Do WMAP data favor ν mass and CDM-DE coupling?

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References:

- GLV, S. A. Bonometto, L. P. L. Colombo, *arXiv:0810.0127 [astro-ph], New Astron.*
- GLV *et al., arXiv:0902.2711 [astro-ph.CO], submitted to JCAP*
- J. R. Kristiansen *et al., arXiv:0902.2737 [astro-ph.CO], submitted to PRL*

- M.B. Gavela *et al., arXiv:0901.1611 [astro-ph]*

0-th order approximation: ΛCDM

→ fits all data (available)
→ conceptually unacceptable (coincidence, fine tuning)

1-st order approximation: ?

→ DE is a self-interacting scalar field
also linearly interacting with CDM

i.e. the dark Sector is some kind of unique “substance”

WHY SHOULD THE 2 DARK COMPONENTS BE DISJOINT?

Assuming no coupling:
ad-hoc extra hypothesis

The point of this talk:

coupled DE cosmology fully acceptable,
with coupling at the Planck Scale,

IF NEUTRINOS HAVE SIGNIFICANT MASSES $\sum m_\nu \approx 1\ eV$

MORE THAN upper limits on coupling and neutrino masses!

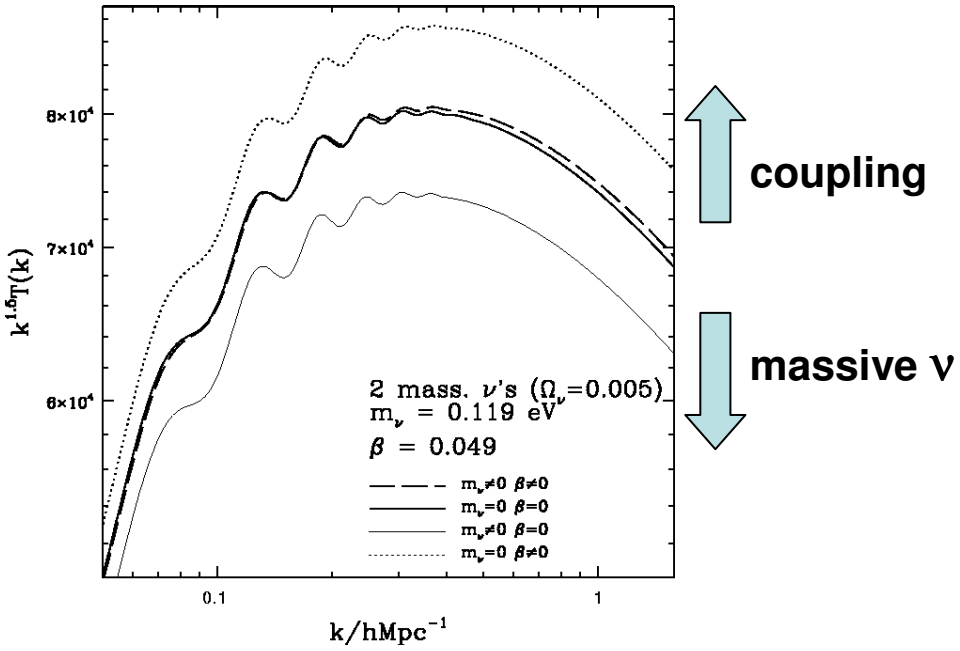
Vice versa:

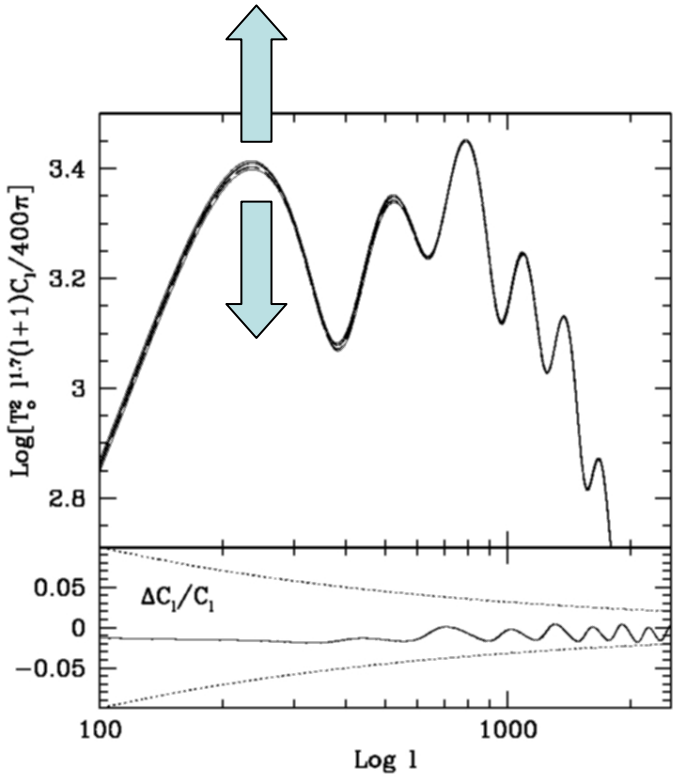
If ν masses above current cosmological limits,
as detectable in future β-decay or 0νββ-decay experiments,

STRONG EVIDENCE OF CDM-DE COUPLING $\beta \approx 0.17$

CDM – DE COUPLING ALREADY DETECTED?
(if coupling at Planck Scale, at the available sensitivity level, NO stronger signal possible)

Modifing spectra with cDE and massive ν





$$V(\phi) = \frac{\Lambda^{\alpha+4}}{\phi^{\alpha}}$$ Ratra-Peebles (RP) potential

$$V(\phi) = \frac{\Lambda^{\alpha+4}}{\phi^{\alpha}} \exp\left(\frac{4\pi\phi^2}{m_p^2}\right)$$ SUGRA potential

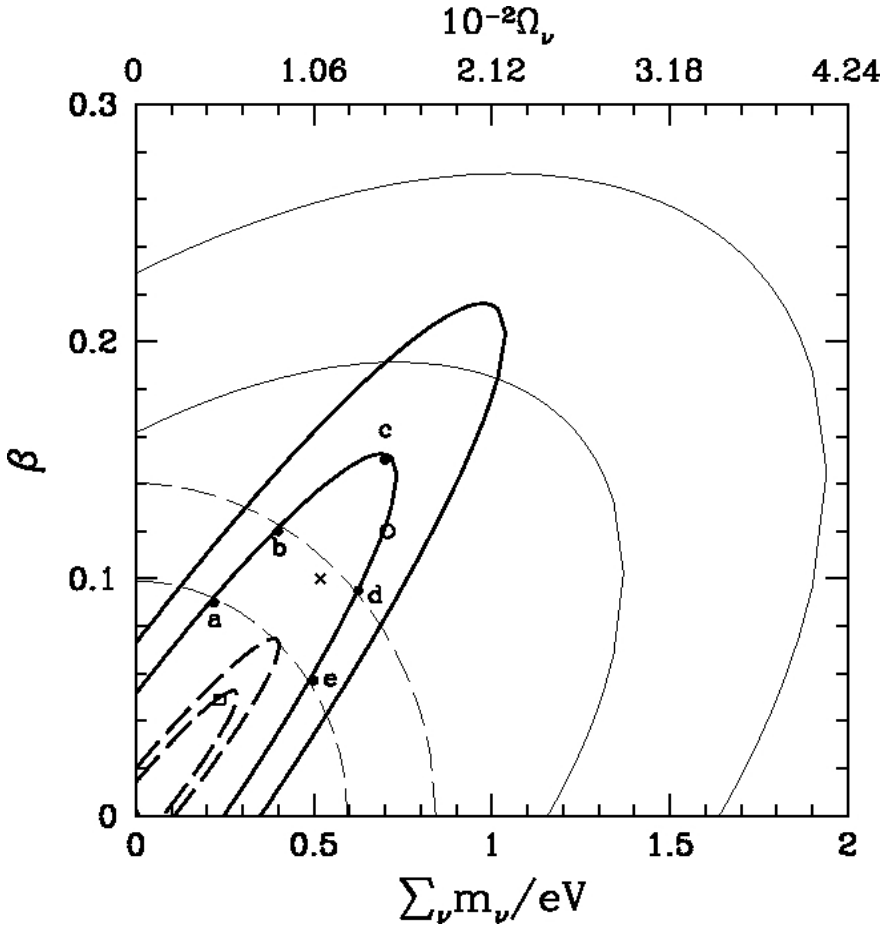
$$\begin{aligned} \phi'' + 2\mathcal{H}\phi' + a^2 V_{,\phi} &= C\rho_c a^2, \\ \rho'_c + 3\mathcal{H}\rho_c &= -C\rho_c\phi' \end{aligned}$$

