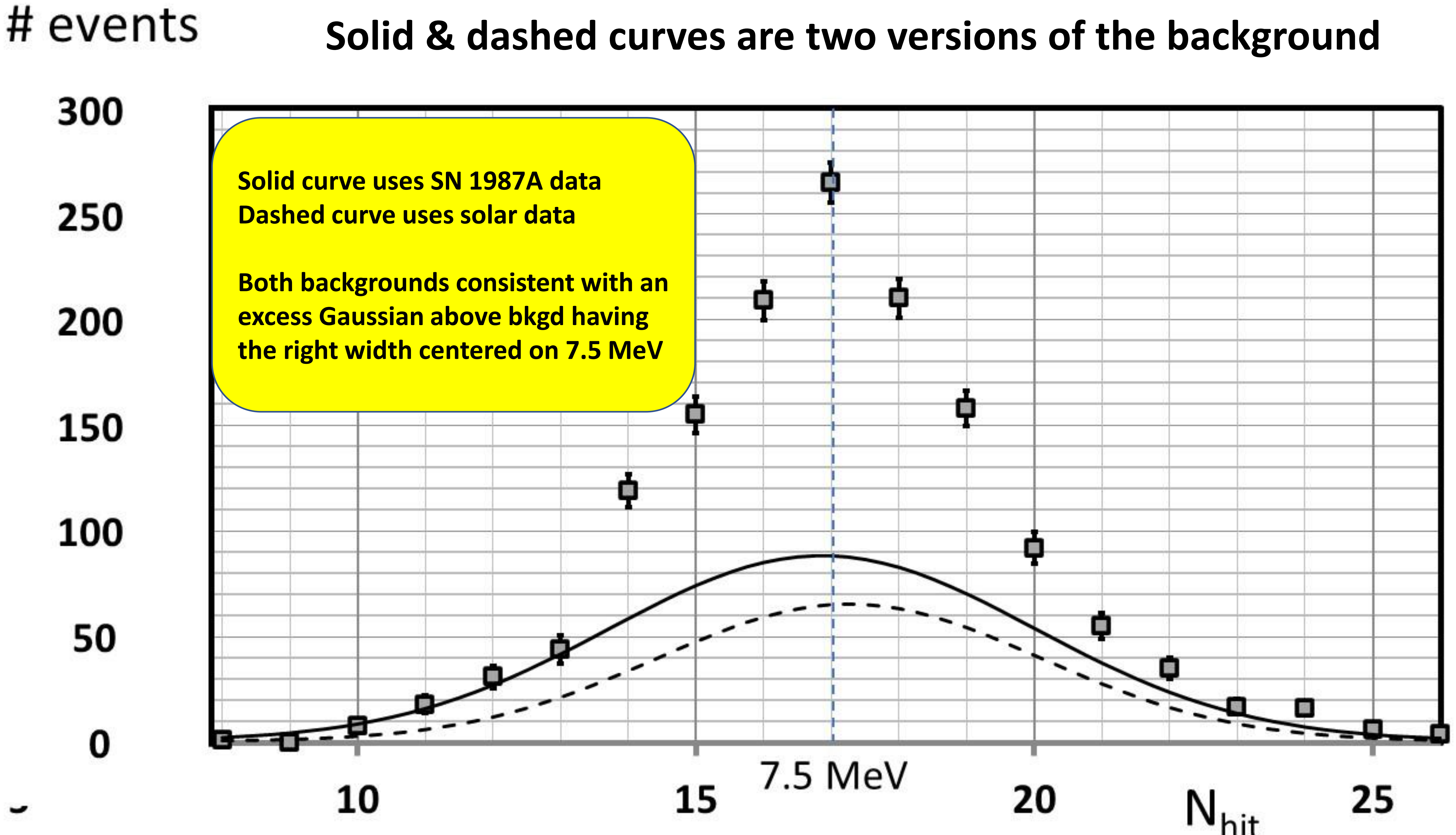
https://arxiv.org/abs/2101.08128

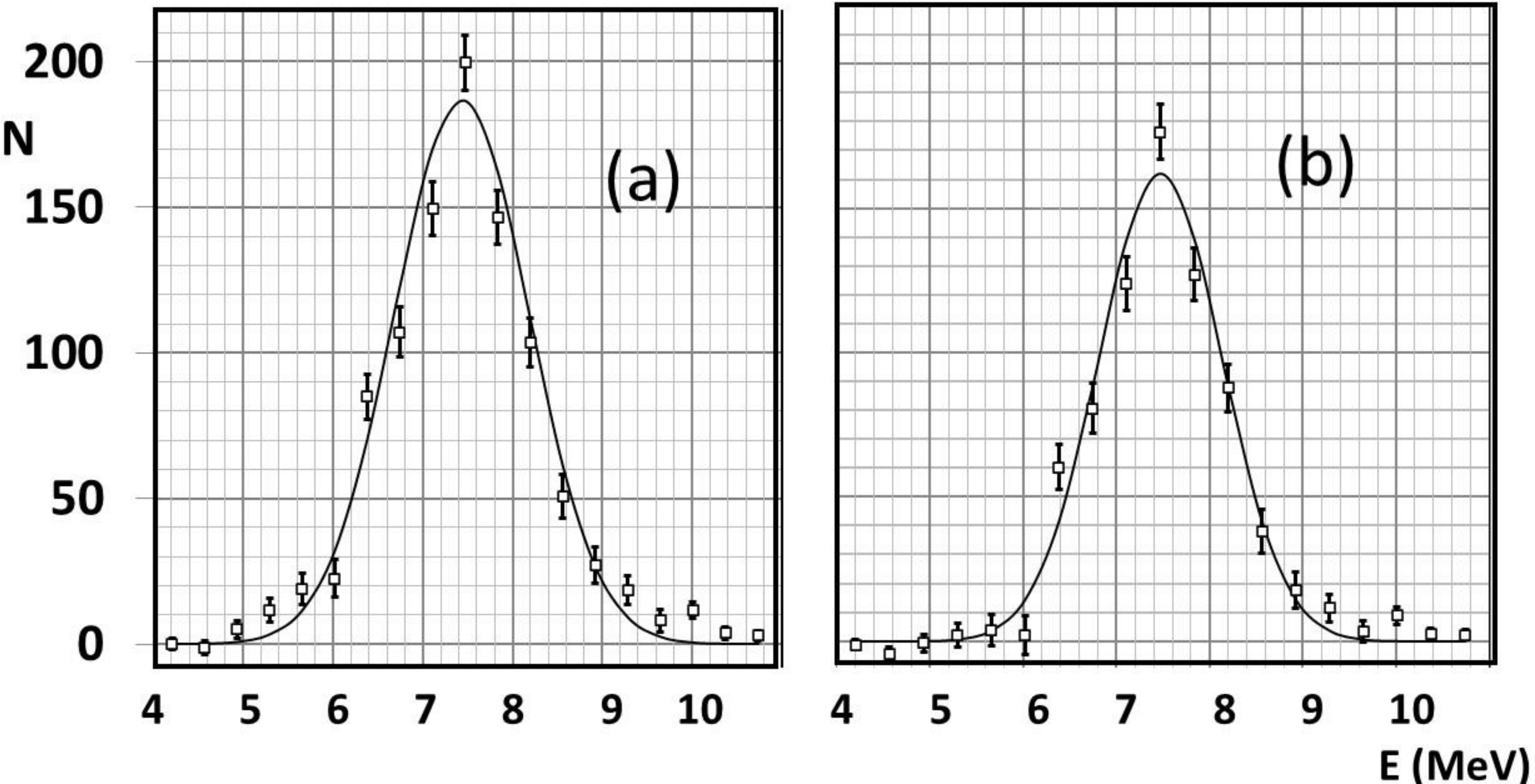
Kamiokande-II data Feb 24, 1987A



Solid & dashed curves are two versions of the background



Background subtracted data consistent with a 7.5 MeV neutrino line.



How to get an ~ 8 MeV neutrino line?

