Solar neutrino spectra

- Overview – see Gabriel Orebi Gann talk
- hep – spectrum shape?
- ^{8}B – review by Alejandro Garcia
- EC lines from CNO
- CNO – see Gabriel's talk
- pep – new calculation of line shape, but I can't find it!
- ^{7}Be – nothing new
- pp – Gallium anomaly, sterile neutrinos
- Thermal flux – Haxton/Lin spectrum

Solar limit on sterile admixture

Goldhagen, Maltoni, Reichard, and Schwetz 2109.14898

No completely model-independent limit, but maybe a solid one from luminosity constraint. (Gonzalez-Garcia)

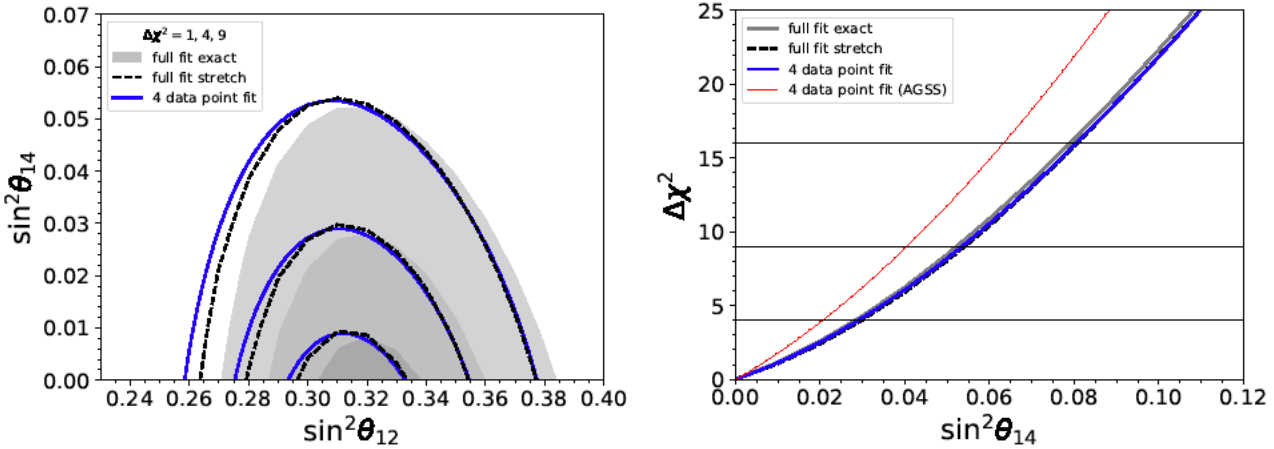
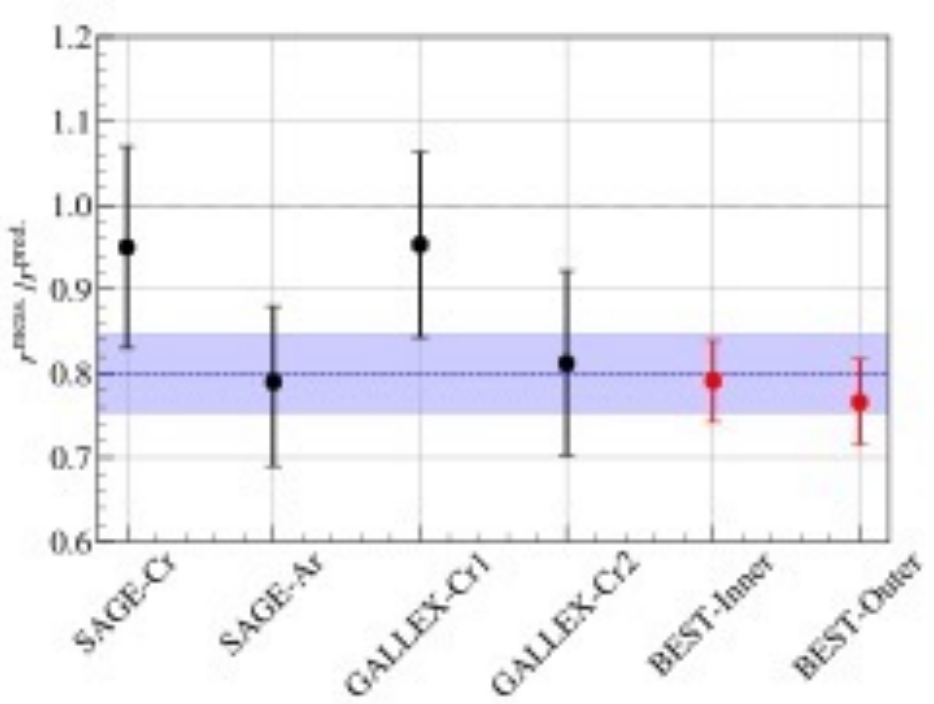