$$\beta \equiv \sqrt{\frac{3}{16\pi}} m_P C$$

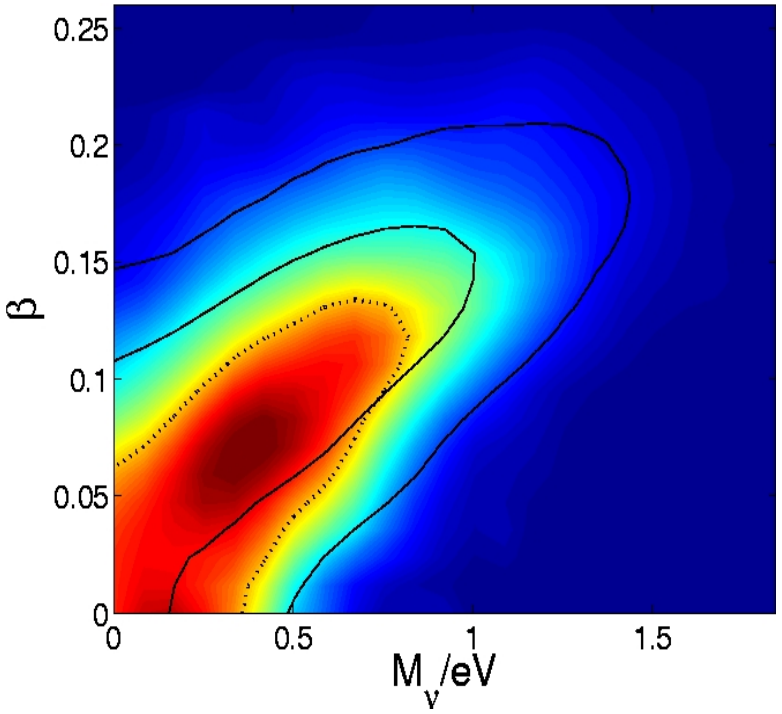
From theory to data:

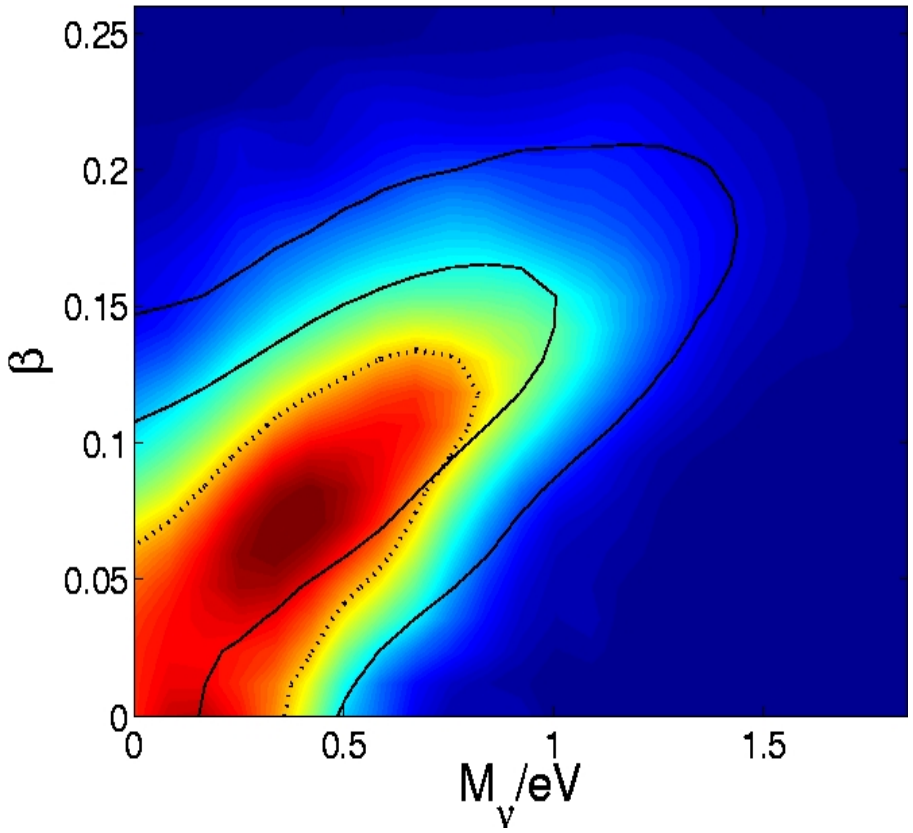
sugra

FISHER matrix
(WMAP5 + LSS)



MCMC
(WMAP5 + LSS + SNIa)

