

Astrophysical Neutrinos 20th Century and Beyond

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IUPAP Centennial Lecture

P. Krastev, E. Lisi,
A. Smirnov, E. Waxman

Outline

- Solar neutrinos
- Extragalactic neutrinos

1967: 'Neutrino Experiments and the Problem of Leptonic Charge'

“From the point of view of detection probabilities, an ideal object is the Sun.”



Sov Phys JETP 26, 984 (1968)

1964: Sole motivation

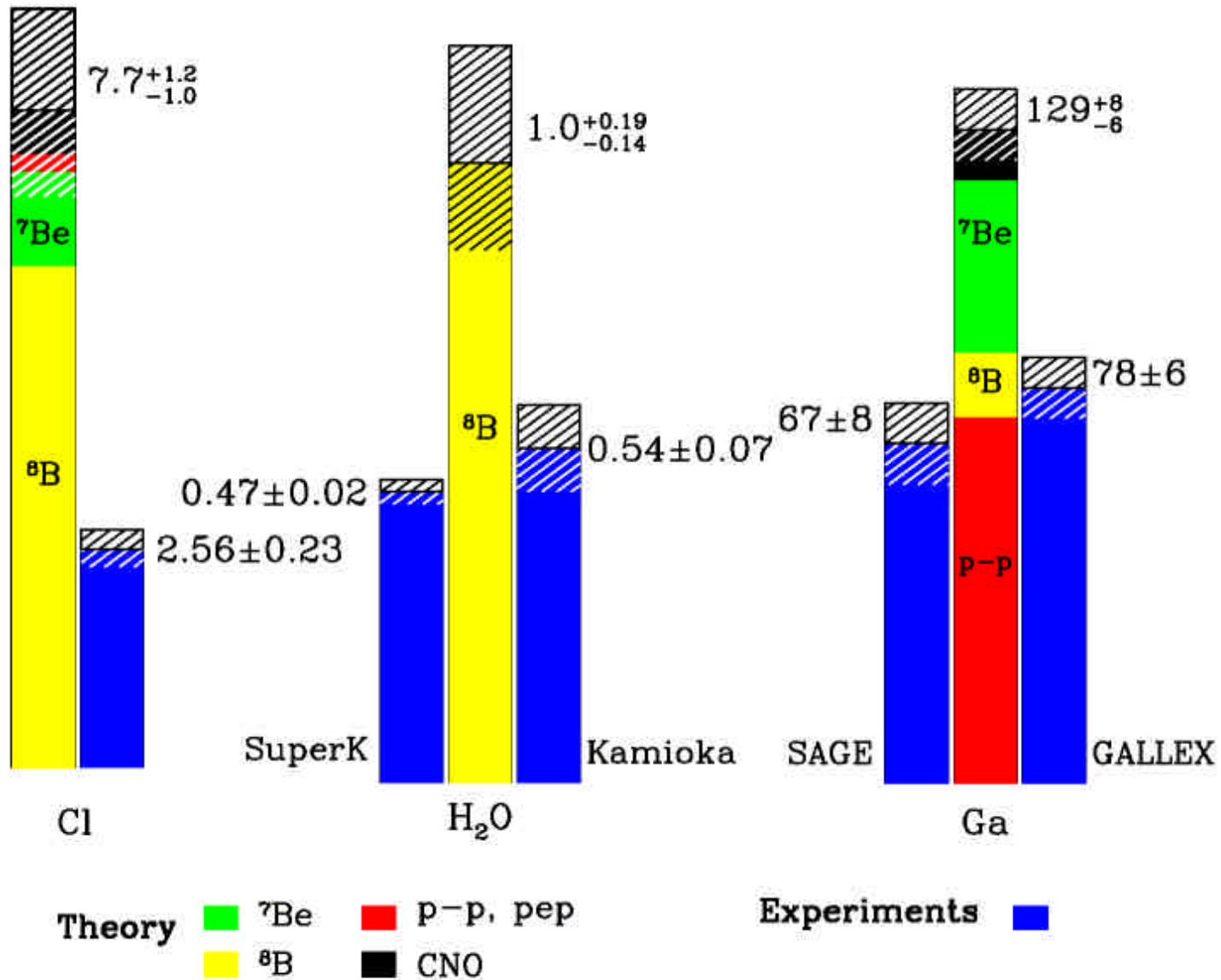
“... to see into the interior of a star and thus verify directly the hypothesis of nuclear energy generation in stars.”