Figure 1: Results for the GS98 solar models. We compare the exact solar neutrino fit (grey), the full solar fit but using the "stretch" parameterization for the probabilities from eq. (2.9) (black-dash), and our 4-data point approximation (blue). In the right panel we show in red the 4-data point fit for the AGSS09 solar model.

Gallium anomaly

BEST collaboration:
Phys.Rev.Lett. 128 (2022) 23, 232501
• e-Print: 2109.11482 [nucl-ex]

Sterile neutrinos?
Experimental problem?
Theoretical problem?



Barinov & Gorbunov
2109.14654

Solar limit is from Giunti et al. Phys. Lett. B816, 136214 (2021).

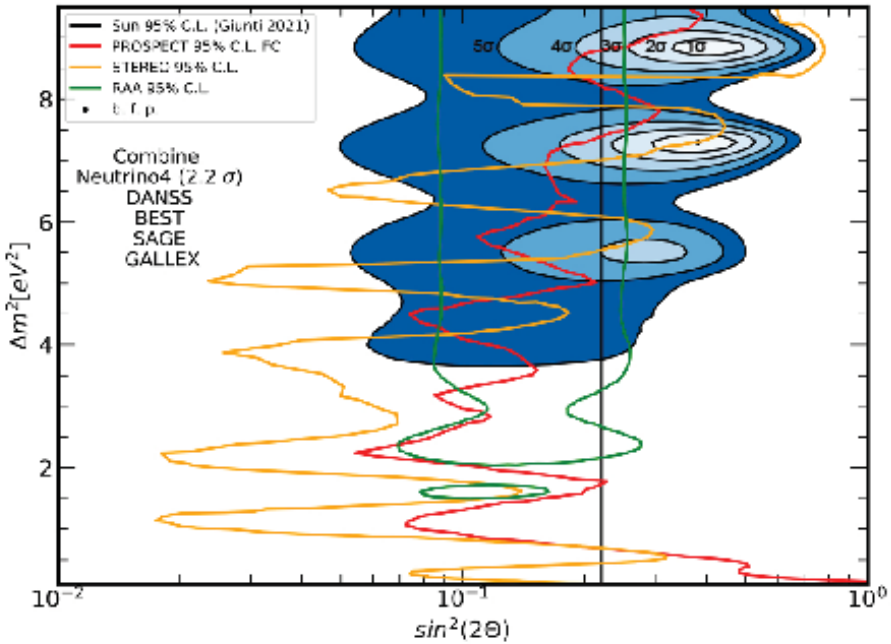
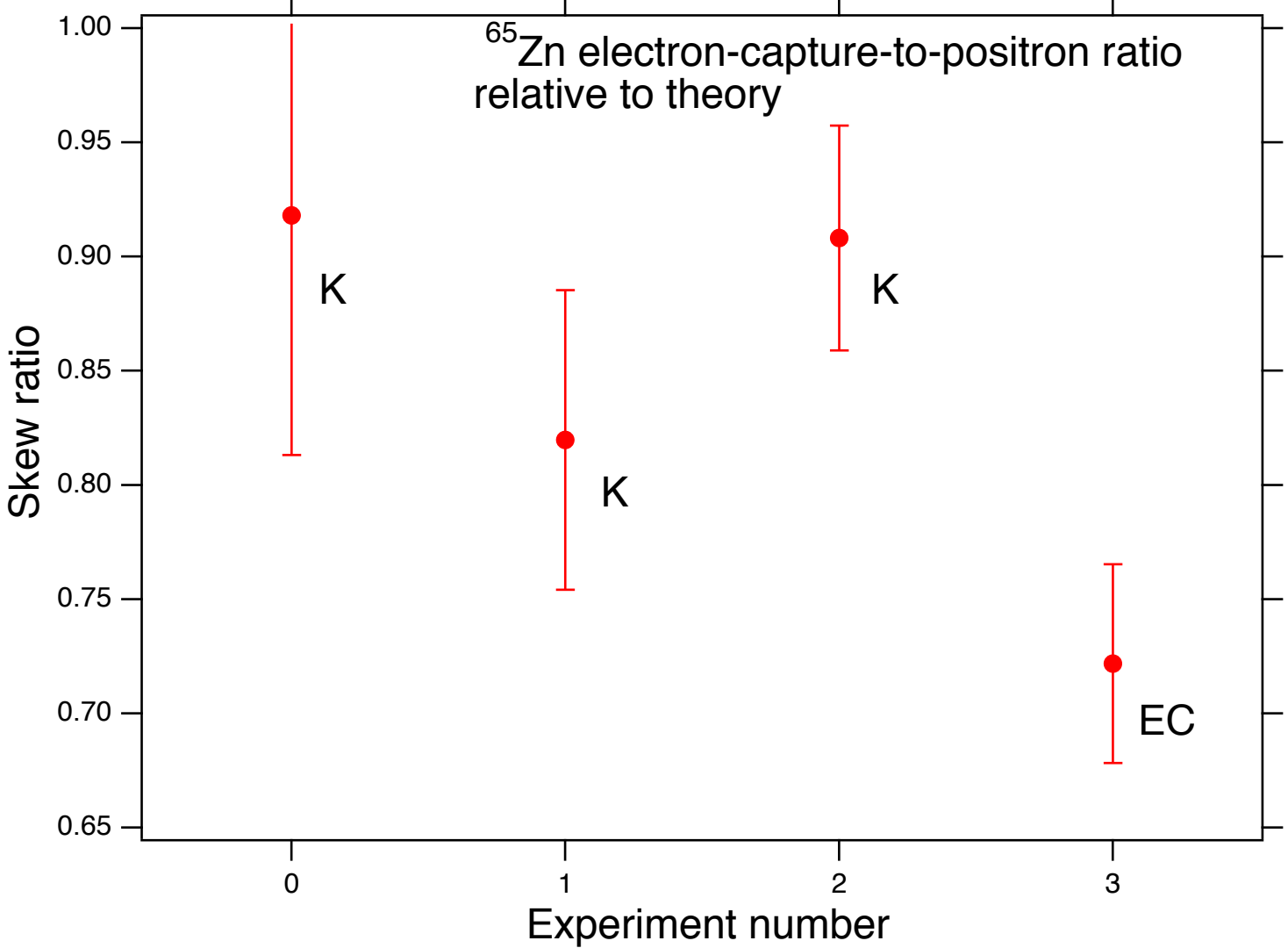


FIG. 3. The regions (in shades of blue) *favored* by the joint analysis of the gallium experiments, DANSS [32] and NEUTRINO-4 [29]. There are also regions *excluded* at 95% C.L. from sterile neutrino searches at reactor antineutrino experiments STEREO [30], PROSPECT [31]. The regions outlined by the green line is *favored* at 95% C.L. by the reactor antineutrino anomaly (RAA) [16]. The region to the right of the black vertical line is *excluded* at 95% C.L. from observations of solar neutrinos [34].

Possible systematics

- ^{71}Ge Q – value: 0.5%
- ^{71}Ge lifetime: 0.03%
- Radiochemical efficiency: ^{71}As calibrations are right.
- Excited states: Frekers et al. ~7%, Kostensalo et al. ~3%. (Must be ≥0.)
- Radiative corrections: Not done for EC, but usually < 1%
- EC atomic theory: Testable.