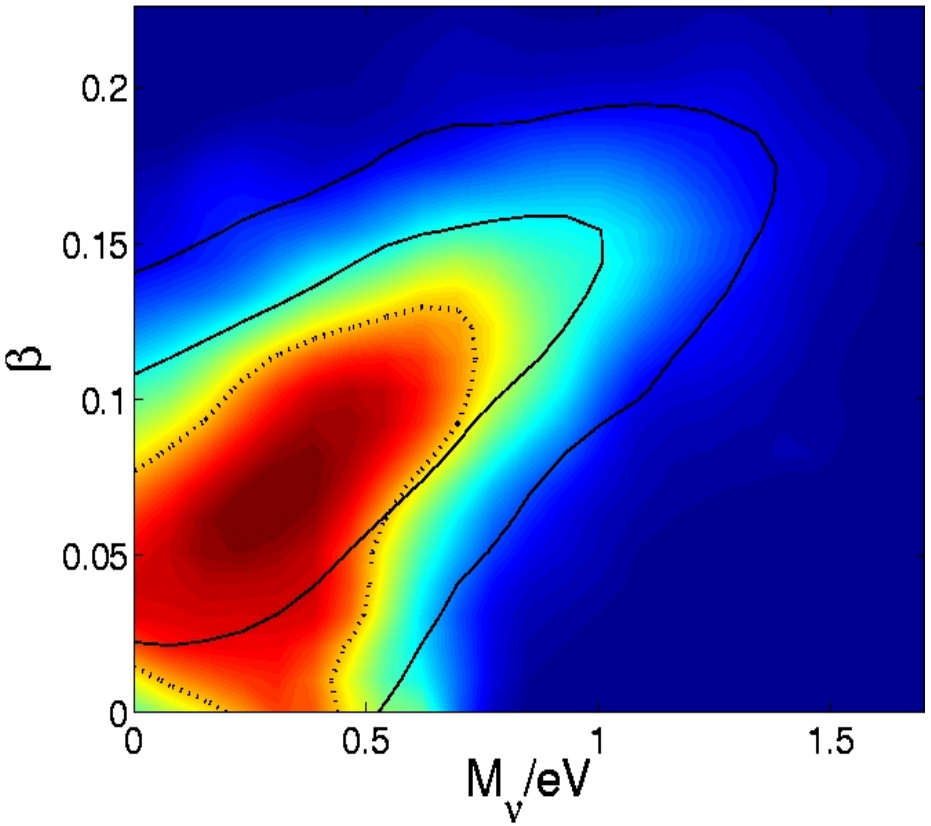




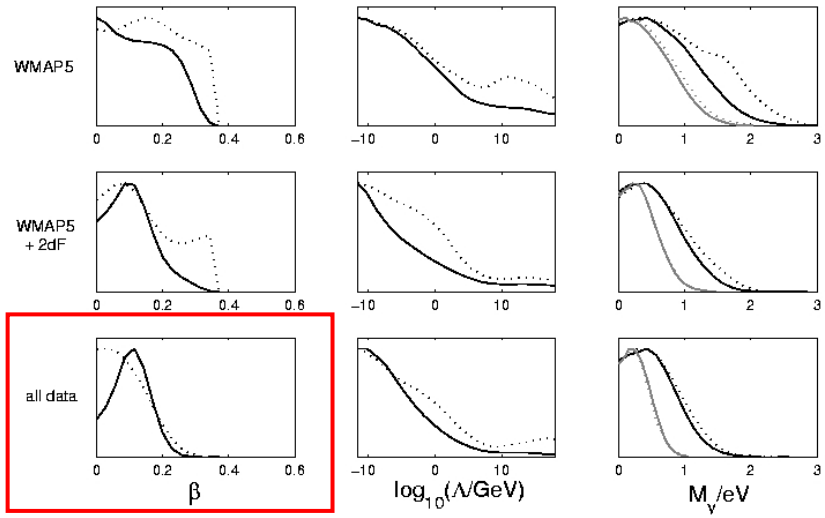
sugra

MCMC
(WMAP5 + LSS + SNIa)

RP



The results:



Parameter	ΛCDM + ν's WMAP only	ΛCDM + ν's all data	w = const. all data	cRP + ν's all data	cSUGRA + ν's all data
$10^2\,\omega_b$	2.244 ± 0.066	2.258 ± 0.061	2.247 ± 0.062	2.260 ± 0.061	2.260 ± 0.065
ω_c	0.1156 ± 0.0078	0.1098 ± 0.0040	0.1132 ± 0.0069	0.1039 ± 0.0062	0.1042 ± 0.0084
$10^2\theta$	1.0401 ± 0.0030	1.0401 ± 0.0030	1.0402 ± 0.0030	1.0401 ± 0.0029	1.0406 ± 0.0030
τ	0.085 ± 0.017	0.087 ± 0.017	0.085 ± 0.017	0.087 ± 0.016	0.088 ± 0.017
M_ν (eV) (95% C.L.)	< 1.20	< 0.66	< 0.94	< 1.13	< 1.17
β (95% C.L.)	—	—	—	<0.17	<0.18
$\log_{10}(\Lambda/\mathrm{GeV})$ (95% C.L.)	—	—	—	< -4.2	< 6.3
n_s	0.955 ± 0.017	0.962 ± 0.014	0.958 ± 0.015	0.969 ± 0.015	0.970 ± 0.018
$\ln(10^{10} A_s)$	3.053 ± 0.043	3.045 ± 0.040	3.049 ± 0.040	3.055 ± 0.040	3.057 ± 0.041
σ_8	0.691 ± 0.075	0.713 ± 0.056	0.711 ± 0.059	0.723 ± 0.062	0.717 ± 0.069
H_o (km/s/Mpc)	67.0 ± 4.4	70.1 ± 2.1	69.7 ± 2.2	71.8 ± 2.5	71.9 ± 2.7
-2 ln($\mathcal{L}$)	1329.39	1407.25	1407.38	1407.44	1407.33