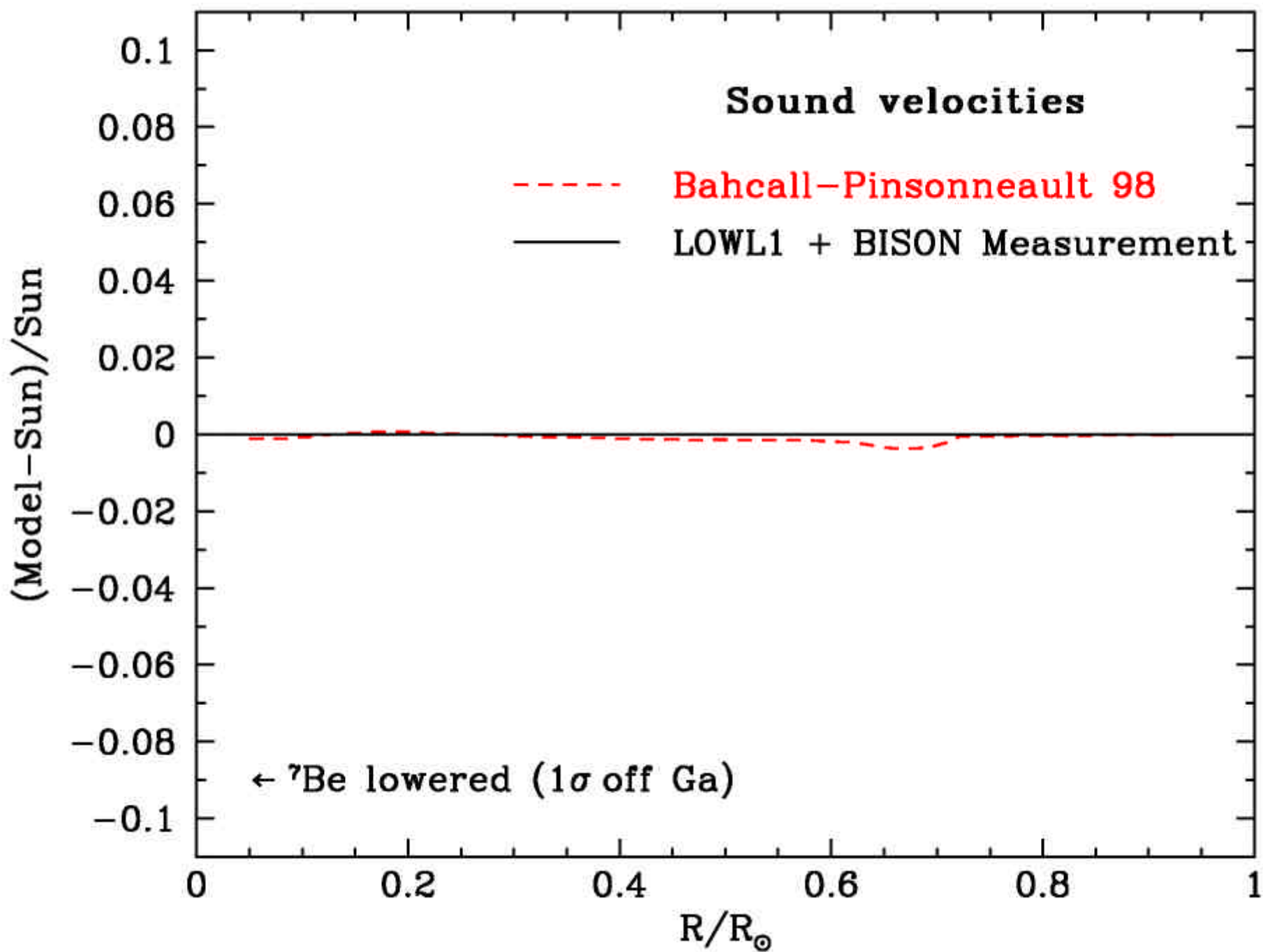


PRL 12, 300, 1964

Total Rates: Standard Model vs. Experiment

Bahcall-Pinsonneault 98

