

Fineberg, Moses, and Steinberg Reply: A linear mechanism in the Comment¹ is supposed to explain the temporal modulation seen in the wave-number spectrum in a state of spatially and temporally modulated traveling waves (TW) (a blinking state),² and seems to be interesting. This brings out a point of the relevance of linear models to nonlinear states near onset, and, more important, stresses the richness of wave-number dynamics in TW states. The model we used,³ and which also reproduced the observed spatial behavior, is based on the existence of more than one wave number k , due to the existence of more than one frequency ω and a nonzero $d\omega/dk$. If one takes the superposition of two counter-propagating waves (CPW) with two different k and ω with both Δk and $\Delta\omega$ bands corresponding to values observed in the experiment² one gets³

$$A(x,t) = \epsilon^{\gamma x} \cos(kx - \omega t) \cos(\Delta kx - \Delta\omega t) + e^{-\gamma x} \cos(kx + \omega t) \sin(\Delta kx + \Delta\omega t). \quad (1)$$

The results of the numerical simulations presented in Fig. 1 show that this model reproduces the temporally modulated wave-number spectrum of the blinking state pretty well. In spite of the fact that we consider a symmetric blinking state, the model suggested in the Comment deals with an asymmetric state with a ratio factor for CPW which oscillates with a modulation frequency.

However, as we emphasized in our Letter, we observed "the variation of the wave number in time during the modulation period," i.e., we pointed out the overall phenomenon of the modulation. Moreover, we do not see a need to differentiate between the low- and high-lying blinking states. Although it is clear that for the "first blinking (low-lying) state" a linear mechanism prevails over a nonlinear one (while for high-lying states the contrary is correct), there is no clear boundary between these states since a long-period wave-number modulation is evident in both cases.

Thus, although both linear models correctly describe the temporal modulation on the fast time scale, neither of them can explain the more complicated k spectra of

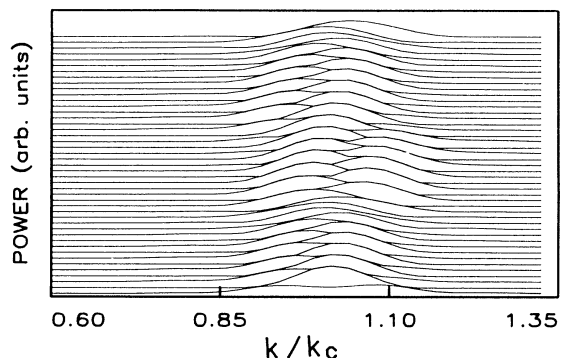


FIG. 1. Wave-number spectrum based on Eq. (1) with $\Delta k = 0.035k$, $k = \pi$, $\omega = 1.51$, $\Delta\omega = \Delta k\omega/k$, and $\gamma = 0.082$.

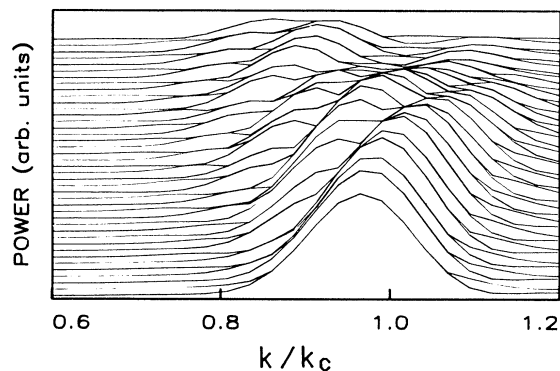


FIG. 2. Wave-number power spectrum as a function of time of the blinking TW state observed for $\Psi = -0.058$, $\Gamma = 20$ at $\epsilon = 3.4 \times 10^{-3}$ taken with $0.32\tau_c$ time interval.

the blinking TW higher on the branch presented by us in Fig. 6(b) of Ref. 2.

In order to emphasize this point more we present additional data of time-dependent k spectra at $\Psi = -0.058$ and $\epsilon = 3.4 \times 10^{-3}$ ($\epsilon = \Delta T/\Delta T_c - 1$) (Fig. 2). Temporal modulation on the fast time scale is still evident here; however, the time dependence of the k spectra on the long-time scale cannot be explained by the model suggested in the Comment. It also cannot explain the jump in the average wave number of about $0.07k_c$ which accompanies the transition from the nonlinear CPW to the blinking TW.³ This instability in the average wave numbers, the band of the wave numbers observed in the blinking TW which is wider than the theoretically stable,²⁻⁴ and the complicated time dependence of the k spectra at higher ϵ brings us back to the question of what physical mechanism is responsible for the phenomena observed.

Thus, a possible explanation for the overall time dependence of k spectra may lie in the interplay between two mechanisms: linear, as suggested in the Comment, and by us [Eq. (1)], and nonlinear modulational instability, as suggested by us.²

J. Fineberg, E. Moses, and V. Steinberg
Department of Nuclear Physics
The Weizmann Institute of Science
76100 Rehovot, Israel

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¹P. Kolodner, preceding Comment, Phys. Rev. Lett. **63**, 578 (1989).

²J. Fineberg, E. Moses, and V. Steinberg, Phys. Rev. Lett. **61**, 838 (1988).

³V. Steinberg, J. Fineberg, E. Moses, and I. Rehberg, Physica (Amsterdam) D (to be published).

⁴W. Schöpf and W. Zimmerman, Europhys. Lett. **8**, 4 (1989).