^{65}Zn electron-capture-to-positron ratio relative to theory
Skew ratio
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
K
K
K
EC
0
1
2
3
Experiment number

Applied Radiation and Isotopes 134 (2018) 225–232

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Improved calculations of electron capture transitions for decay data and radionuclide metrology

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logFT (Gove-Martin)	Mougeout
Relativistic	Relativistic
Closed shells	Closed shells
Hartree-Fock-Slater	?
Fermi-Dirac nucleus	?
Overlap & Exchange	Overlap &
(non-rel)	Exchange (rel)
None	Shake included
None	Hole effect

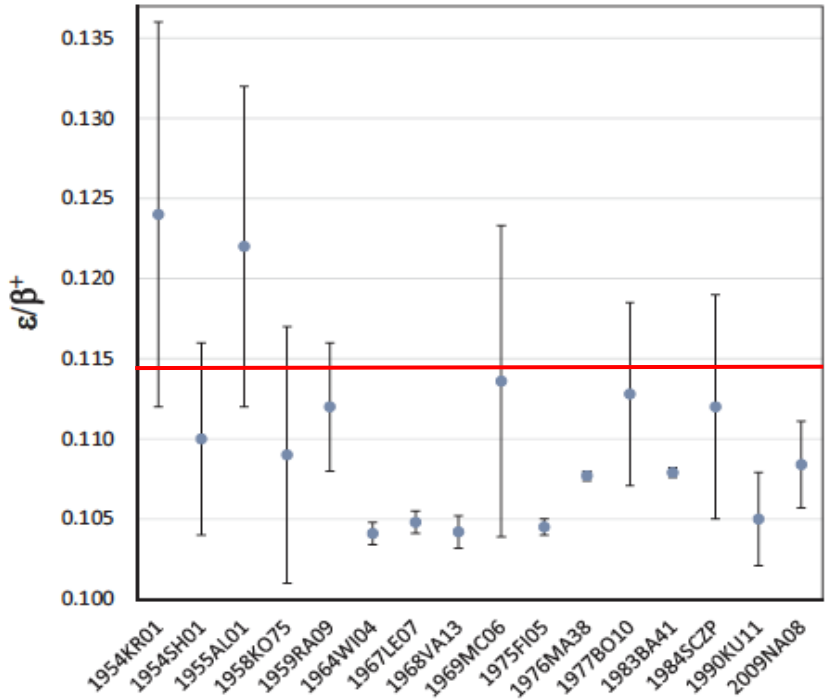


Fig. 1. Experimental values of the total capture-to-positron ratio for the main allowed transition in ^{22}Na decay. The NSR key-numbers which correspond to the publications are given on the abscissa (Pritychenko et al., 2011).