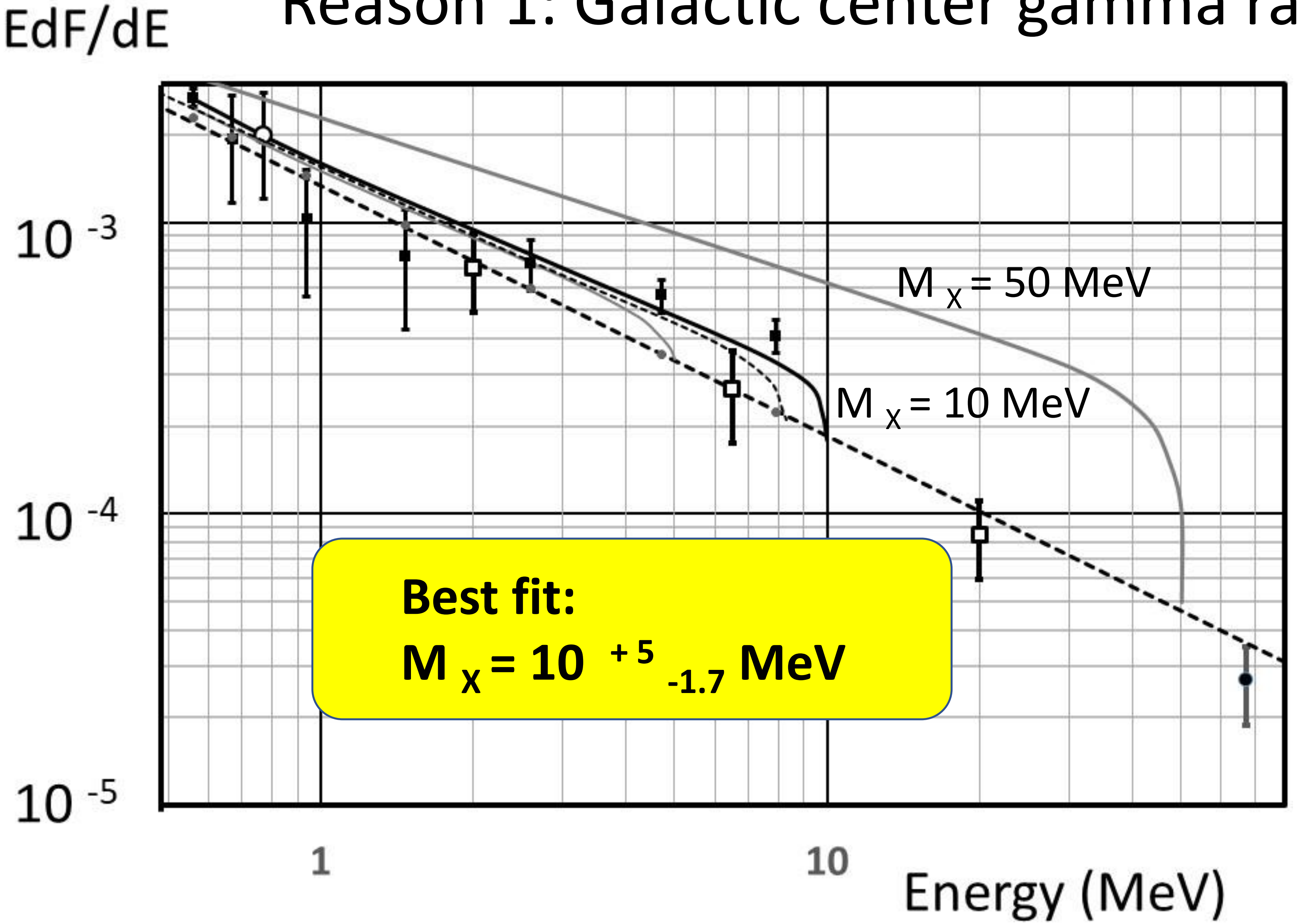
CDM annihilation of a DM particle of mass 8 MeV

$$XX \to Z' \to \nu\bar{\nu}$$

Z′ would be a 16 MeV mediator particle
-- the only other leptonic decay mode: $Z' \to e^+e^-$

Evidence of 8 MeV X particle in Galactic Center gammas?

