Light neutralinos and white dwarfs

John Conley☂, Herbi Dreiner☂, Jeff Fortin☀ ,

Lorenzo Ubaldi☂

☂*Bethe Center for Theoretical Physics & Physikalisches Institut der Universität Bonn, Germany*

☀*University of California, San Diego*

Corfu, September 2012

Can we put bounds on SUSY with light neutralinos using white dwarf cooling?

1. Why light neutralinos?

2. Why white dwarfs?

1. Why light neutralinos?

In this talk the neutralino is the Lightest Supersymmetric Particle (LSP)

How light can the neutralino be?

Assuming gaugino mass unification, limits on the chargino masses from LEP translate into a lower bound for the neutralino mass

$$m_\chi > 46 \text{ GeV}$$

BUT...

Dropping this assumption, *particle physics* does NOT impose any bound on the mass of the neutralino.

A massless neutralino LSP is possible!

Maybe *astrophysics* can put bounds on light neutralinos...

PHYSICAL REVIEW D **68**, 055004 (2003)

Supernovas and light neutralinos: SN 1987A bounds on supersymmetry reexamined

H. K. Dreiner,[1] C. Hanhart,[2] U. Langenfeld,[1] and D. R. Phillips[3]
[1]*Physikalisches Institut, Universität Bonn, Nußallee 12, 53113 Bonn, Germany*
[2]*Institut für Kernphysik, Forschungszentrum Jülich, 52428 Jülich, Germany*
[3]*Department of Physics and Astronomy, Ohio University, Athens, Ohio 45701, USA*
(Received 5 May 2003; published 29 September 2003)

The idea

Neutralinos can be produced in a supernova

$$e^+ + e^- \to \tilde{\chi} + \tilde{\chi}, \qquad \text{pair production}$$

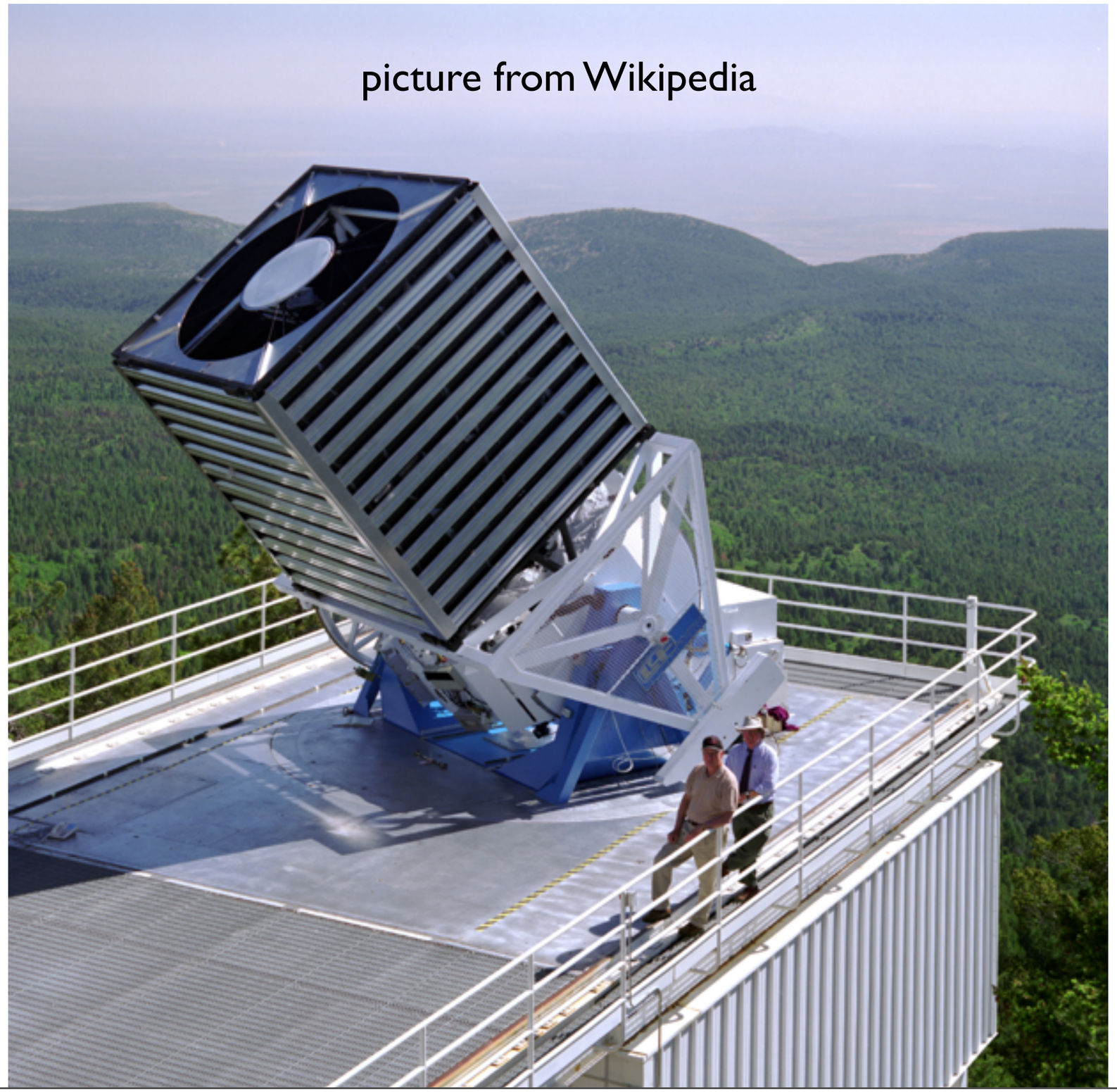
neutralinostrahlung $\quad N + N \to N + N + \tilde{\chi} + \tilde{\chi}.$

