

Supernova neutrinos

5 min thoughts

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Galactic supernova neutrinos

- Physics payoff is potentially enormous
 - Explosion mechanism
 - Synthesis of heavy elements
 - Nuclear equation of state
 - Particle physics beyond the SM
 - Very rich neutrino oscillation physics
 - regime unachievable on Earth

Collective neutrino oscillations

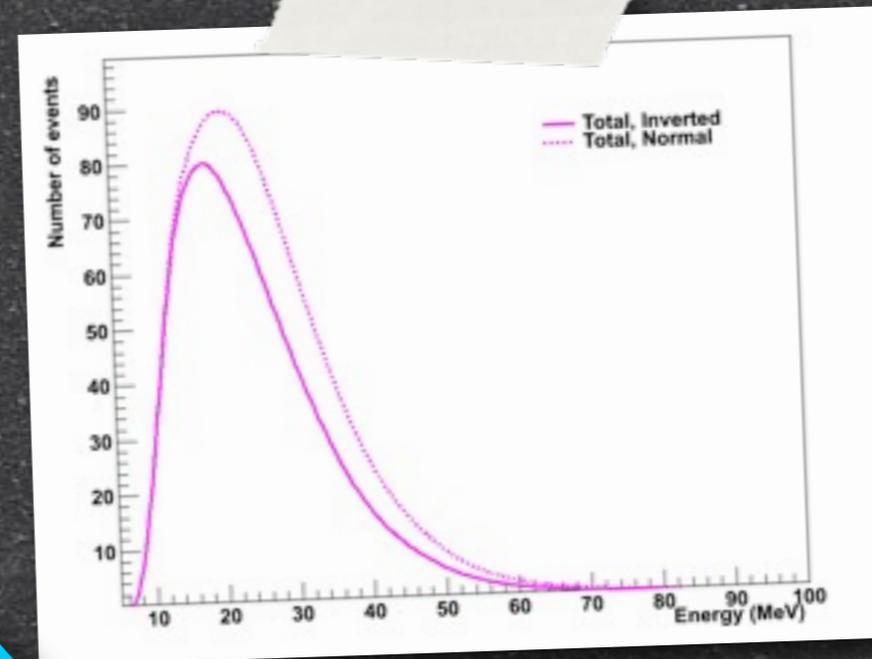
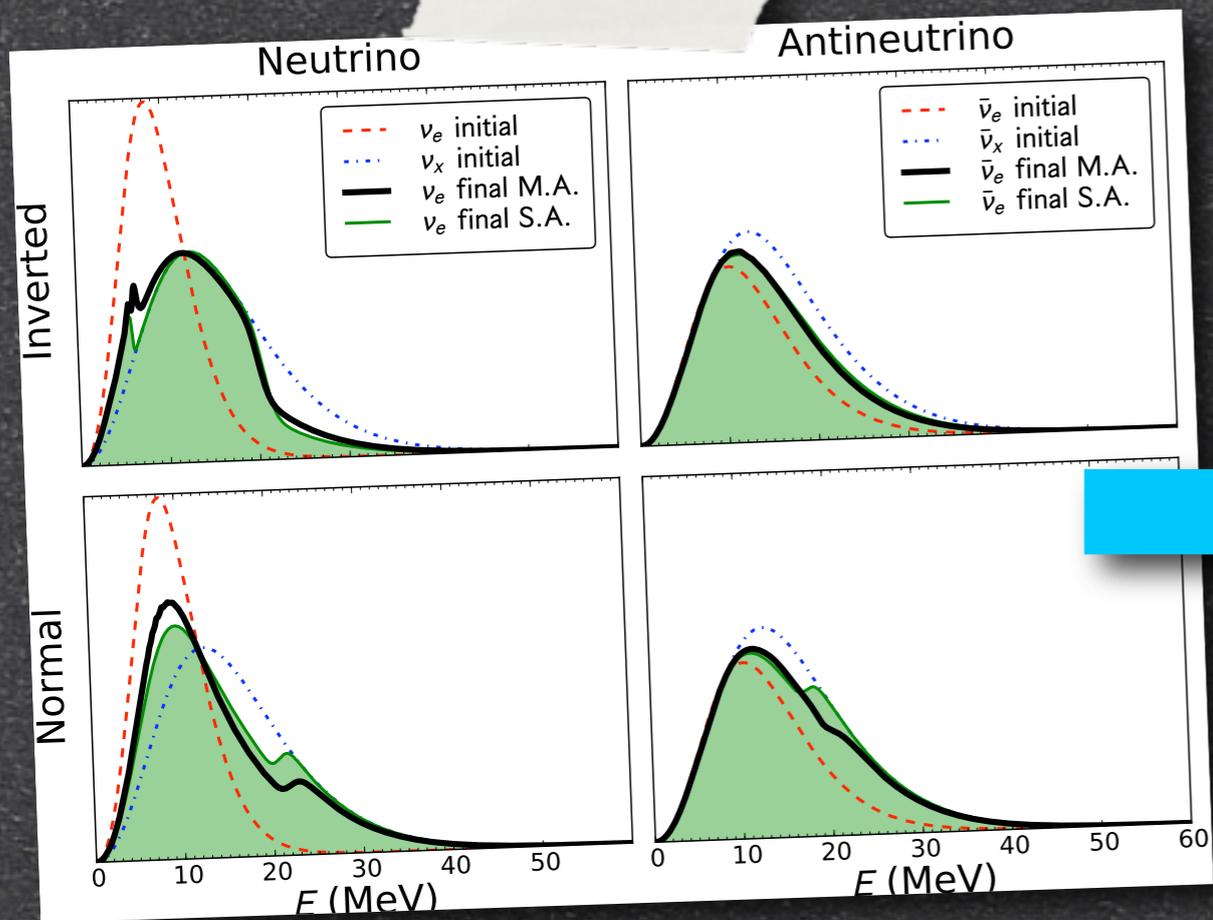
- Streaming neutrinos are so dense that their oscillations on different trajectories and with different energies are coupled
 - Definitely unachievable on Earth!
- The entire ensemble evolves collectively -> qualitatively new dynamics

Computationally demanding

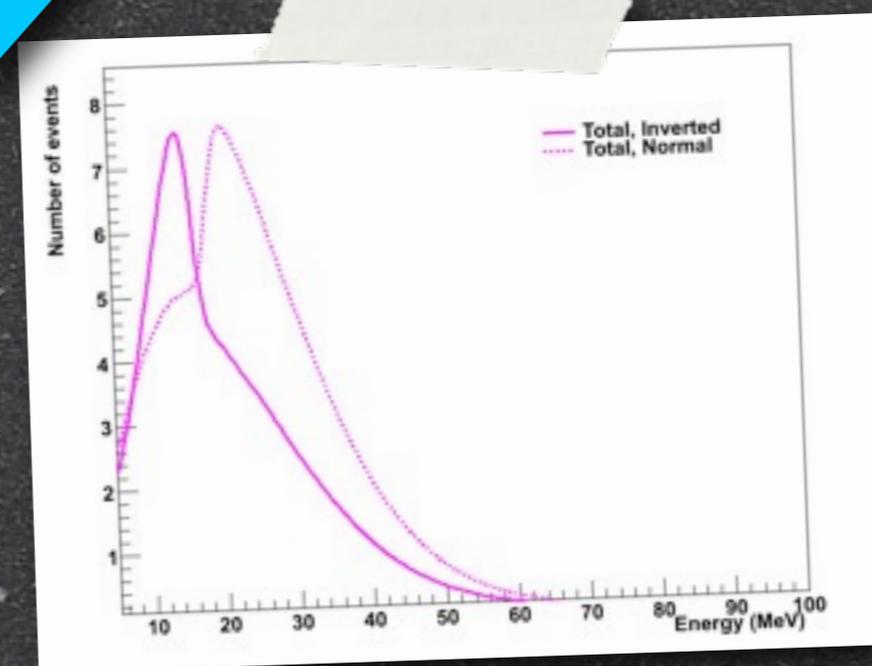
- 10^3 angular bins x 10^3 energy bins
 - requires supercomputing
 - became possible only in the last ~5 years
- There was hope that the problem could be simplified by taking an averaged coupling between different rays
 - Turns out this works only in some regimes and explicitly fails in others

Since supercomputing is hard...

