

Neutrino oscillations and nucleosynthesis

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Brainstorming and fun: stellar evolution/explosions,
nuclear/particle physics input, origin of the elements and evolution of galaxies
Basel, 2014/09/29-2014/09/30

(1) collective neutrino oscillations in core-collapse supernovae :

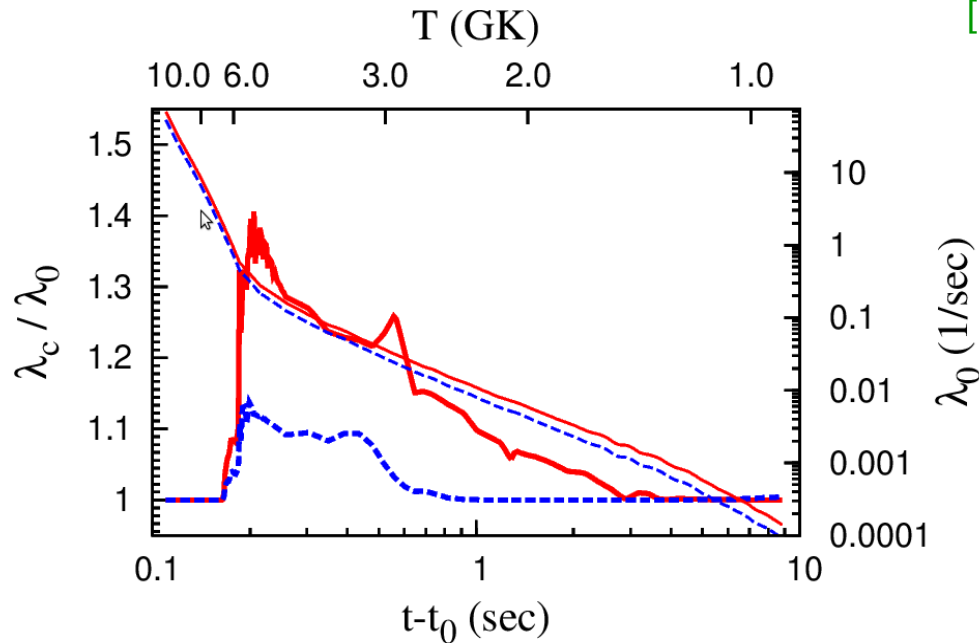
$R_{\text{osc}} \sim 100\text{-}250 \text{ km}$

→ $T_{\text{osc}} < 6 \text{ GK}$

→ probably no impact on Y_e before the α formation

→ Recent models show no impact on νp process

[Frohlich et al & Wu et al]



The needs :

- Better neutrino spectra provided by SN model
- full 6D simulation of neutrino flavor oscillations
- include scattered/local emitted neutrinos

Do we really understand :

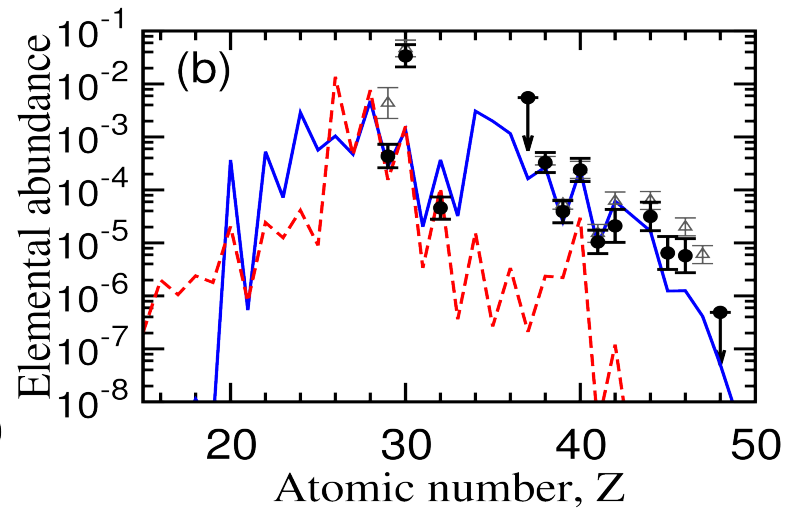
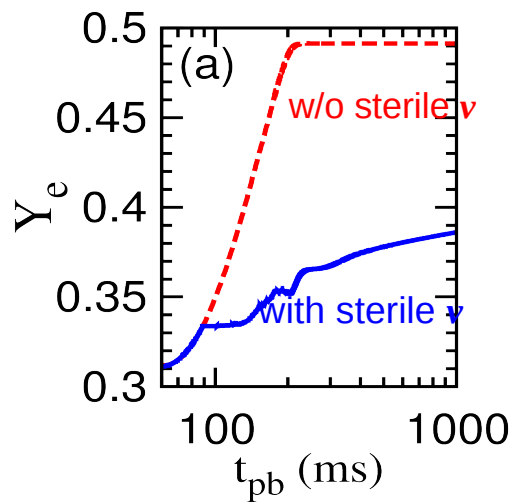
- many body effect?
- spin-spin coherence?
- wave packet size?