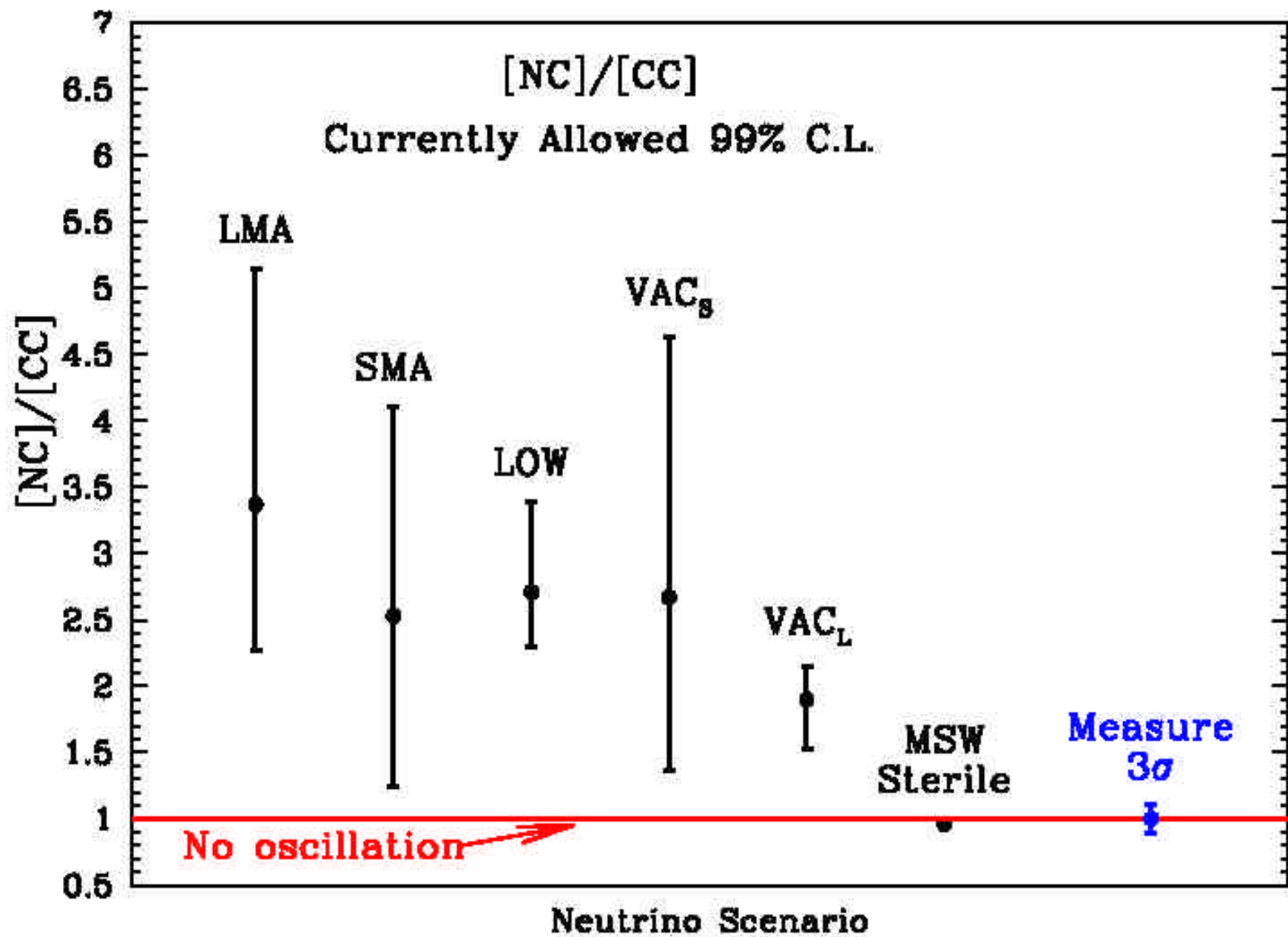


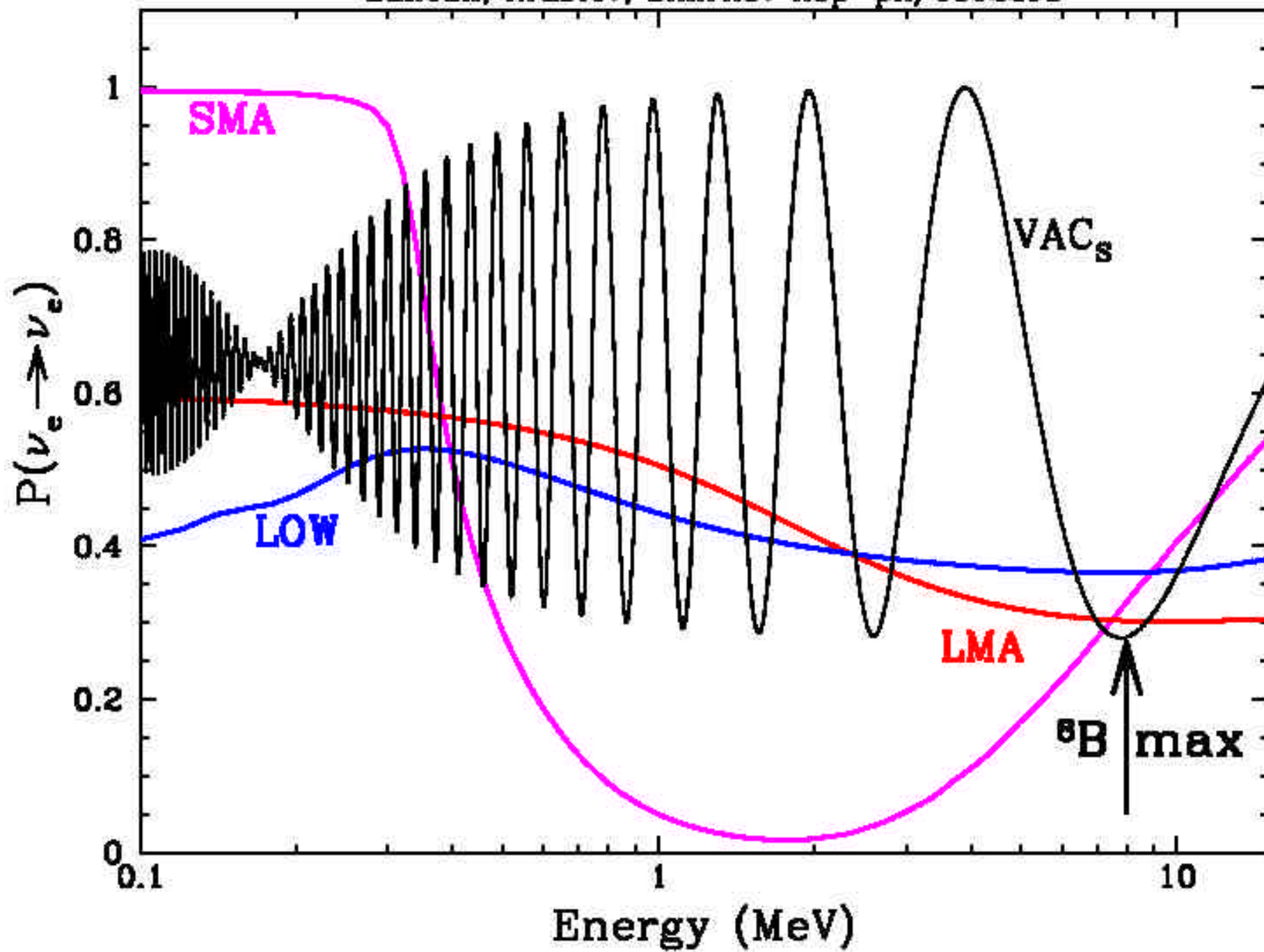


Solar neutrinos: 1968-2000

- Solar neutrinos detected
- Evidence for new physics
- $0.55 \hat{=} \hat{=} \text{}^8\text{B} = \text{}^8\text{B}_{\text{SSM}} \hat{=} 1.32^{\tilde{a}}$