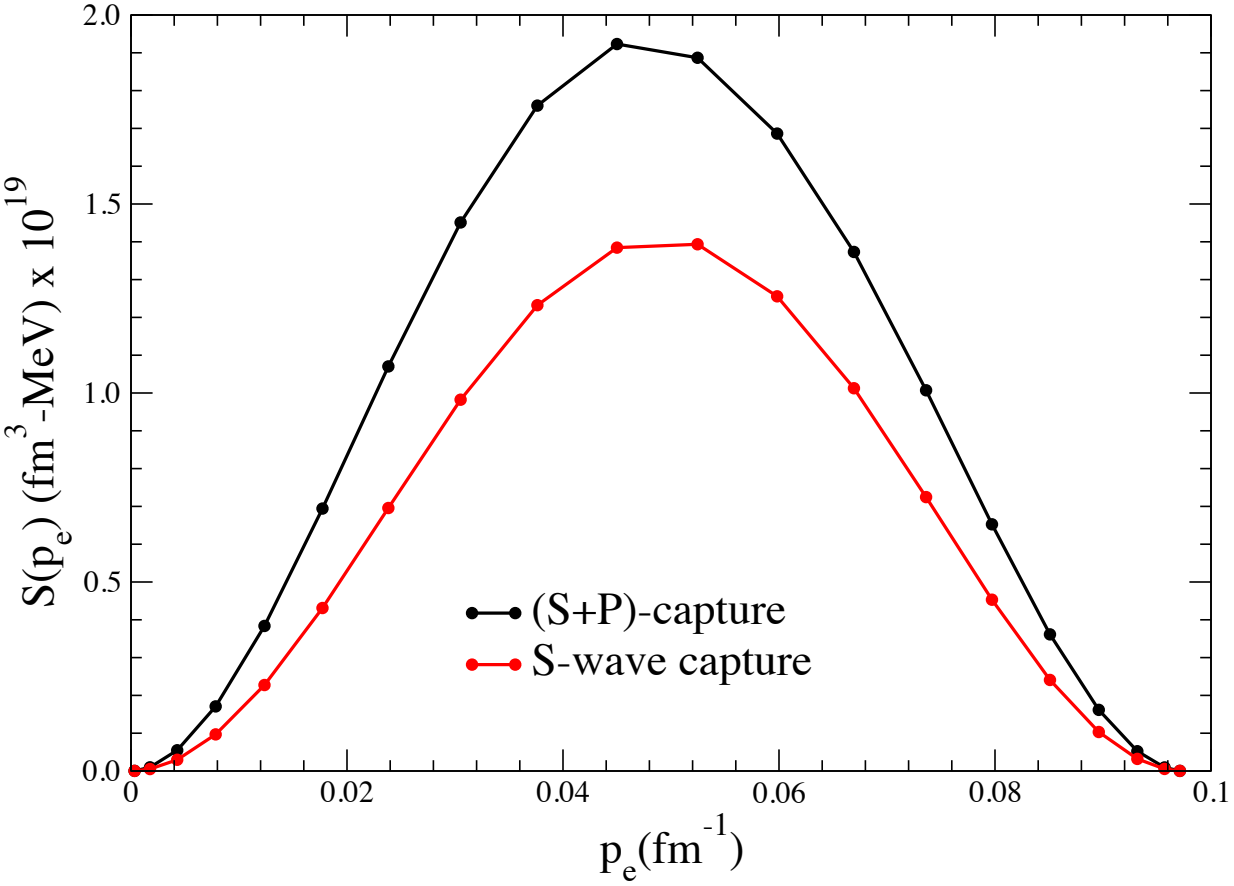
The ^{22}Na anomaly is still there, even a bit bigger.

The ^{65}Zn problem seems gone, but why…?

hep Spectrum

Spectral shape is not exactly the allowed shape, because of the first-forbidden component.

This was not used by SNO in the hep paper PHYS. REV. D 102, 062006 (2020)



This comes from Rocco Schiavelli via Gerry Garvey (April 2017):

Hi Rocco,

Some folks on SNO were asking me about the spectrum of neutrinos from the Hep process in the sun. They had assumed it has an allowed shape but that seems unlikely to me as the Q value is large and the distances large on a nuclear scale and your papers claim that approximately 40% of the CS comes from p wave part.

Are there some old results hanging around that show the neutrino momentum dependence in the transition $^3He + p \rightarrow {}^4He + \nu_e + e^+$ apart from the phase space factor? Perhaps the result is already in the literature but a rather quick look at your old papers did not turn up what I was looking for. If you can't locate any relevant material would you venture a guess on how much of a deviation from an allowed spectrum could be expected.

Best Regards,

Gerry

This comes from Rocco Schiavelli via Gerry Garvey (April 2017):

Dear Gerry,

in attachment is a figure of the S-factor dependence on the electron momentum. The two curves correspond to capture in relative S-wave only (red) or both (S+P)-wave (black). The results are at zero relative energy in the p+3He channel. The area under these curves gives the S-factor (at zero energy), i.e.

S(0) = 7.02 10^{-20} keV-b for S-wave capture

= 9.95 10^{-20} keV-b for (S+P)-wave capture

These results correspond to our most recent work on this reaction, see Table IV (column with Lambda=500 MeV) of PRC67, 055206 (2003). However, they are close to those published in the original work of 2001. Inclusion of the P waves leads to a slight shift of the max in the spectrum to lower electron momentum.

Best regards,

Rocco