Comment on "Biological Effects of Stellar Collapse Neutrinos"

Collar has recently presented important conclusions on this subject [1]. Here we wish to point out related considerations that merit further discussion.

Several references cited by Collar are based on *in vitro* studies. The connection of results from *in vitro* studies with *in vivo* conditions, exemplified by cancer induction, presents specific problems, not discussed by Collar, which have been described elsewhere [2].

Assuming $C_4H_{40}O_{17}N_1$ to be "representative" of biological tissue is not necessarily valid when effects on DNA are considered. It neglects the presence of heavier elements such as the phosphorous in nucleotides (9%–10% by mass). The effect of these recoil ions on DNA was not discussed by Collar.

References [3] and [4], cited by Collar, express conclusions, with suitable *caveats*, that unique and important biological effects may result from high linear-energy-transfer (LET) radiation. However, serious reservations about drawing definitive conclusions appear in Ref. [4] where it is stated that much more experimental and theoretical work is needed to understand these effects. Furthermore, Ref. [4] states, "Further understanding of these questions could lead, in future (*sic*), to substantial increases or decreases in estimations of risk." A number of more recent studies that better define the boundaries of the effects of high LET radiation have now been reported [2,5–9].

Collar has pointed out that if the average recoil results in interactions with 3.6 nucleosomes out of 3×10^7 per cell nucleus, there is a 97% certainty that at least one nucleosome is hit. In our view, the author has not established a confirmed link between such "hits" and the formation of malignant foci. Other possible results of such "hits" discussed elsewhere [2,5–9] are ignored.

Collar has referred to "effectively infinite" values of radiobiological effectiveness (RBE). RBE is defined as the ratio of the absorbed dose of reference radiation, usually taken to be x or gamma rays, required to produce a specific response to the absorbed dose of the given radiation required to produce an equal response [10]. One can estimate a value of RBE for the radiation damage due to the neutrino recoils for a particular end point such as fatal cancer. An established measure of risk for *Homo sapiens* exposed to photons is 5×10^{-2} latent fatal cancers Gy^{-1} (Gy ≡ Gray) [11]. The absorbed dose calculated by Collar due to a stellar collapse at 1 parsec from Earth is $\approx 10^{-8}$ Gy. If this absorbed dose were due to photons, the rate of fatal cancers would be 5×10^{-10} per exposed individual. For comparison, humans are subject to a lifetime cancer mortality rate of about 20% [12]. Given this fact, it is unlikely that an increment of even 1% in this mortality rate is sufficient to result in the extinction of species. For 10^{-8} Gy due to the neutrino recoils to result in a fatal cancer production of 1% per exposed organism, the RBE must be $\approx 2 \times 10^7$. Currently accepted RBE values assigned for all types of damage inclusive of cancer induction, do not exceed approximately 200 [10,13]. RBE values determined in recent work involving high LET ions [5–9] are bound by this value, which is far smaller than that needed to support Collar's conclusion.

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