Reason 1: Galactic center gamma ray spectrum



N. Prantzos, et al. Rev. Mod. Phys., 83, 1001 (2011).

Reason 2: The “Atomki experiment” suggests a new 17 MeV mass Z’ particle

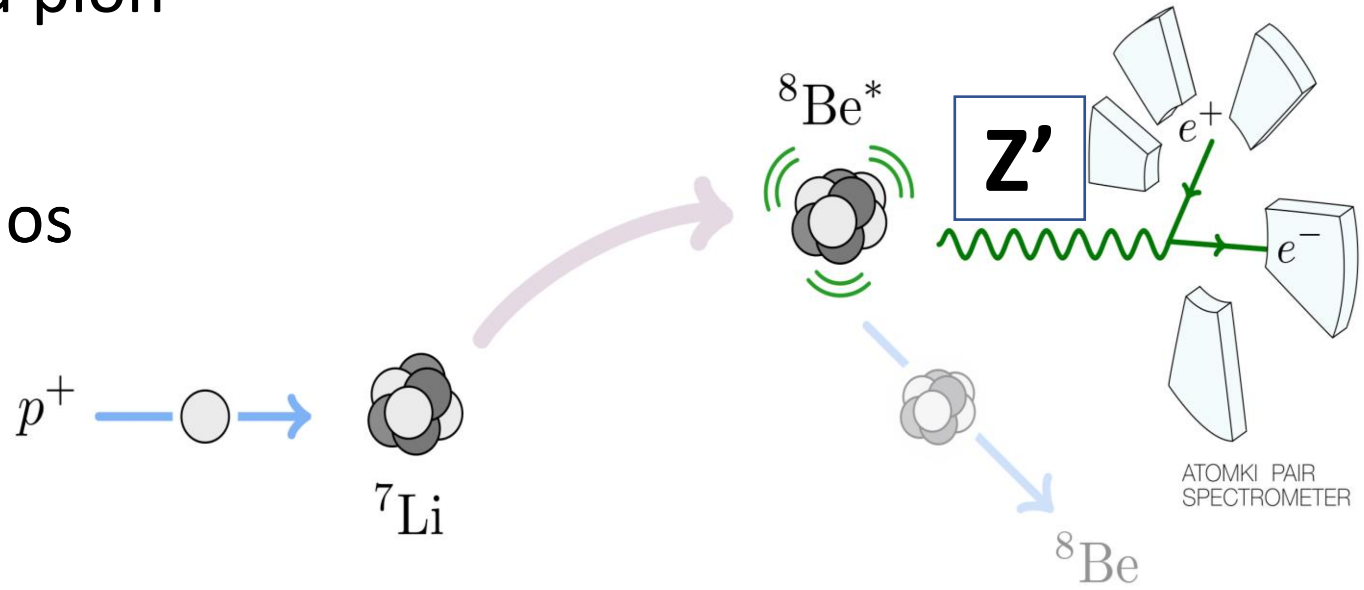
Same anomaly seen in He^* decay

Existence of Z’ Supported by B decay lepton and flavor anomaly and pion lepton decay anomaly

Would create 8.5 MeV neutrinos

$$Z' \to \nu\bar{\nu}$$

$$Z' \to e^+e^-$$



A. J. Krasznahorkay et al., Phys. Rev. Lett. 116, 042501 (2016).

Reason 3: Light Dark matter in Supernovae

XX annihilation into leptons could provide the energy to prevent shock wave stalling.

Fayet et al. show m_X ~ 1-30 MeV DM particles can play a significant role in the core-collapse.[1]

Important that if $m_X < 10$MeV the DM would cool on a time scale > 100 times longer, i.e. hours not seconds.[1]

P. Fayet, D. Hooper, and G. Sigl, PRL 96, 211302 (2006).

Reason 4: The ~5 hr early Mont Blanc SN 1987A burst

TABLE I – *Event number, time (UT), and preliminary visible energy (MeV) of the pulses in the burst detected on February 23rd, 1987.*

Event No.	Time (UT)	E_v (MeV)
994	2 h 52 m 36 s.79	7
995	40.65	8
996	41.01	11
997	42.70	7
998	43.80	9