- Take a specific choice of conditions (e.g., from a particular simulation)
- Oscillate
- Hope that the results are “typical”
draw general conclusions



WC



LAr

- Fall 2010 LBNE report by SN working group
- * spectra by Duan & Friedland (PRL 2011)
 - * detector modeling by Kate Scholberg & co

So how typical are
these typical results?

Los Alamos Weather

Updated: Oct 23, 2011, 7:25pm MDT

Tomorrow



Sunny

67°

High

Chance of Rain:
0%

Tomorrow Night



Partly Cloudy

49°

Low

Chance of Rain:
20%

Batavia Weather

Updated: Oct 23, 2011, 8:25pm C

Tomorrow



Sunny

64°

High

Chance of Rain:
0%

Tomorrow Night



Mostly Clear

44°

Low

Chance of Rain:
20%

Los Alamos Weather

Updated: Oct 23, 2011, 7:25pm MDT



Batavia Weather

Updated: Oct 23, 2011, 8:25pm C



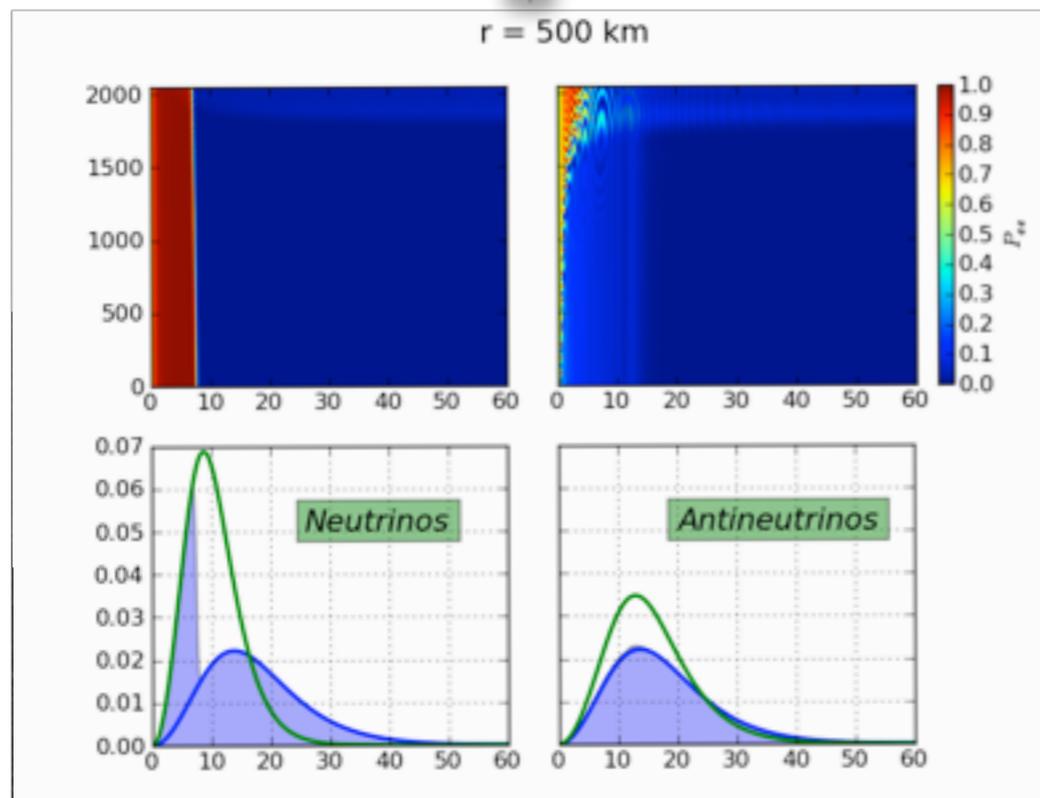
One might be tempted to conclude that this is “typical” weather in the US!

📌 Needed:

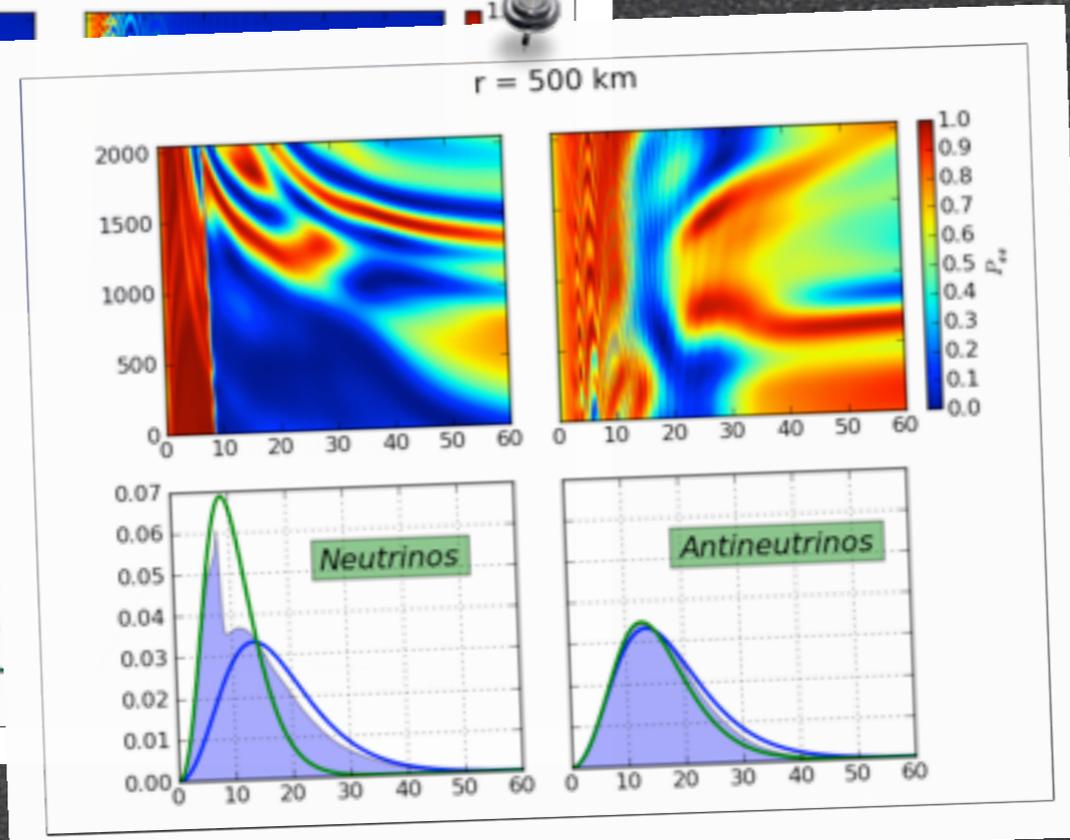
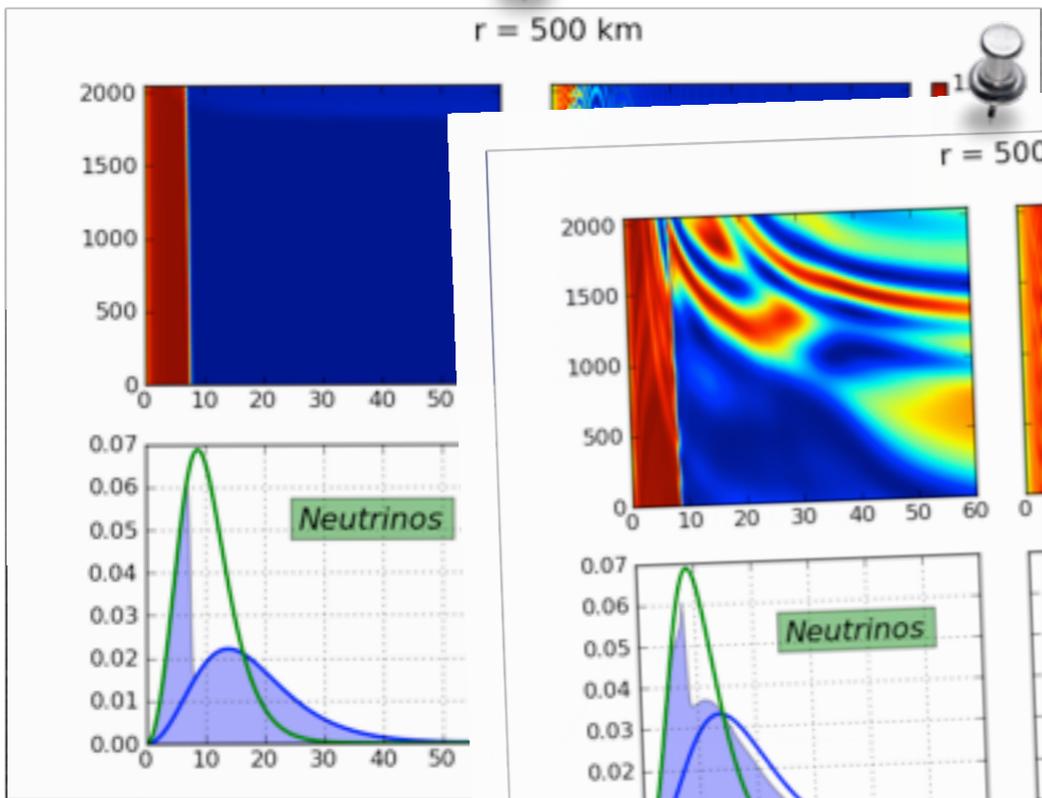
📌 Better codes