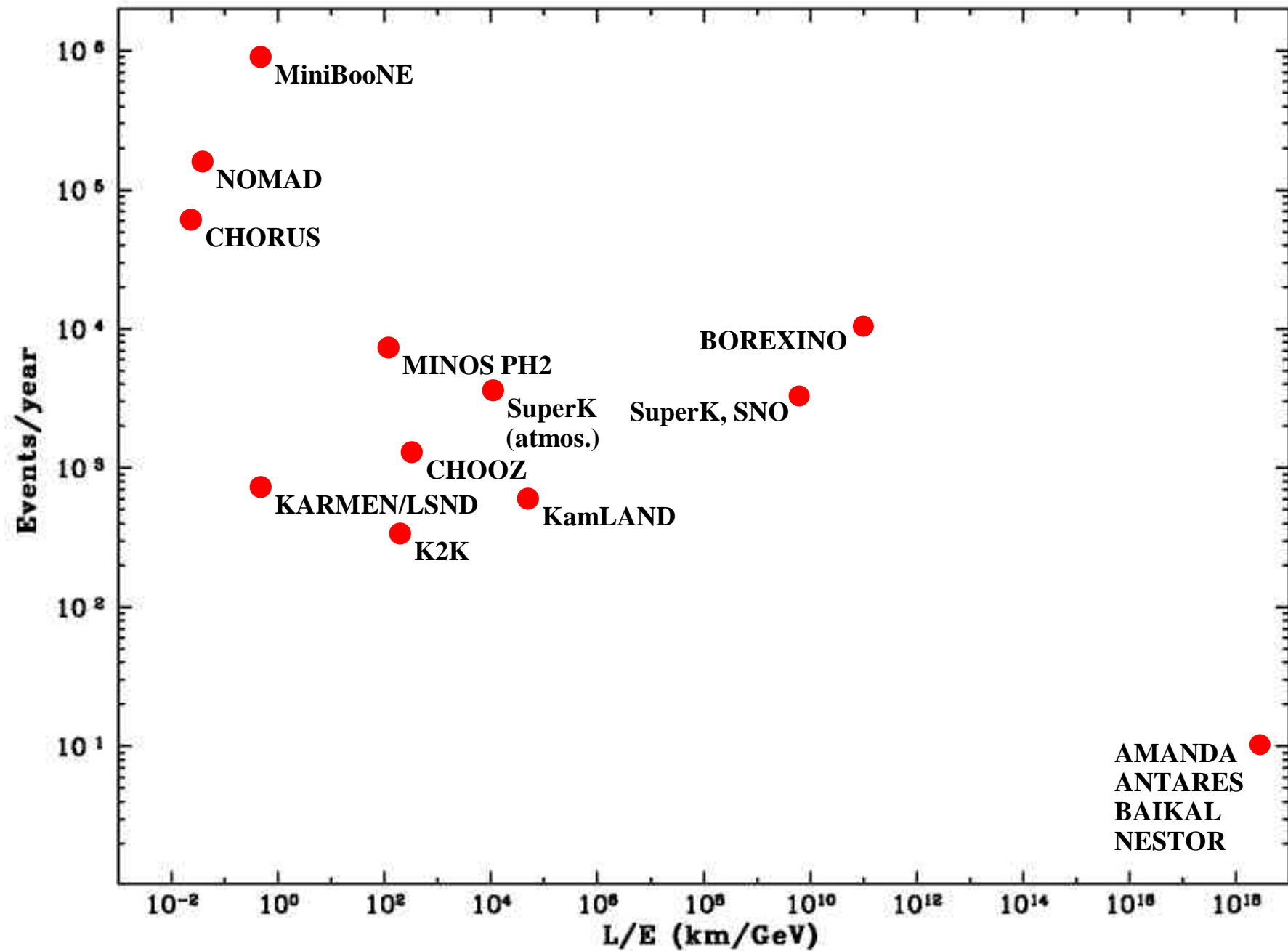
* Bahcall, Krastev, Smirnov: hep-ph/9911248





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Why is searching for ν 's from GRBs of interest?