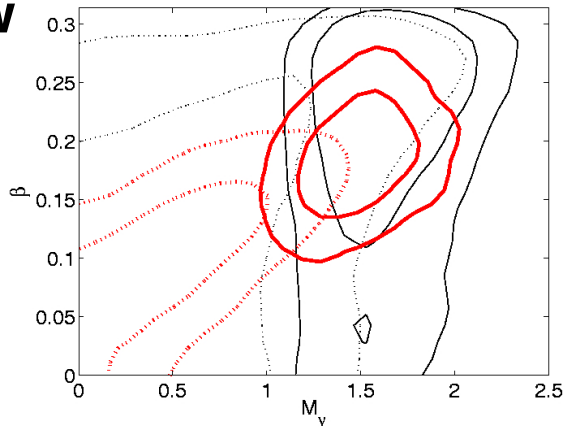
Joining sky and earth...

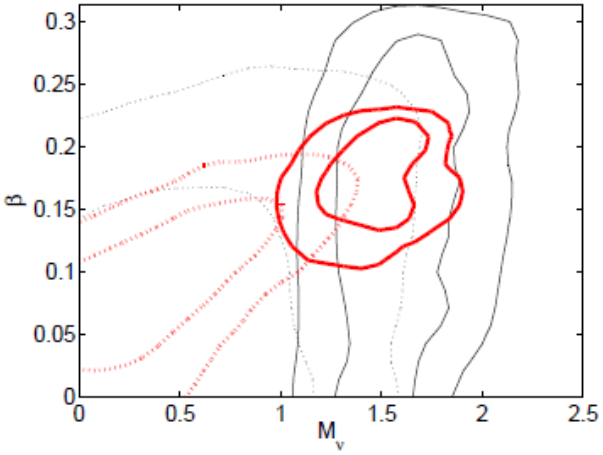
coupled SUGRA + massive ν : **"all data" + lab results**

sugra

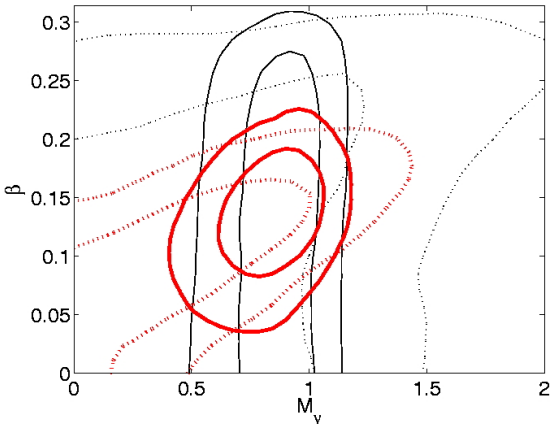
RP

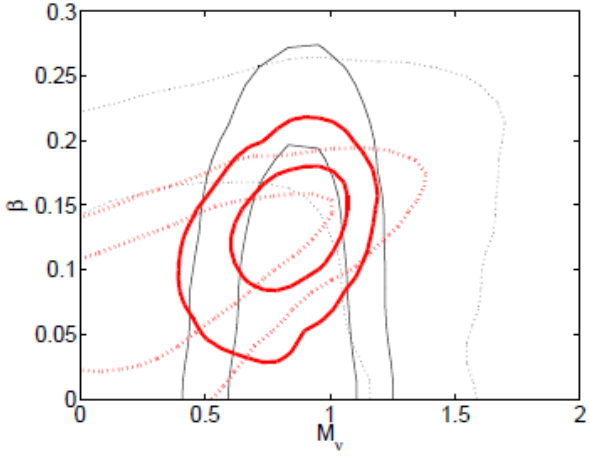
Heidelberg-Moscow
0νββ
5σ signal detection?





Katrin
tritium β decay
taking data in 2009





Conclusions

- ν mass limits from cosmology: within which model set ?

- opening the option of DE-CDM coupling
  ν mass and coupling degenerate,
  softening usual cosmological limits

- COUPLING ALREADY IN CURRENT DATA?
  (a nearly 2σ signal)

- combining cosmic and (possible) lab data,
  ν mass and coupling fully constrained
  (5σ on coupling obtainable).