📌 A lot of supercomputer time

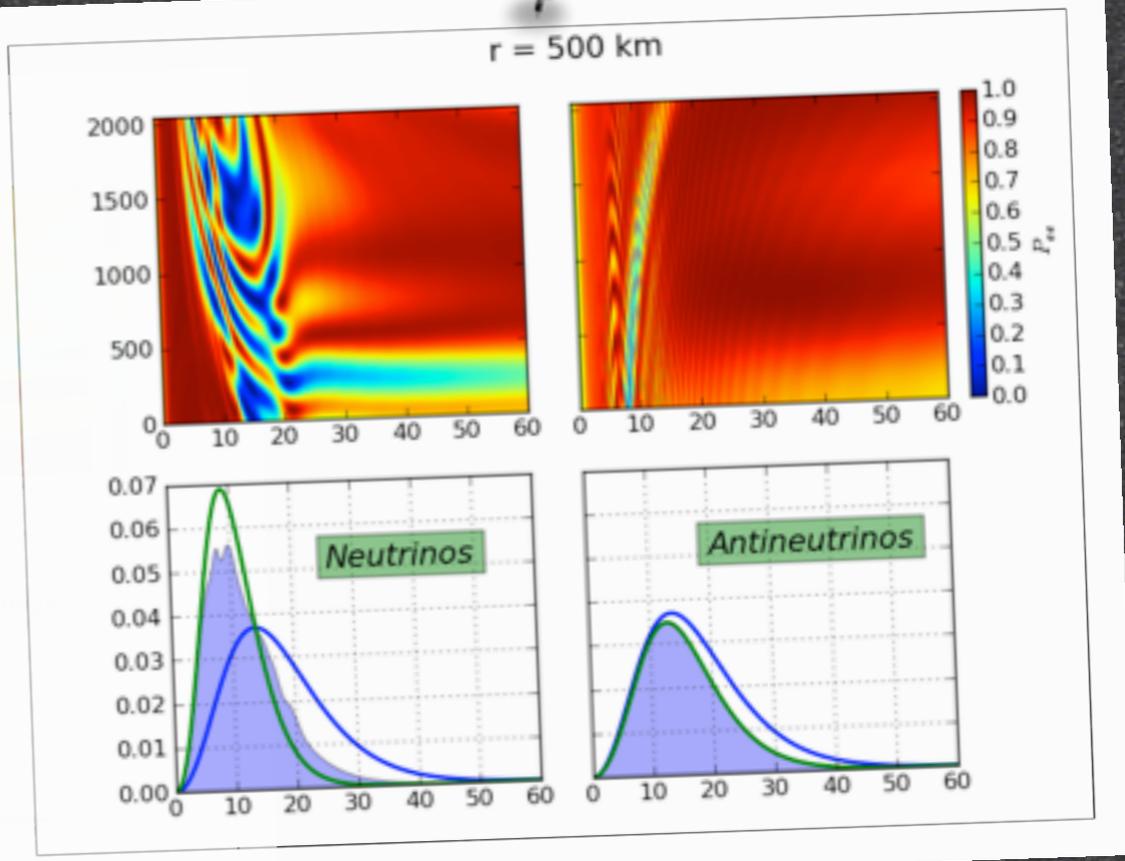
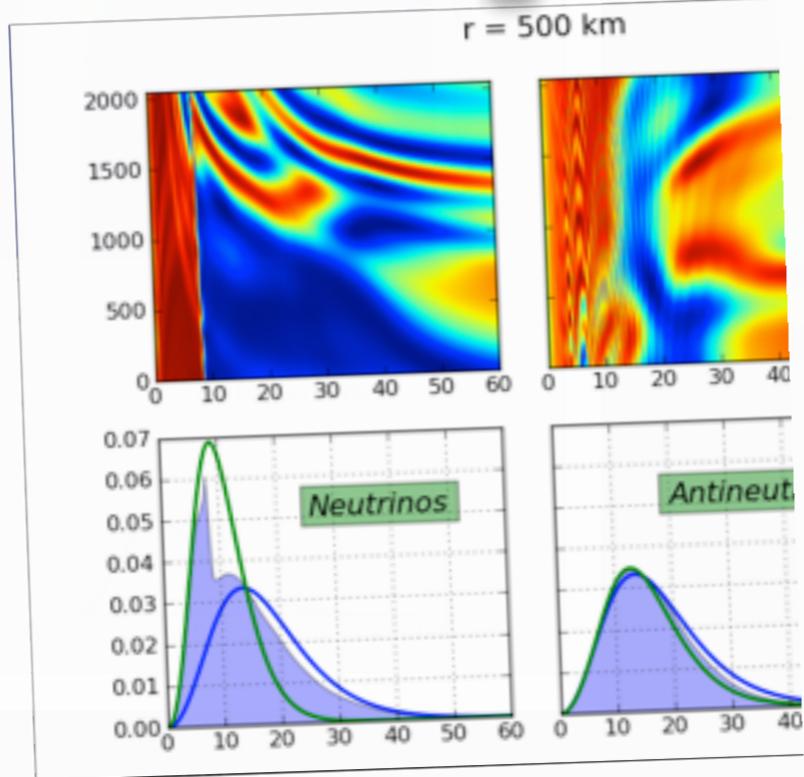
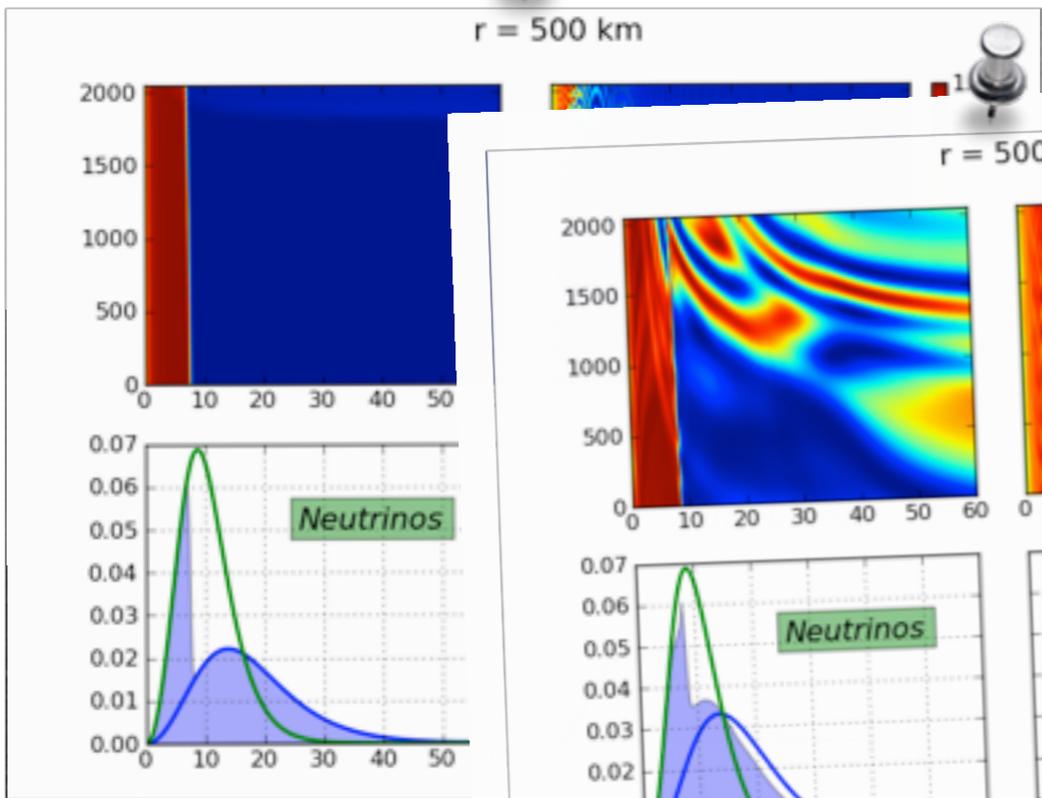
Let's vary initial spectra ...