(2) active-sterile neutrino oscillations in supernovae :

$$R_{\text{osc}} \sim R(Y_e \sim 1/3)$$

$$\& R(\rho \sim 10^7 \text{ g/cc})$$

→ potentially large impact for early supernova ejecta
with $Y_e(t_{\text{ej}}) > 1/3$:



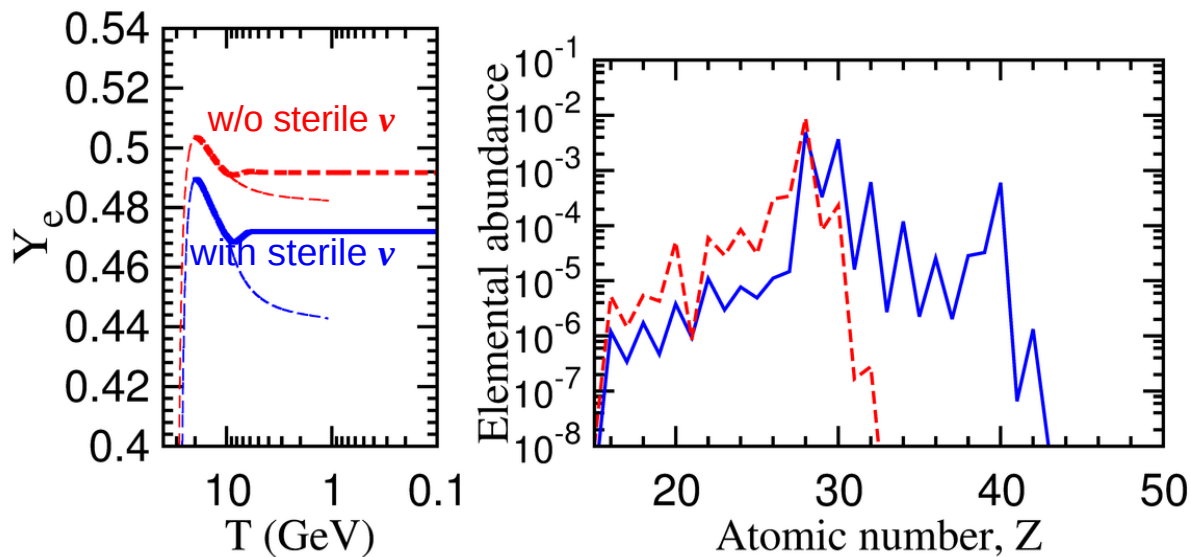
(2) active-sterile neutrino oscillations in supernovae :

$$R_{\text{osc}} \sim R(Y_e \sim 1/3)$$

$$\& R(\rho \sim 10^7 \text{ g/cc})$$

→ potentially large impact for early supernova ejecta
with $Y_e(t_{\text{ej}}) > 1/3$:

→ smaller impact on the later neutrino-driven wind
with $Y_e(t_{\text{ej}}) < 1/3$:



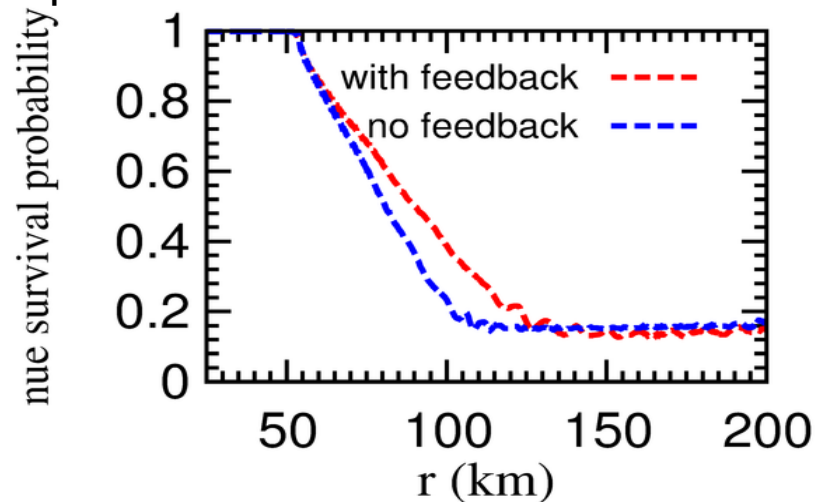
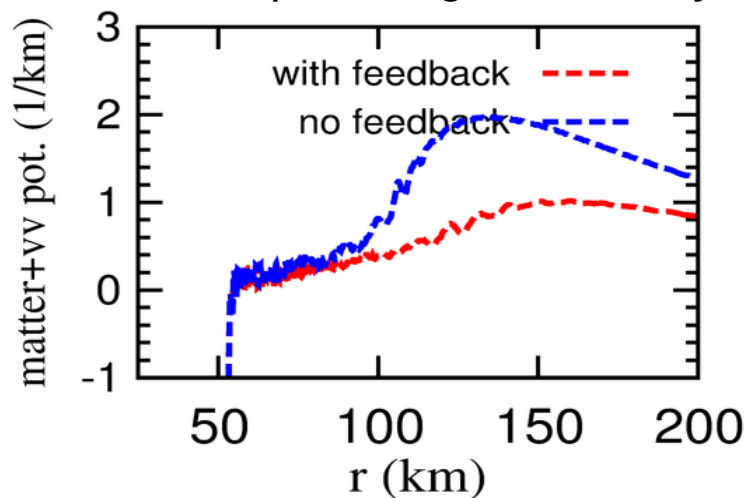
What mixing parameter space is compatible with supernova explosions?

(3) Neutrino-matter resonances :

$$R_{\text{osc}} \sim R(n_e + n_{\nu, \text{eff}} \sim 0)$$

- dominating electron anti-neutrino flux over electron neutrinos
- may possibly happen in the neutrino-driven winds of accretion disks of collapsar or mergers [A. Malkus et al, PRD 86 085015 2012, A. Malkus et al, arXiv: 1403.5797]
- feedback of oscillations on Y_e ?

A test case with profiles generated by a supernova wind model :



The needs :

- Better neutrino spectra provided by disk model
- more realistic model of neutrino flavor oscillations

Do we really understand :

- many body effect?
- spin-spin coherence?
- wave packet size?