Astrophys Space Sci (2014) 349:407–413
DOI 10.1007/s10509-013-1603-2

ORIGINAL ARTICLE

Sterile neutrino fits to dark matter mass profiles in the Milky Way and in galaxy clusters

Man Ho Chan · Robert Ehrlich

Received: 12 June 2013 / Accepted: 9 August 2013 / Published online: 17 September 2013

Abstract In recent papers it was claimed that SN 1987A data supports the existence of 4.0 eV and 21.4 eV active neutrino mass eigenstates, and it was suggested that such large active neutrino masses could be made consistent with existing constraints including neutrino oscillation data and upper limits on the neutrino flavor state masses. The requirement was that there exist a pair of sterile neutrino mass states nearly degenerate with the active ones, plus a third active-sterile doublet that is tachyonic ($m^2 < 0$). Here, independent evidence is presented for the existence of sterile neutrinos with the previously claimed masses based on fits to the dark matter distributions in the Milky Way galaxy and four clusters of galaxies. The fits are in excellent agreement with observations within the uncertainties of the masses. In addition, sterile neutrinos having the suggested masses address the "cusp" problem and the missing satellites problem, as well as that of the "top down" scenario of structure formation—previously a chief drawback of HDM particles. Nevertheless, due to the highly controversial nature of the claim, and the need for two free parameters in the dark matter fits, additional confirming evidence will be required before it can be considered proven.

Keywords Dark matter

M.H. Chan (✉)
The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong, Hong Kong
e-mail: mhchan@phy.cuhk.edu.hk

R. Ehrlich
George Mason University, Fairfax, VA 22030, USA
e-mail: rehrlich@gmu.edu

1 Introduction

In several recent papers evidence was presented based on an analysis of SN 1987A for the existence of two active neutrino mass eigenstates having masses 4.0 ± 0.5 eV and 21.4 ± 1.2 eV, hereafter referred to as the "claim" (Ehrlich 2012, 2013a). The present paper reviews that claim and presents new independent evidence supporting it. It is shown that the problem of dark matter within galaxies and galaxy clusters can be resolved using a pair of sterile neutrinos having the very same masses as claimed previously. Even though the claim was based on active neutrinos from SN 1987A, their existence would require sterile neutrinos having nearly the same masses, so as to be compatible with the very small values of Δm^2_{atm} and Δm^2_{sol} measured in neutrino oscillation experiments. Of course, in such a case the small Δm^2 values observed to date in most oscillation experiments would need to be between an active and a sterile mass state, contrary to what is normally assumed. While the main new result presented here involves the dark matter fits, we first review the prior work supporting the "claim," and discuss how such large neutrino masses could be made consistent with other observations.

2 Prior work making the claim

The values of the neutrino masses have been a matter of considerable interest both theoretically and experimentally ever since they were shown to be nonzero by virtue of the existence of neutrino oscillations. It is of course only the mass differences between pairs of the mass eigenstates, i.e., Δm^2, that are revealed in neutrino oscillation experiments not the masses themselves, with the relation between the flavor and mass eigenstates and their respective masses being through