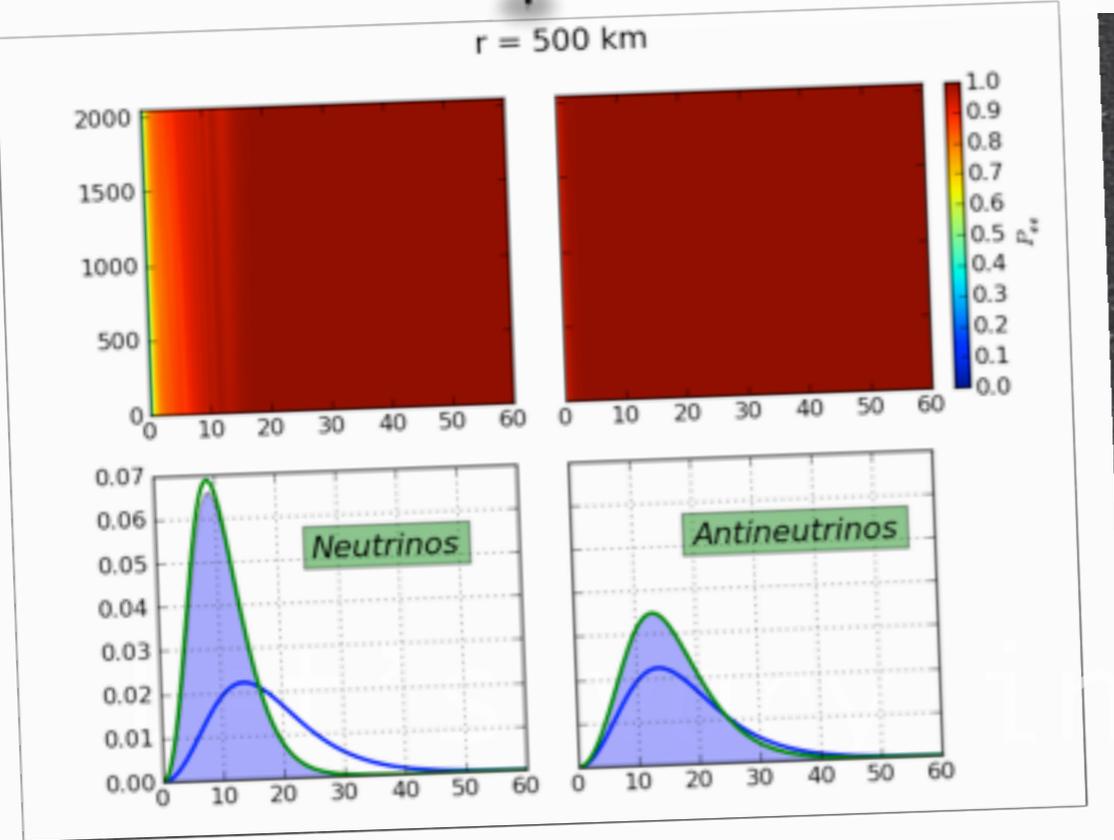
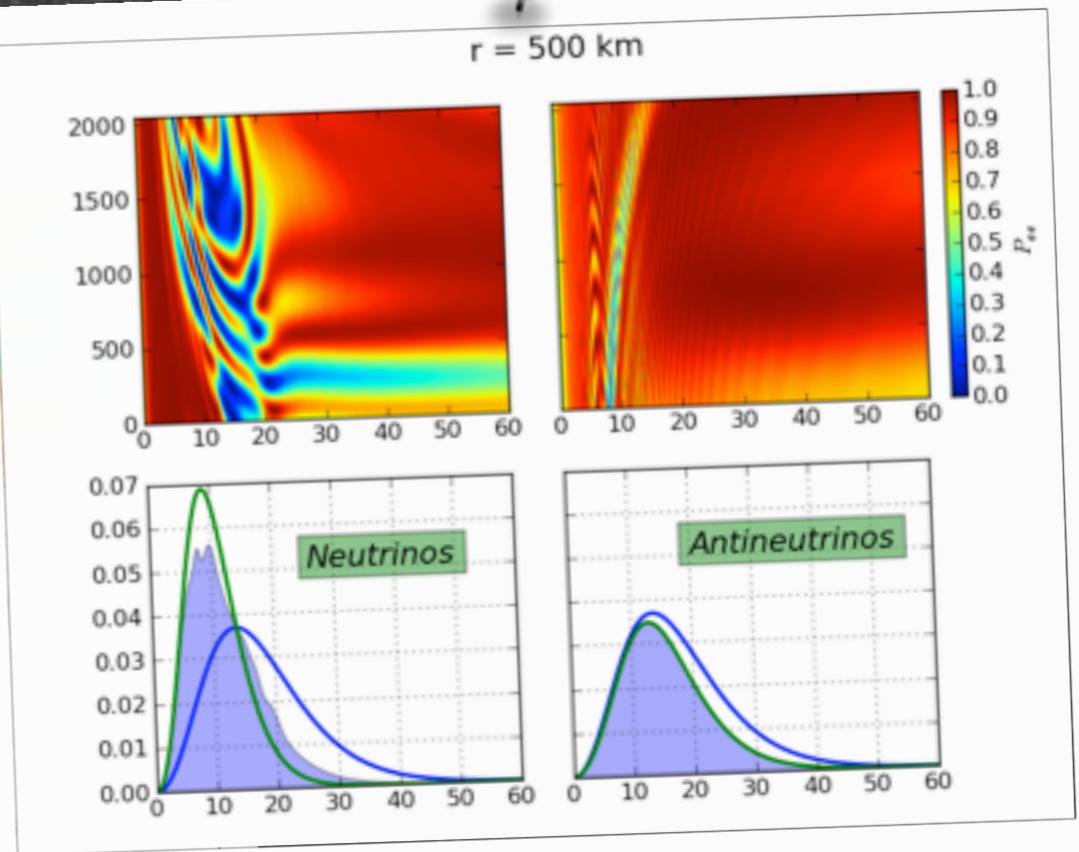
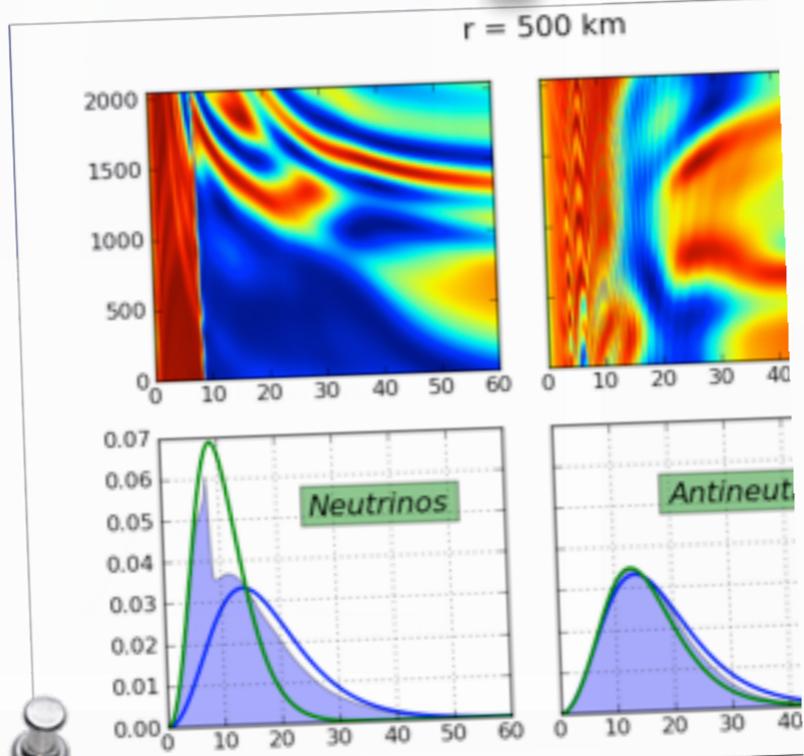
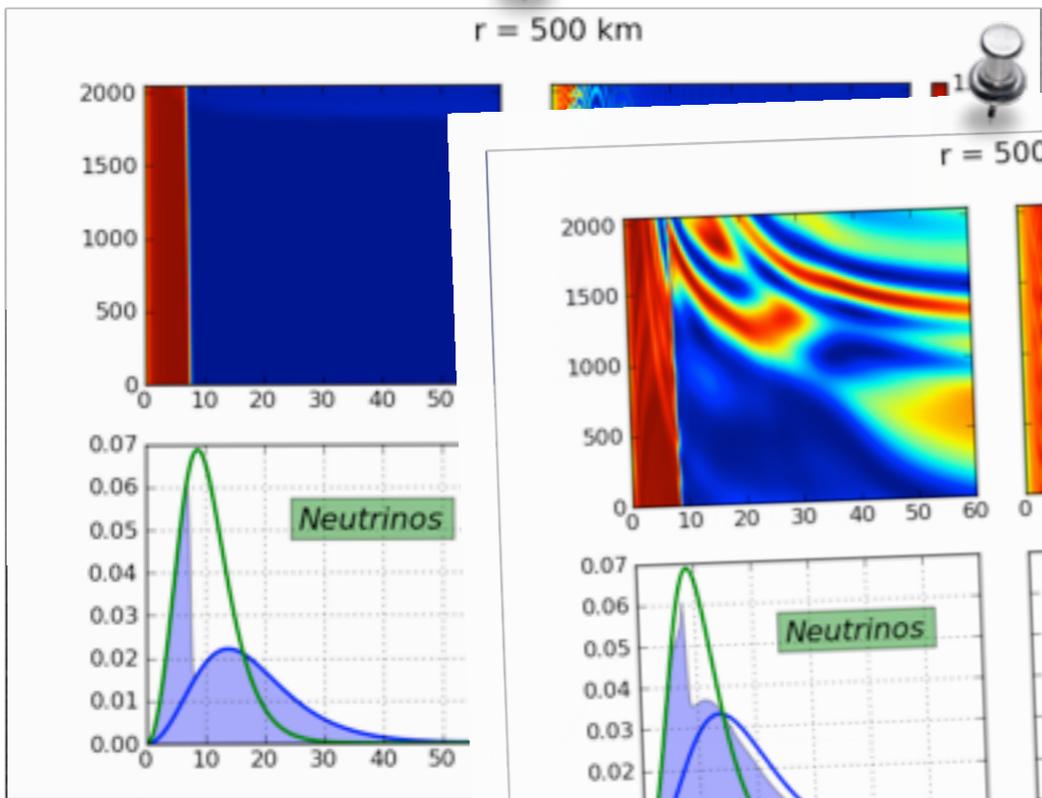
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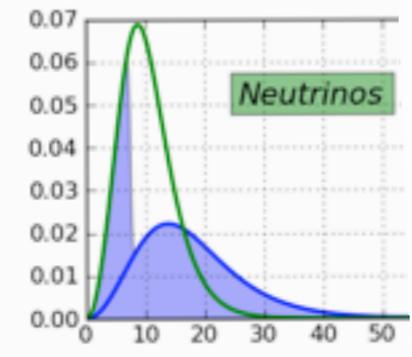
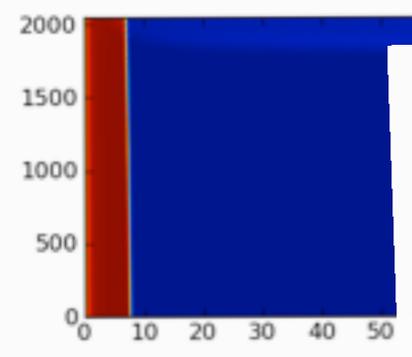


