Comment on "Probing Spacetime Foam with Extragalactic Sources"

In their Letter [1], the authors state that the interference fringe visibility of quasars is sensitive to the foamy structure of spacetime and rules out the so-called random-walk models [2,3] of foaminess. Unfortunately, a central part of the calculations is questionable.

The Letter argues that, for a single telescope, the interferometric fringes vanish when $\Delta\phi \sim \pi$, where $\Delta\phi$ is the phase uncertainty of the wave front reaching the telescope. This corresponds to the picture where a flat wave front of random global phase approaches the telescope; i.e., the average width, say, a, of wave front corrugations is larger than the telescope aperture. This circumstance becomes relevant when the Letter determines the reduction of interferometer fringe visibility from the angular spread of the wave vector. Figure 1 in the Letter shows a corrugated wave front where the average corrugation height δl is estimated from the distance l of the quasar, according to the basic relationship $\delta l \sim l^{1-\alpha} l_P^\alpha$. The authors claim that the angular spread of the local wave vector at the wave front is $\sim\delta l/\lambda$, where λ is the wavelength. In general, the angular spread of the normal vector of the wave front is of the order of $\sim\delta l/a$, where a is the average corrugation width. Do the authors assume $a \sim \lambda$ tacitly? This would deny their previous arguments where, as we pointed out, they must have assumed that a was larger than the telescope aperture. Because of this contradiction, the Letter's calculation of the interferometer effect becomes inconsistent.

Telescopes and interferometers have, as a matter of fact, large spatial sizes. When calculating the effect of the foam on fringes, the spatial correlation between the uncertainties δl (cf., e.g., Ref. [4]) *does matter.* A correct approximation of the wave propagation through the spatiotemporally correlated foam will lead to inevitable revisions or even withdrawal of basic claims in Ref. [1]. The Letter has independently been criticized for similar reasons [5], i.e., for its oversimplified treatment of the transverse propagation.

Finally, let me remark that the Letter could have added that it was not ruling out the *alternative* random-walk model chiefly advocated in Ref. [2]. Rather than to a world line, this random-walk model assigns an uncertainty δl to a world tube of finite radius r:

$$\delta l \sim (l/r)^{1/2} l_P. \tag{1}$$

This relationship describes the drop of uncertainty with increasing r. Toward an ideal world line ($r \to 0$), the growth of δl saturates at a certain cutoff r_0. Hence, the length uncertainty δl in the model [2] is smaller at least by the factor $(l_P/r)^{1/2}$ than δl in the model [3]. If we adopt $r_0 \sim 10^{-5}$ cm [4], the factor becomes $\sim 10^{-17}$ and suppresses the effect of foam on the Hubble Space Telescope observations. However, a related quantum decoherence [6] might become detectable in cosmogenic neutrinos by telescopes under construction [7].

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