Comment on "Shape Fluctuations of Polymerized or Solidlike Membranes"

A recent Letter by Lipowsky and Girardet [1] reported results for Monte Carlo (MC) simulations of a continuum model of a solidlike elastic sheet. The authors concluded from the MC data in combination with scaling arguments that the roughness exponent ζ equals $\frac{1}{2}$ for polymerized membranes having a general bending rigidity κ. They also point out that this is obviously very different from the value of $\zeta \sim 0.65$ reported for tethered solidlike membranes [2,3] and suggest that this discrepancy arises from a pronounced crossover from liquidlike to solidlike behavior. Hence, the value for ζ obtained from simulations of tethered networks represent an "effective" exponent which reflects this crossover. I have independently found that $\zeta \sim \frac{1}{2}$, this work being motivated by an earlier observation [3] that perimeter fluctuations may be masking important scaling features, and have concluded that the "crossover" effect of Lipowsky and Girardet is not relevant to the simulation results of Ref. [3].

In a very recent paper [3] it was pointed out that the out-of-plane fluctuations are most pronounced near the perimeter of the tethered membrane and conjectured that edge "curling" gives the dominant contribution to the out-of-plane roughness $\sim L^{\zeta}$ and to the in-plane interface width $\sim L^{\delta}$, leading to $\delta = \zeta = 0.65$. Thus, my interest became to determine the "bulk" tethered membrane properties by eliminating contributions due to the existence of a free boundary. To eliminate boundary effects of the finite-size membrane, periodic boundary conditions were imposed at the perimeter of the membrane. To insure that such boundary conditions do not squeeze or stretch the membrane (i.e., the membrane is not under compression or tension), the computational box was allowed to vary using a constant-pressure molecular-dynamics technique [4]. The simulations for the self-avoiding tethered membrane were done for zero spreading pressure. In Fig. 1, we see that the roughness exponent is 0.53 from a least-squares fit, consistent with the limiting value of $\frac{1}{2}$ obtained by Lipowsky and Girardet. We note that a value slightly larger than $\frac{1}{2}$ is not excluded and would be consistent with the renormalization-group prediction [5], $\zeta = (2+\omega)/4$ with $\omega \sim 0.08$. Therefore, perimeter fluctuations in the study of Ref. [3] were masking this bulk scaling property for the tethered membrane, and a crossover effect invoked by Lipowsky and Girardet is not needed.

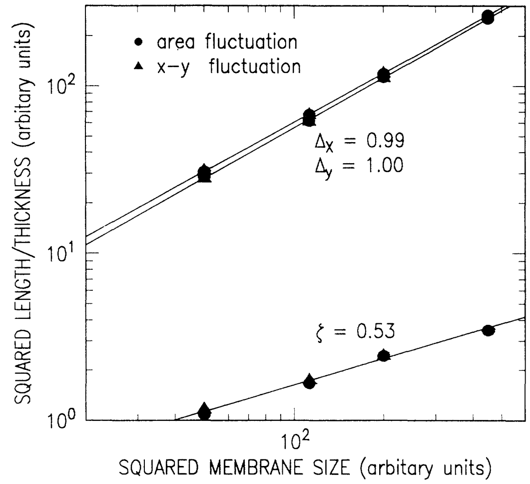

FIG. 1. Time-averaged values of the squared length and thickness as a function of the squared membrane size for a two-dimensional triangular tethered membrane constrained by periodic boundary conditions in the x-y plane and simulation by constant-pressure molecular dynamics (CPMD) [4]. In the CPMD, the area fluctuations were simulated by two methods; by scaling x and y by the same factor (area fluctuations), and by scaling x and y independent of one another (x-y fluctuations).

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