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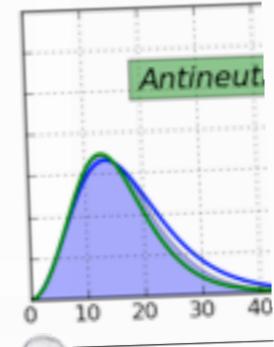
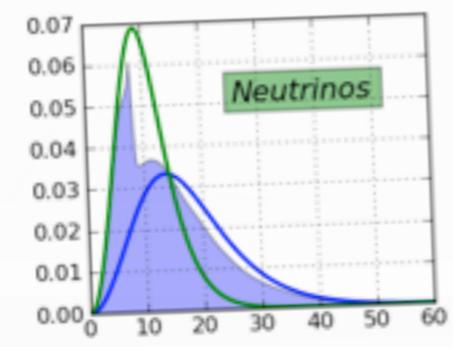
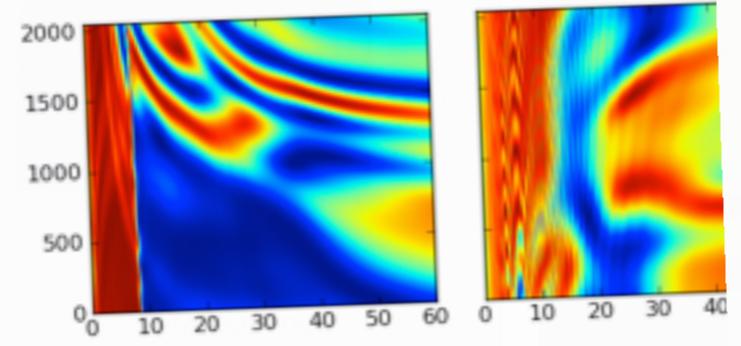


initial spectra . . .