Astrophysical motivations

- Test: origin of highest energy cosmic rays
- Verify: understanding of GRB fireball

Physics motivations

- Search for vacuum oscillations:

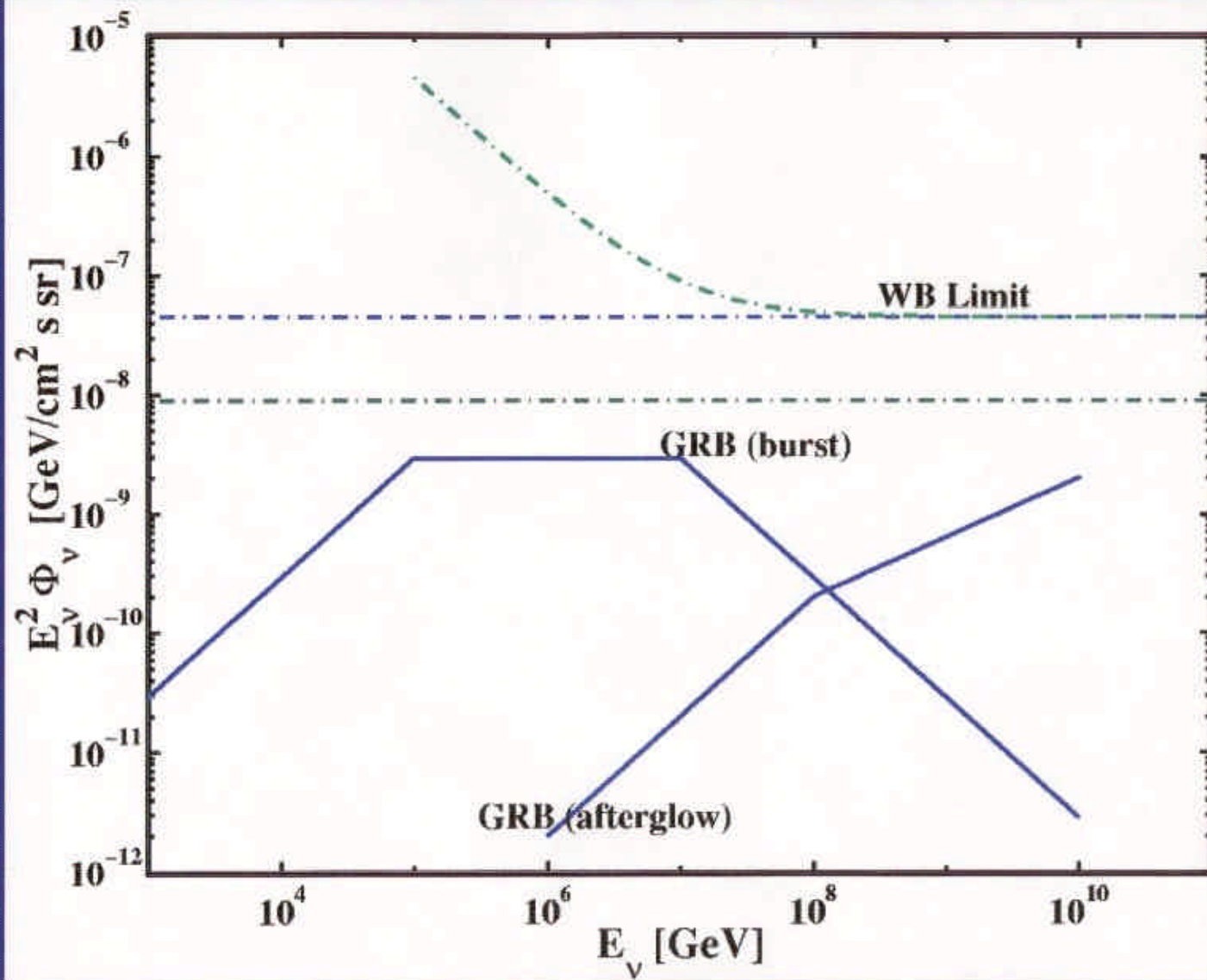
$$\Delta m^2 \sim 10^{-17} \text{eV}^2 \quad (\text{!})$$

- Test special relativity: 10^{-16}
- Test weak equivalence principle: 10^{-6}

Detection signatures

*) Direction of GRB

*) $t_{\dot{z}} = t_{\dot{1}} \quad (\sim 10 \text{ sec})$



Astrophysical Neutrinos: Goals 2000-2010

- Determine mixing angles and mass differences
- Test precisely solar energy generation
- Discover extragalactic neutrinos
- Learn new physics?

“... and Beyond”

- We shall not cease from exploration
- And the end of all our exploring
- Will be to arrive where we started
- And know the place for the first time.

T. S. Elliot, Four Quartets (1943)