and escape, contributing to the supernova cooling.

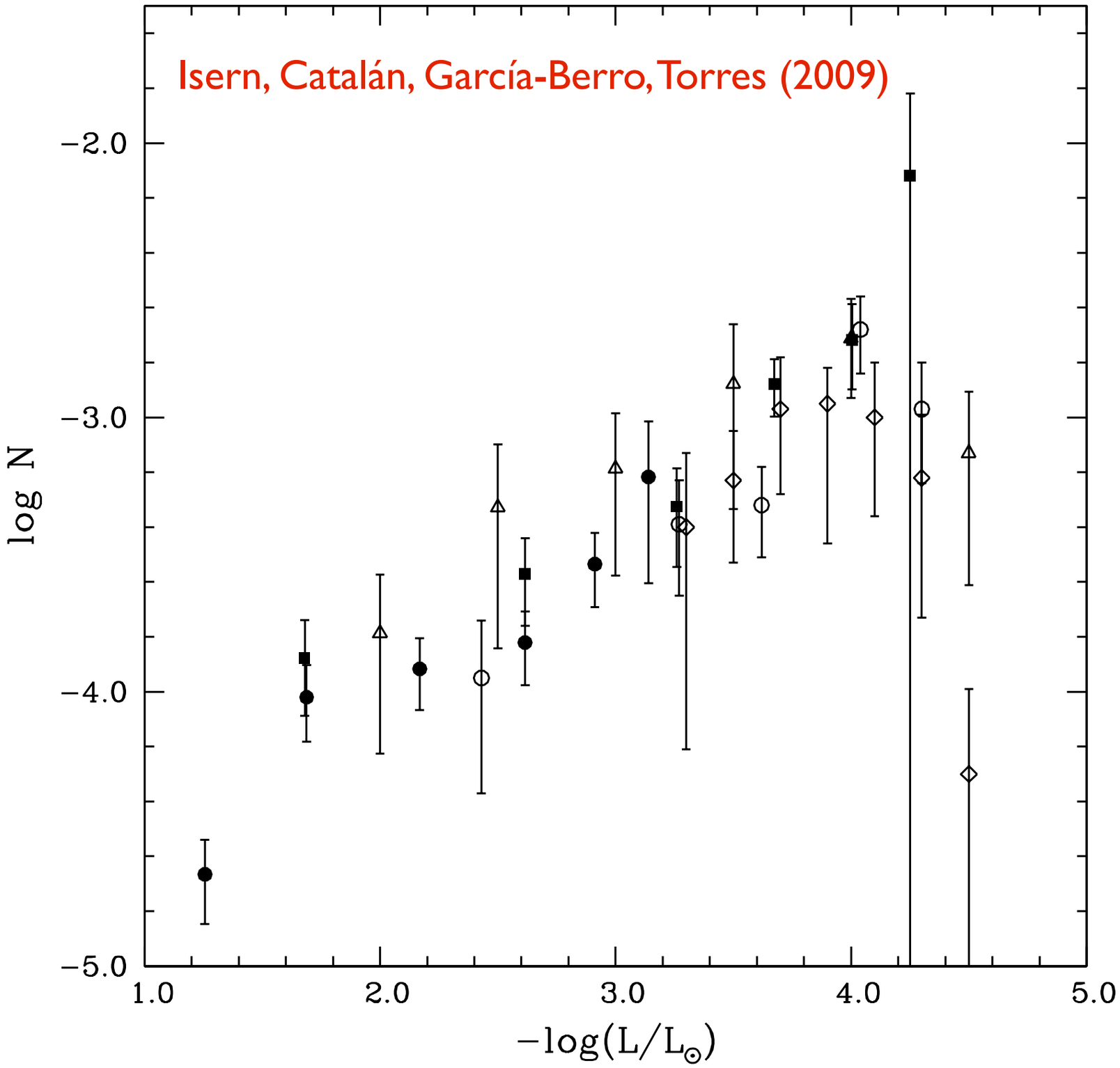
Demand that the neutralino cooling doesn't alter the measured neutrino signal.