All 5 neutrinos have visible energy consistent with the average value 8 MeV

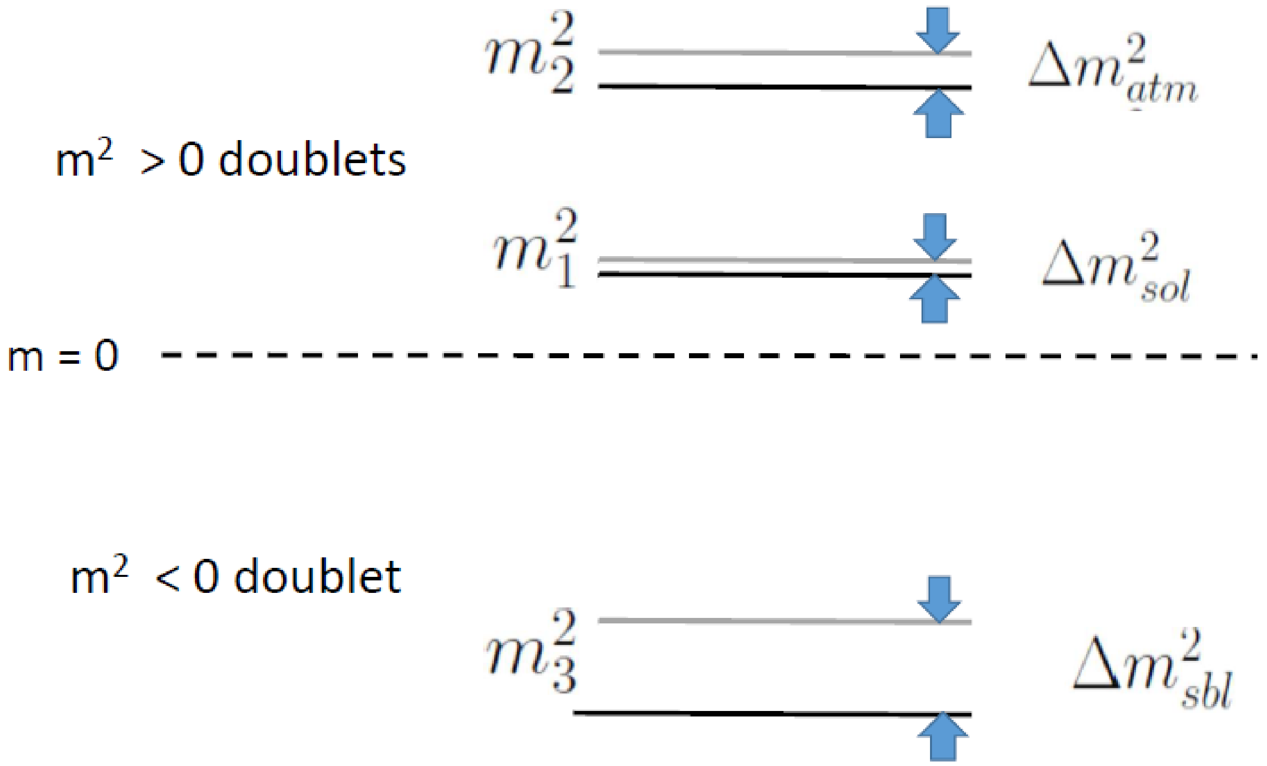
Neutrino energy would be 9.3 MeV (+/- 20%)

Aglietta explains why no such burst seen in Kamiokande detector

M. Aglietta et al., Europhys. Lett., {\bf 3} (12), 1321-1324 (1987).

Reason 5: The "3 + 3" neutrino model (2013)[1]

3 active-sterile pairs having much larger masses than normally assumed



$m_2 = 21.4$ eV

$m_1 = 4.0$ eV

$m_3^2 \sim -0.2\ keV^2$

One pair are tachyons

If the Mont Blanc early burst really are tachyons, they MUST be monochromatic with energy E ~ 8 MeV!

Ehrlich, R. "Tachyonic neutrinos and the neutrino masses," Astropart. Phys., 41 (2013) 1-6, http://arxiv.org/pdf/1204.0484.pdf

Possible contradictions to 8 MeV line

1. No time variation in strength of line seen over hours

   OK for DM which heats & cools very slowly

2. Impossible number of neutrinos above background (~700)

   Barely possible given that DM models allow a substantial fraction of star being DM

3. Line not seen in diffuse supernova searches

   Those searches either had energy threshold > 8 MeV or else looked for very short bursts

Conclusions

There is evidence for an 8 MeV neutrino line from SN 1987A

May be able to see it in diffuse supernova searches using existing detectors

KATRIN will soon test the validity of 3 + 3 model