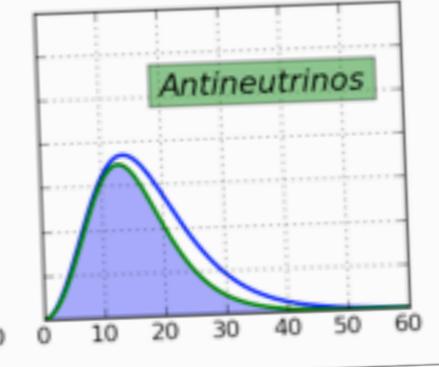
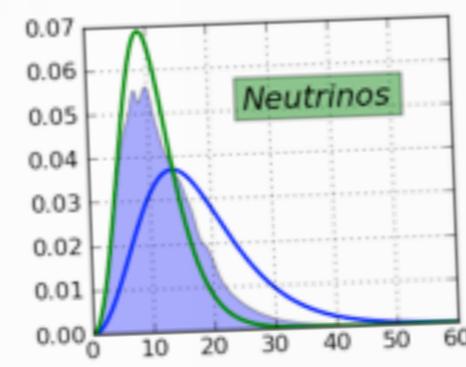
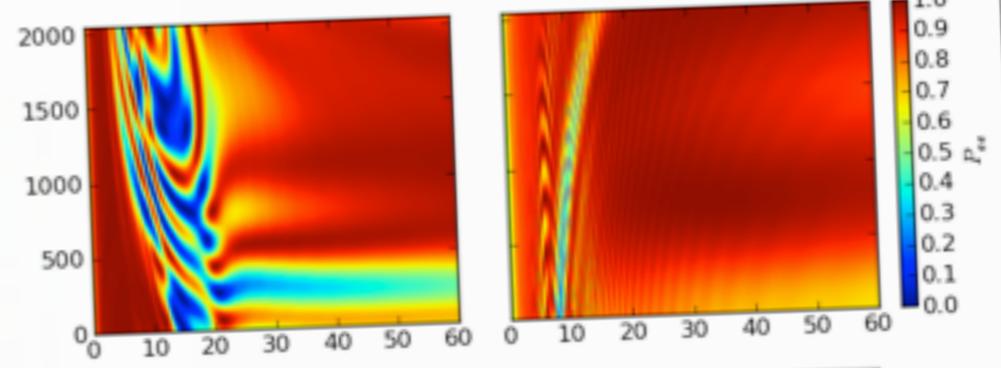
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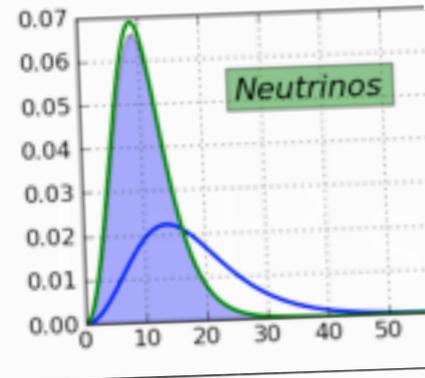
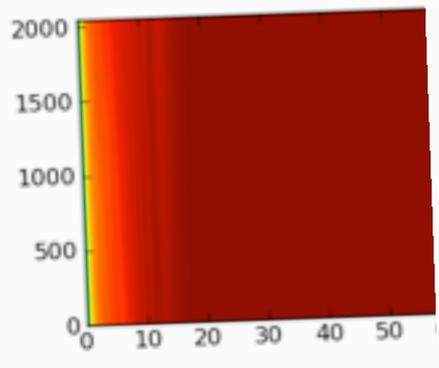
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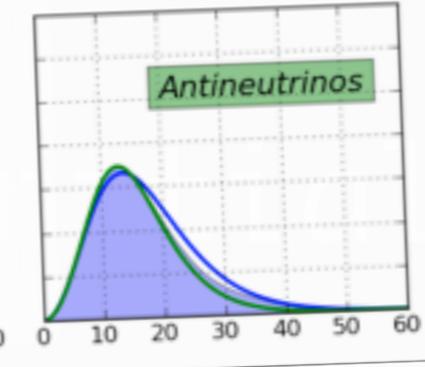
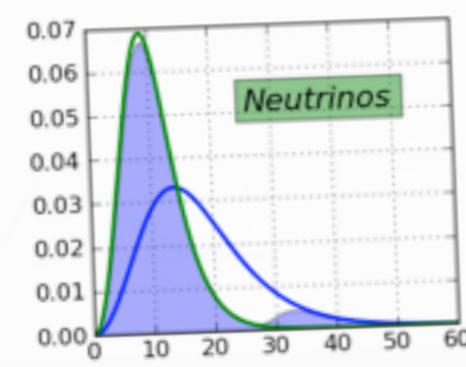
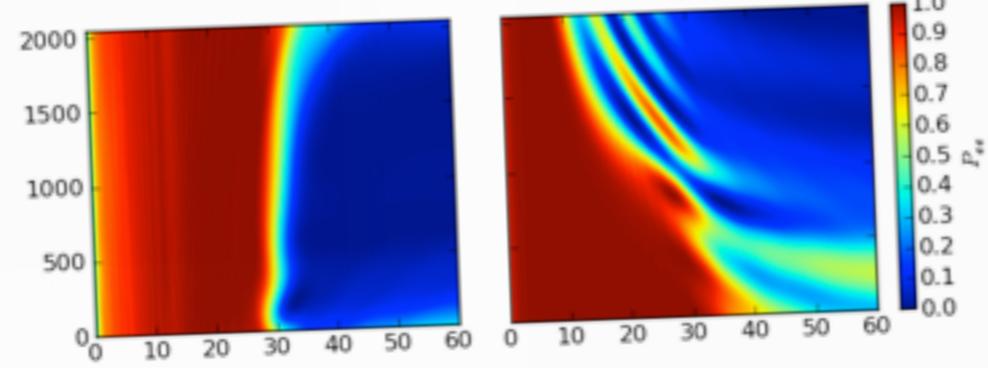
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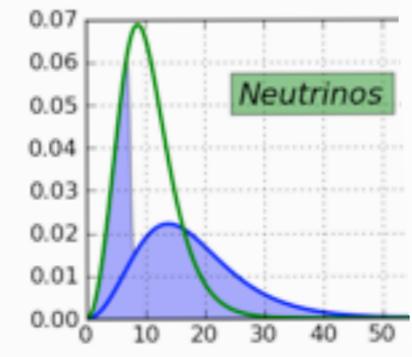
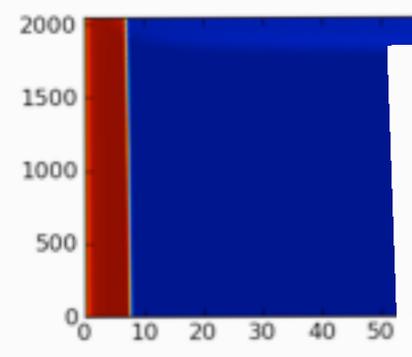


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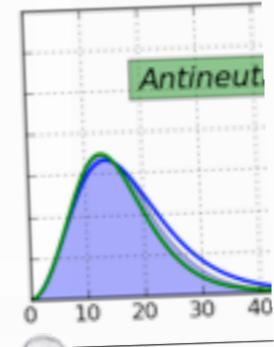
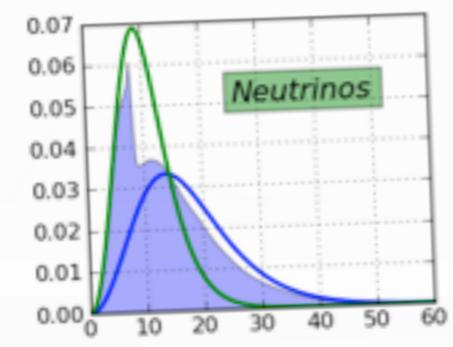
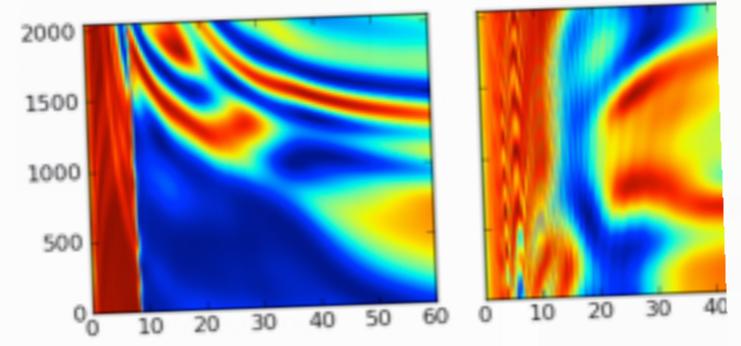


spectra . . .