2. Why white dwarfs?

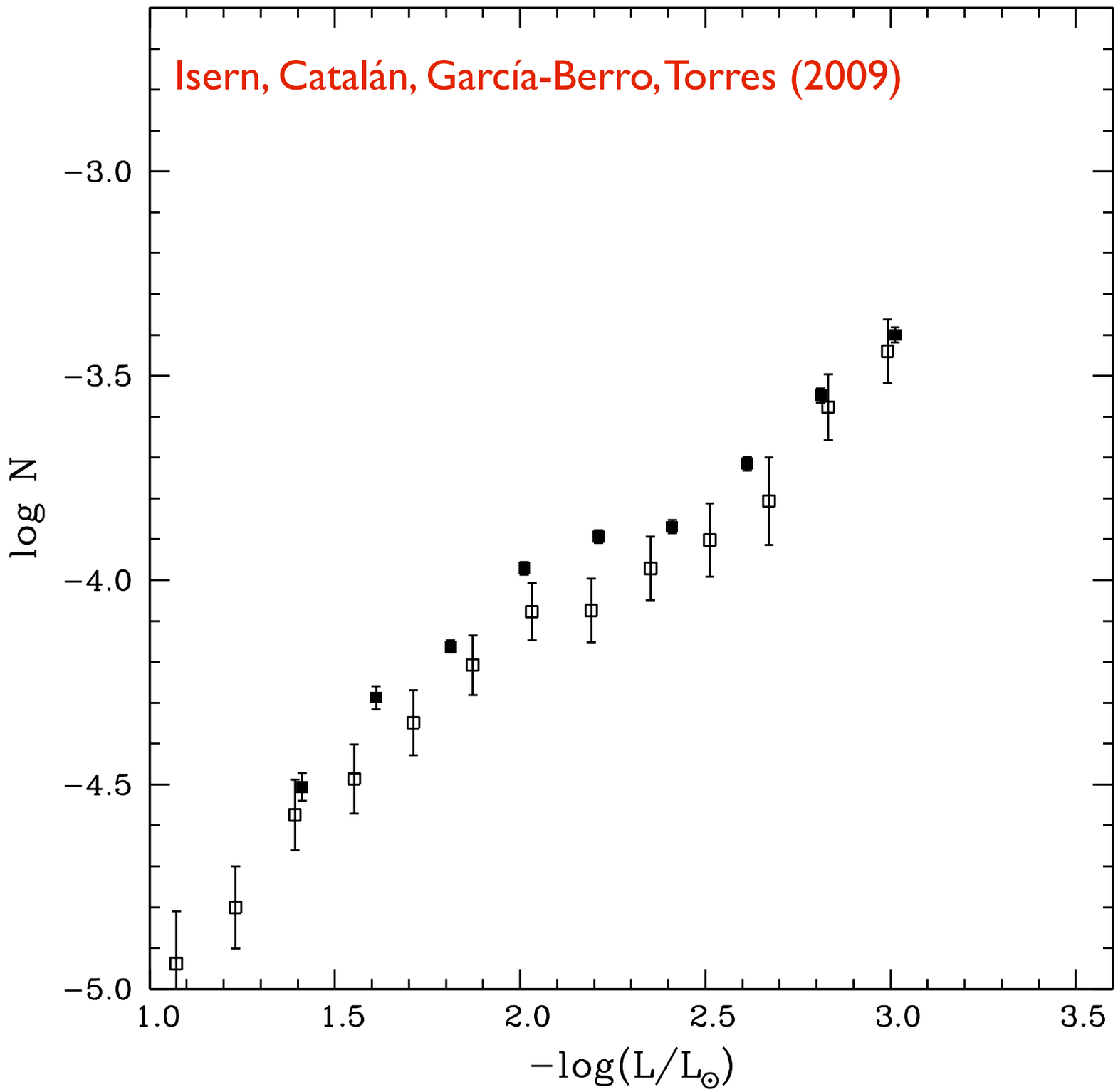
Sloan Digital Sky Survey (SDSS)



WD luminosity function pre-SDSS



WD luminosity function after SDSS



Do we understand the physics of WD cooling *well*?

YES

Are the latest SDSS measurements precise enough to be used to put *significant* bounds on new physics from WD cooling?

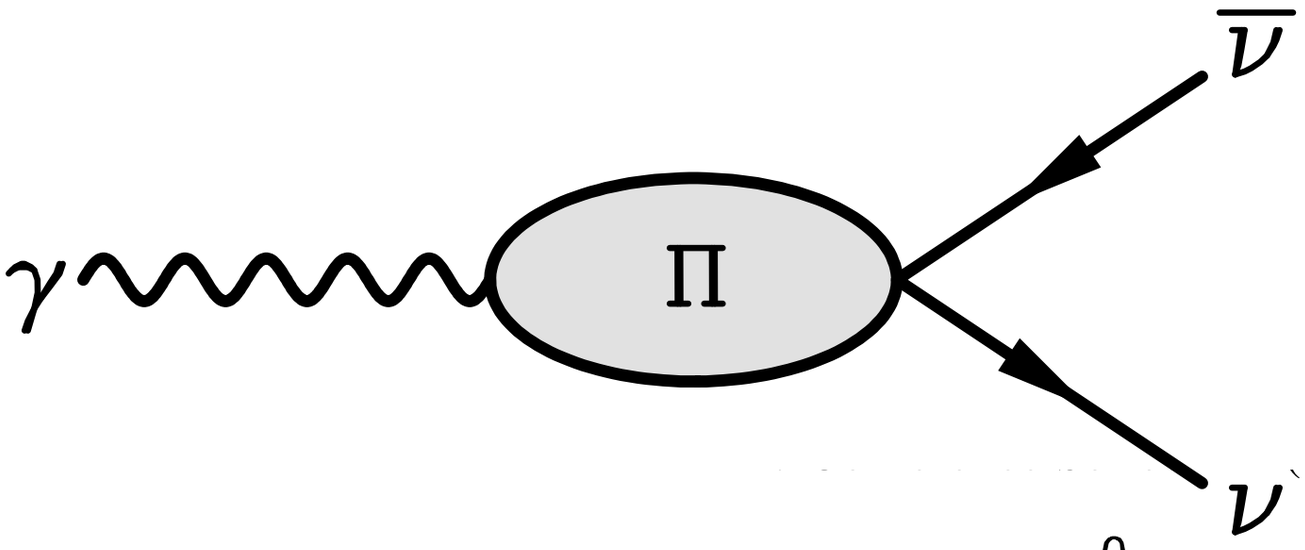
Maybe. Let's try!

What's a white dwarf anyway?