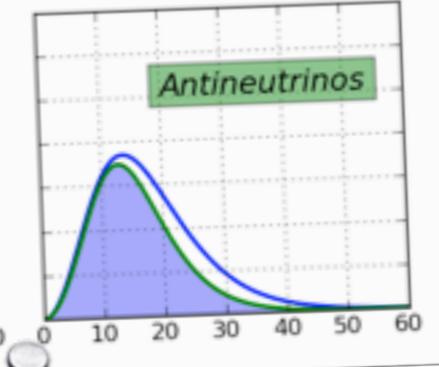
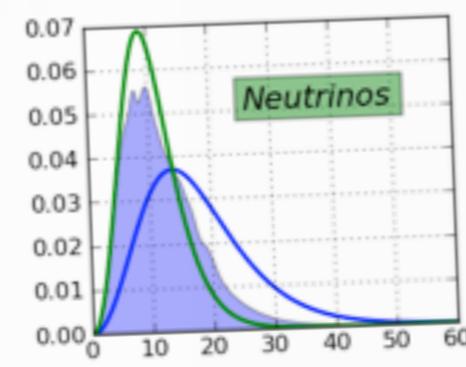
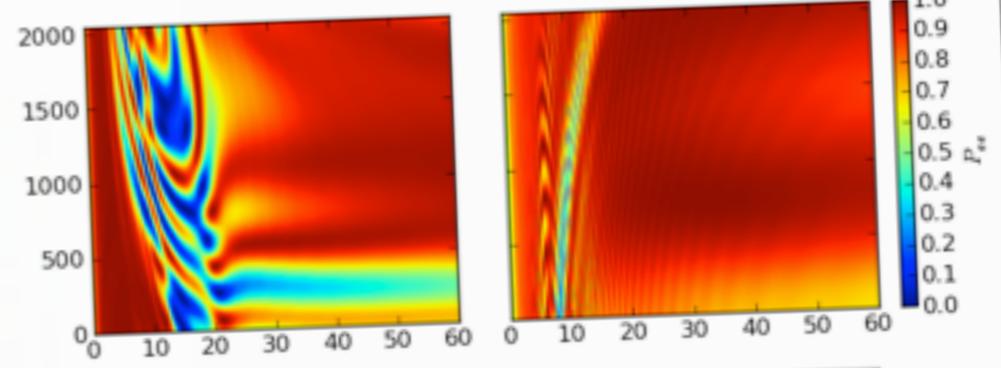
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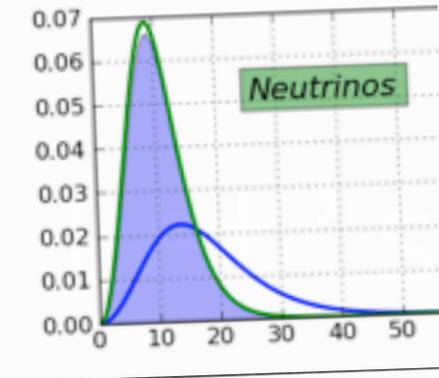
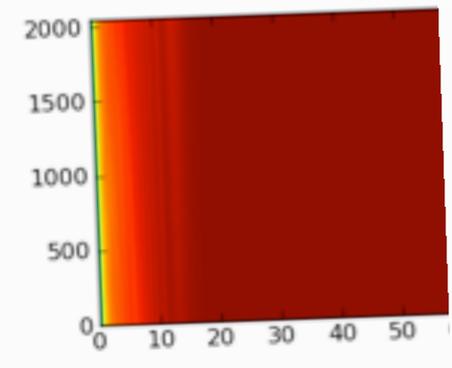
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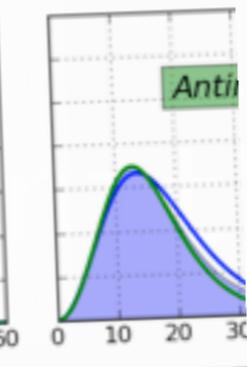
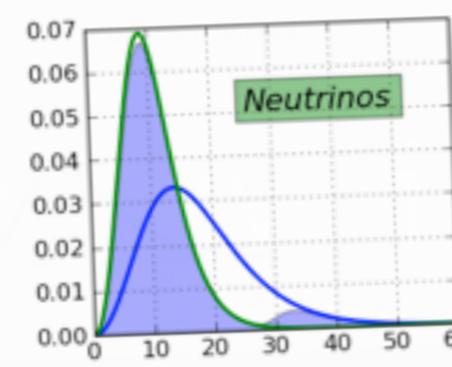
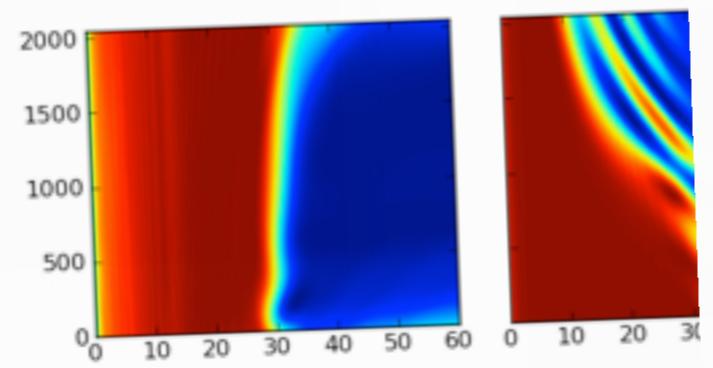
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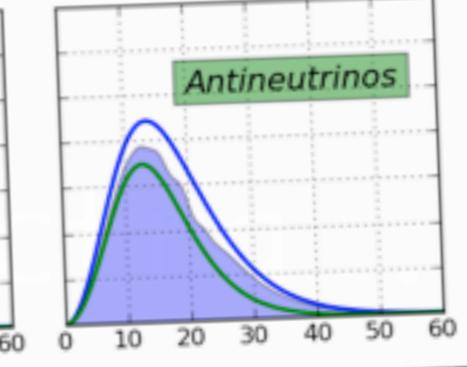
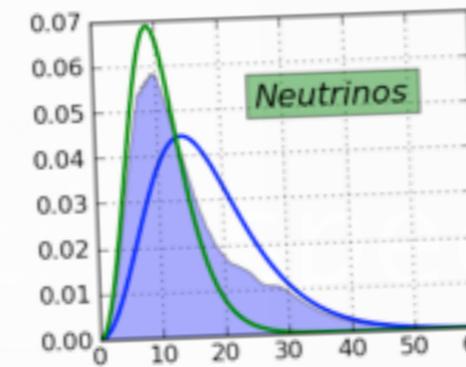
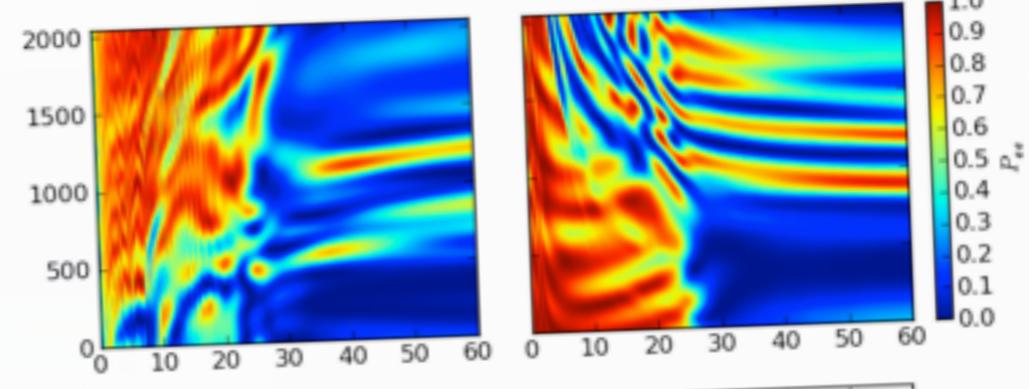
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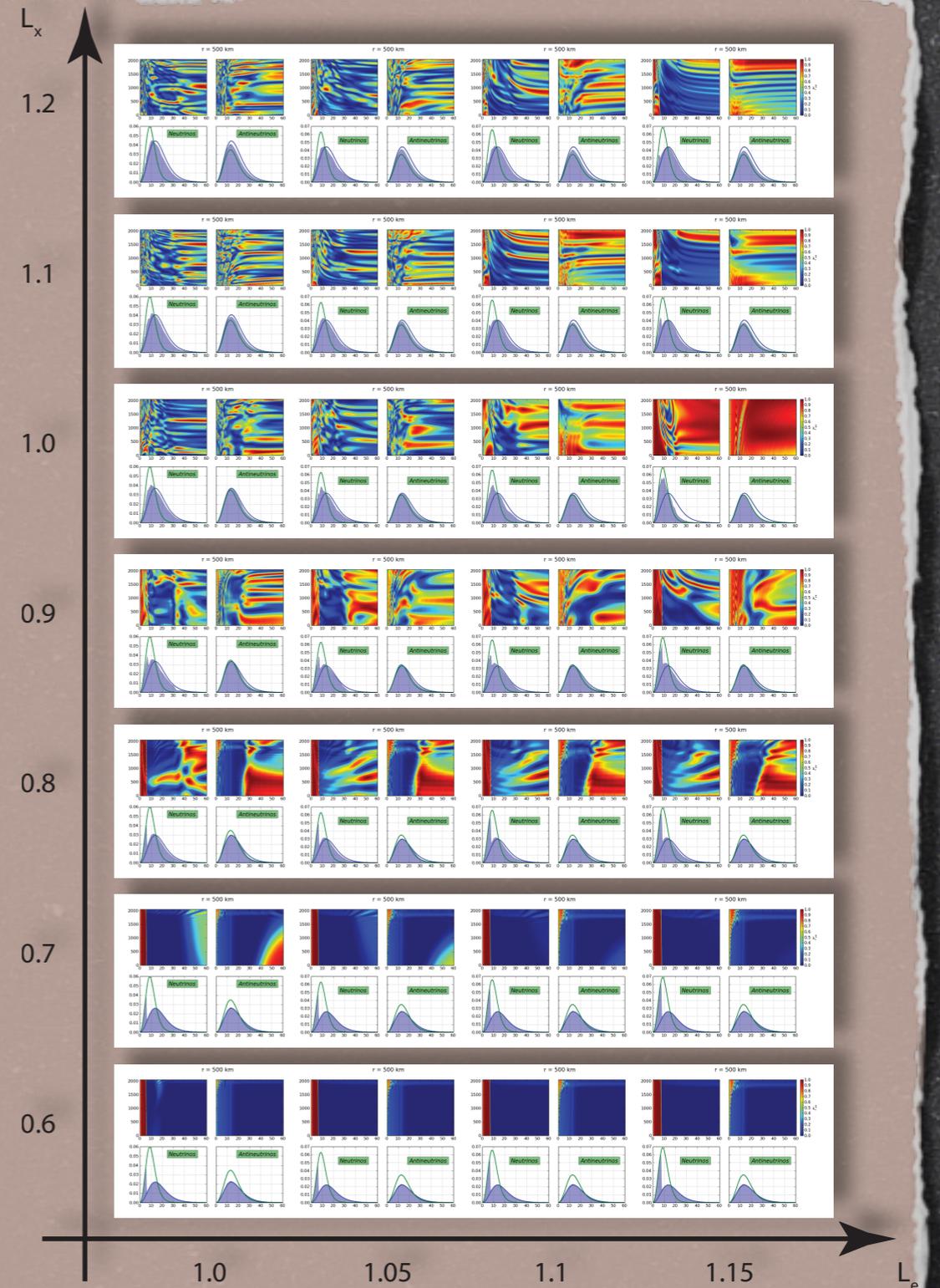
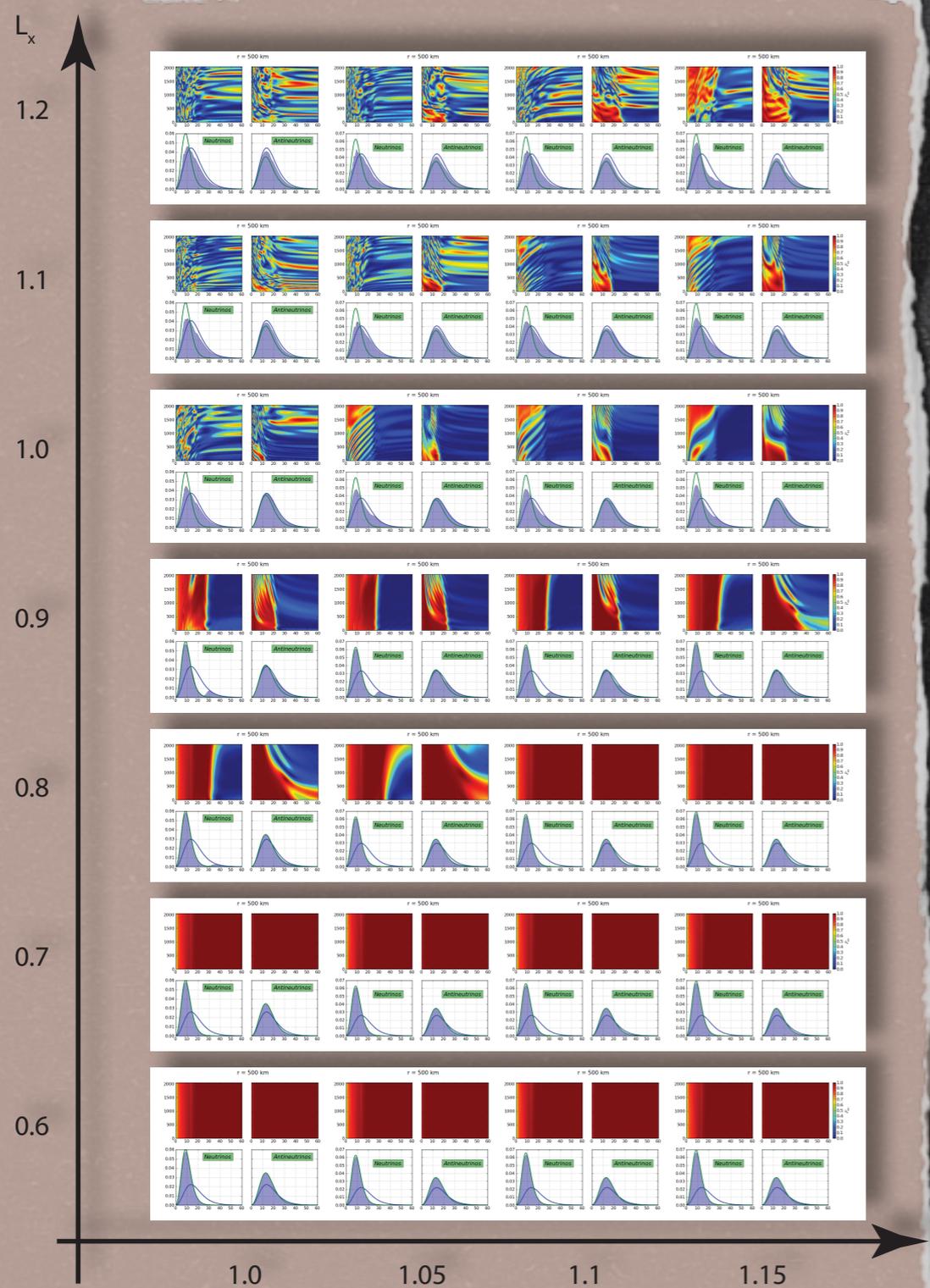
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Phase diagram!



Why is this cool?

- Identified what different regimes there are and where they are on the phase diagram
- Observation of a given regime would give information about the physics of the explosion
- Now need to perform studies of proposed detector configurations!