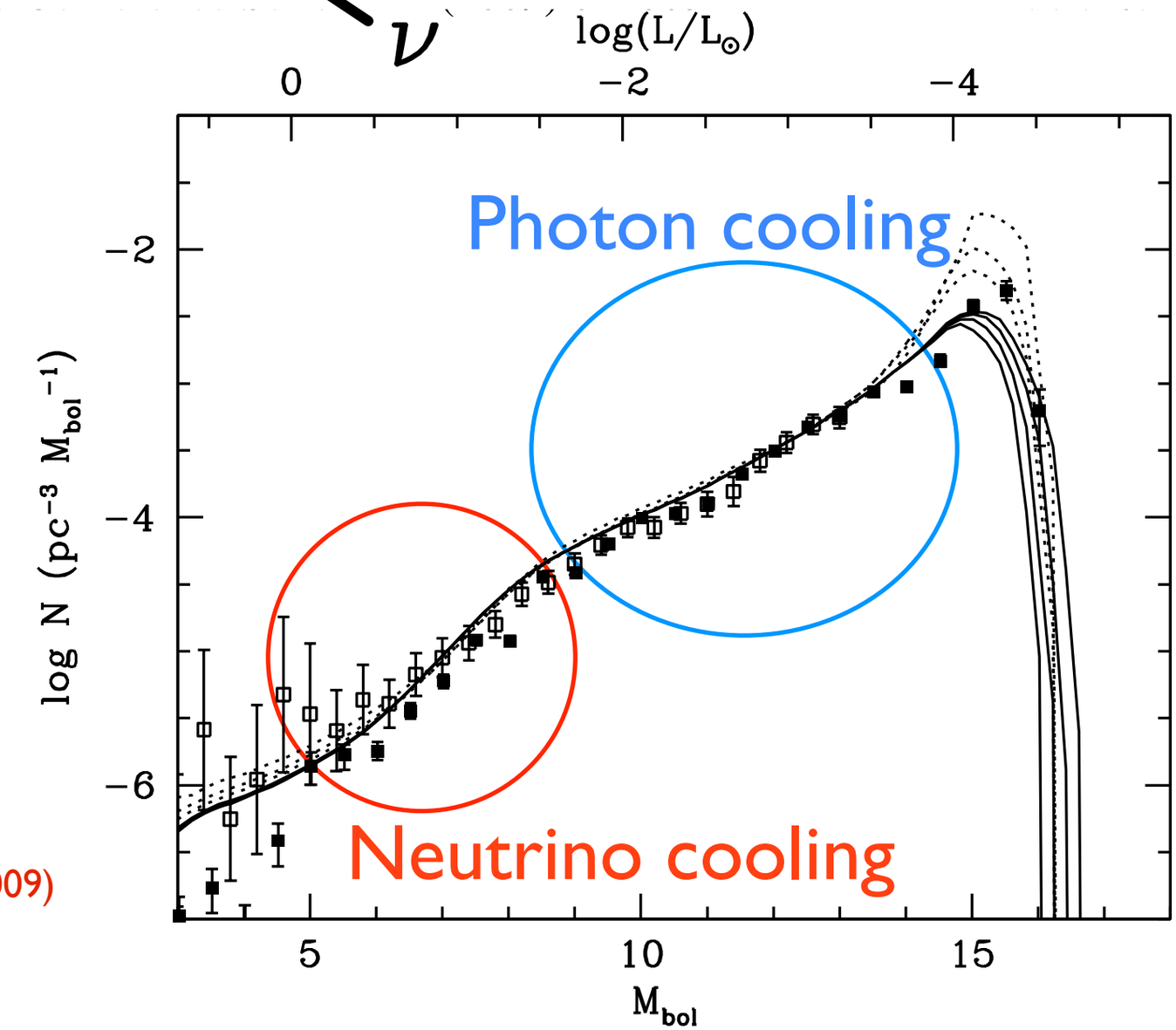
- It's a star with a typical mass of 0.6 $M_\odot$ that has burnt all its fuel. It consists mostly of nuclei of carbon and oxygen and of highly degenerate electrons.

- It's a simple object! It just cools down via emission of photons and neutrinos.

Neutrino cooling

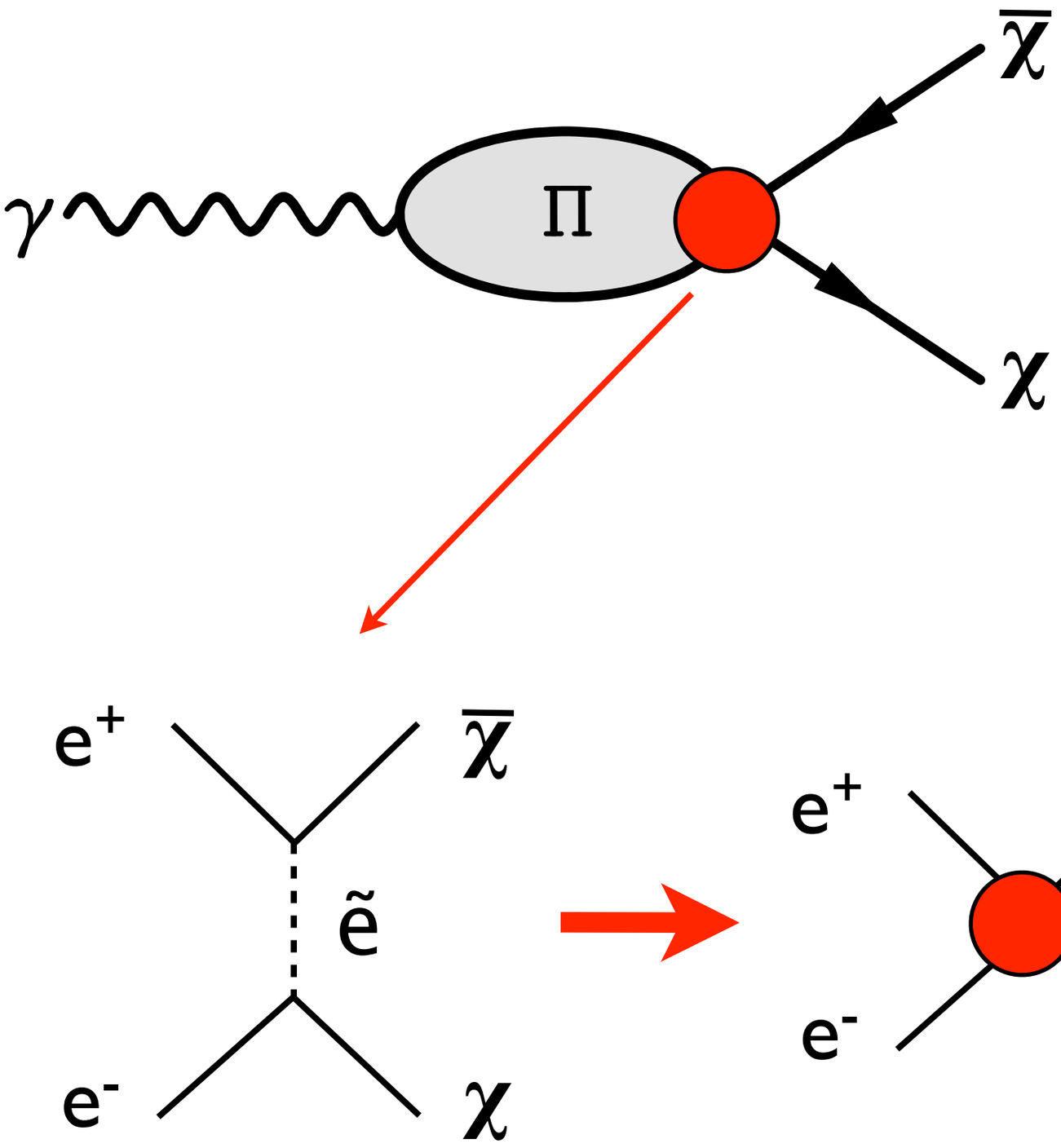


"Plasmon" process

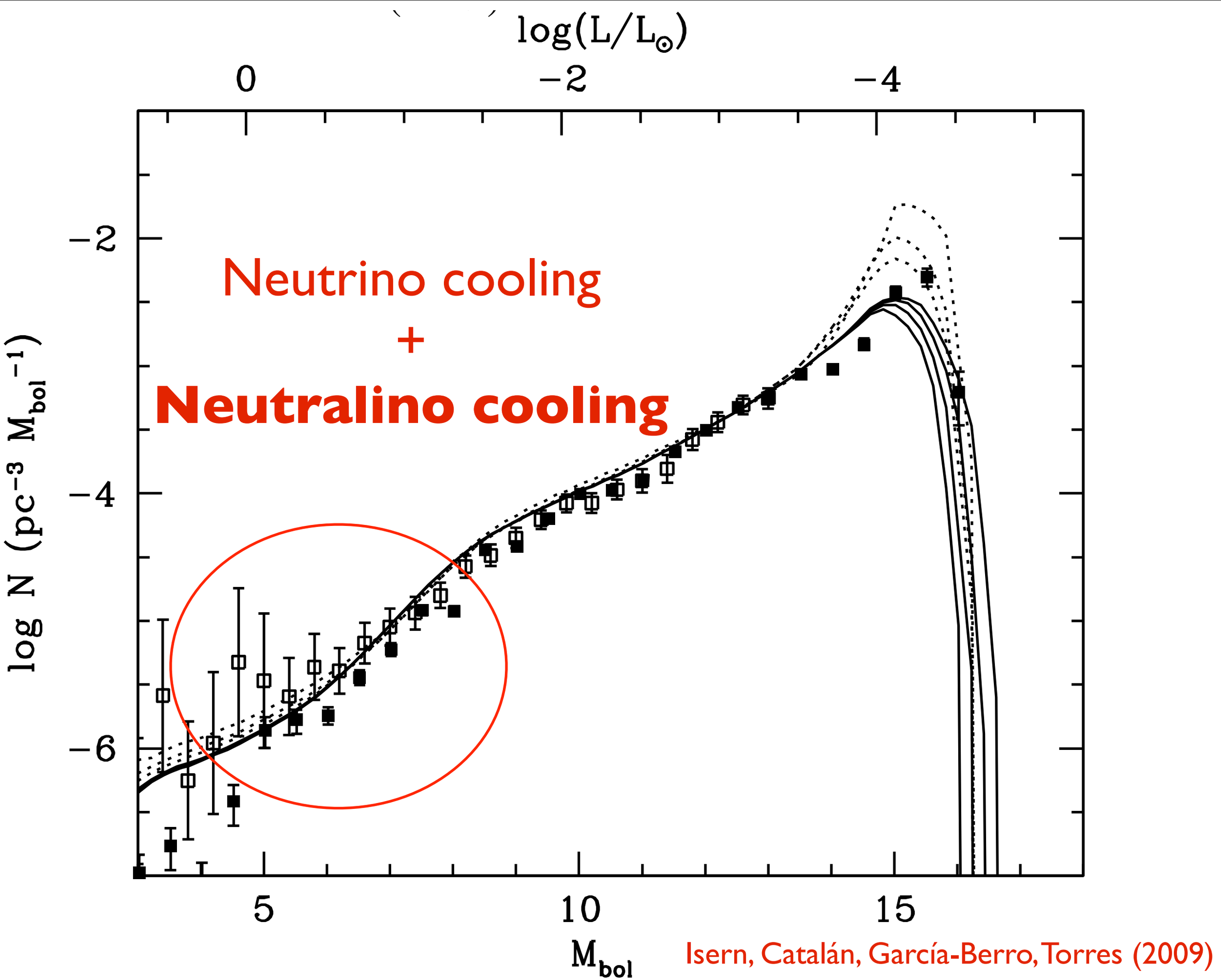


Isern, Catalán, García-Berro, Torres (2009)

Neutralino cooling



$\sim M_{\tilde{e}}^{-2}$



Isern, Catalán, García-Berro, Torres (2009)

The name of the game

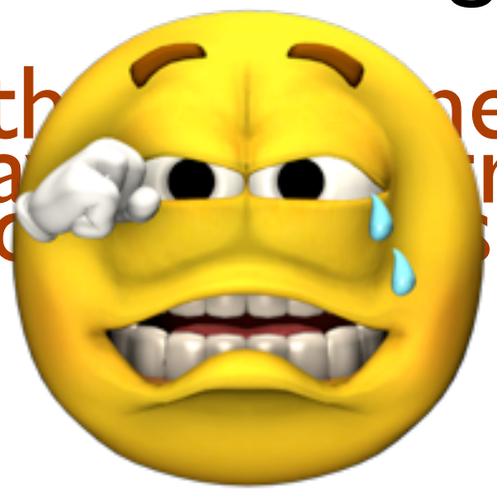
- Standard-Model particle physics already gives a very good fit to the WD luminosity function (LF).
- Add the neutralino-cooling contribution, compute the new LF curve and its chi square fit to the data.
- Establish a chi-square criterium to put bounds on this new contribution.
- As a first step, take a the neutralino to be massless. This will set bounds on the selectron mass.

Time for answers?

Can we put bounds on SUSY with light neutralinos using white dwarf cooling?

YES

Are the latest SDSS measurements precise enough to be used to put *significant* bounds on new physics from WD cooling?

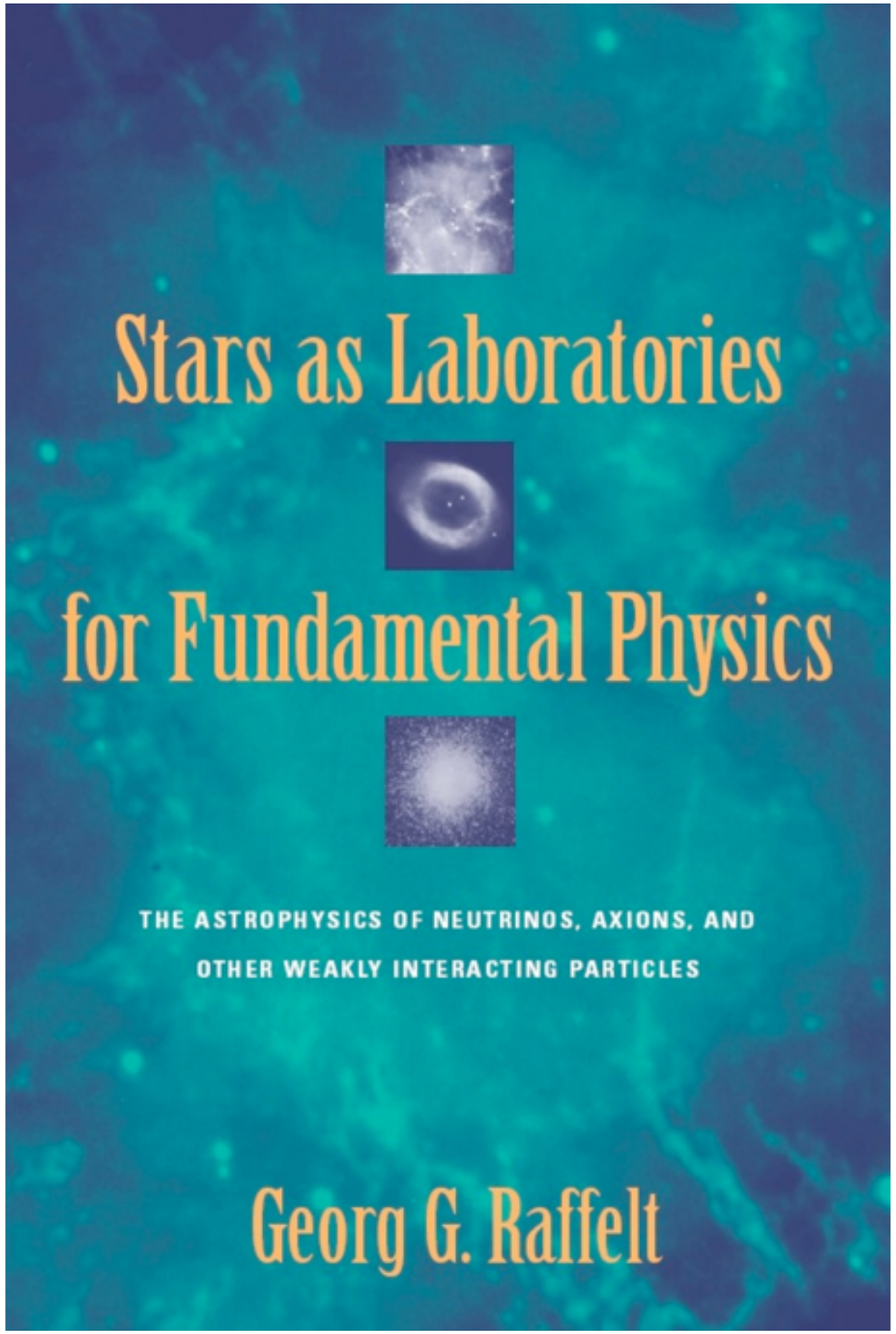


Unfortunately not for th neutralino and selectron, Ma ry! the boun significant.

The hope

With the "expertise" gained doing this exercise, study different new physics models and see if we can put significant bounds.

Advertisement



GREAT BOOK!!