Coarsening Dynamics of Domains in Lipid Membranes

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SUPPORTING MATERIAL (Stanich et al.)

Contents:

• Figure S1 – Related to Figure 2 in the main text
• Figure S2 – Related to Figure 3 in the main text
• Figure S3 – Related to Figure 5 in the main text
• Table S1 – Experimental values for each vesicle
• Movie S1 – Temperature quench of a vesicle through a miscibility transition, followed by coarsening of liquid domains

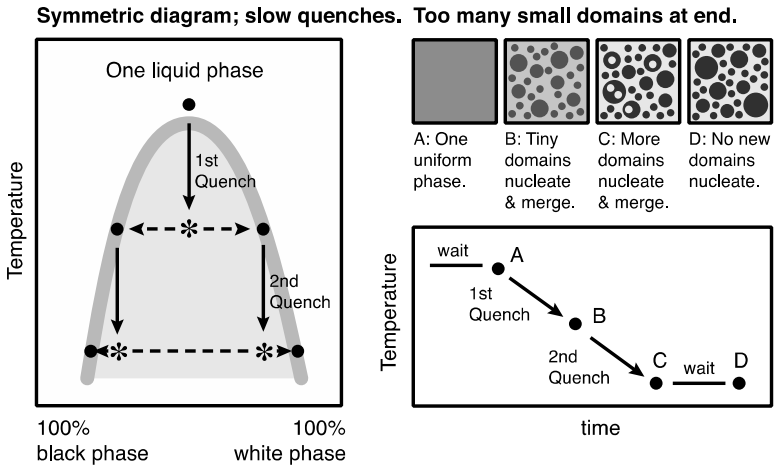

Figure S1:
Growth rates of domains should be measured at a constant temperature, after a single, fast temperature quench. If, instead, growth rates are measured while temperature is changing, spurious values will be found. This is because domains will continually nucleate during the course of the experiment. This concept is illustrated in Figure 2 in the main text for asymmetric phase diagrams. The same concept applies to symmetric phase diagrams, as illustrated in this figure.

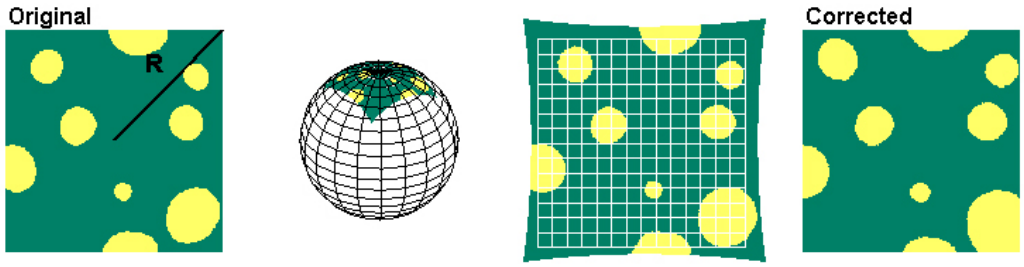

Figure S2:
Two-dimensional images of the surfaces of vesicles were mapped onto three-dimensional spheres, using the radius of each vesicle. This figure illustrates the process for one particular image (using its corresponding vesicle size) taken from the broad data set. This figure was made to correspond to Supplementary Figure S1 in (1). It illustrates that the area in view is a small fraction of the vesicle's total surface area.

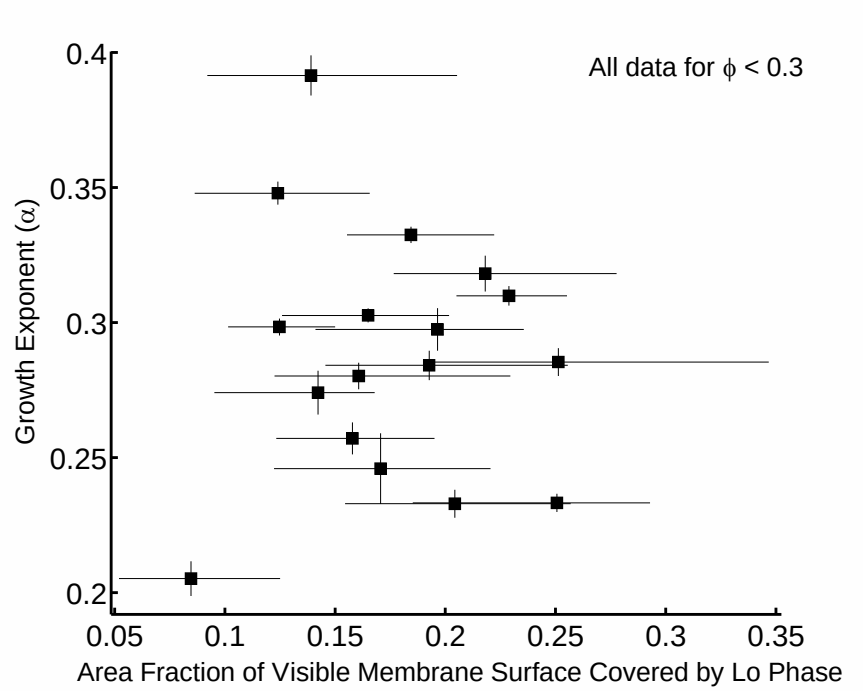

Figure S3:
There is no trend in domain grown exponent, α, versus the fraction of membrane surface area (ϕ) that is covered by liquid-ordered L_o phase over the course of the movie. All data in this figure are for $\phi < 0.3$. Symbols are located at values of average ϕ and horizontal lines show full ranges of observed values of ϕ over the course of each movie (rather than standard deviations).

Table S1: Experimental Values for Each Vesicle

Area fraction $\phi < 0.3$, Bulk Solution = Water

Experimental Run #	1	2	3	4	5	6	7	8	9
Vesicle diameter (microns)	85.9	85.9	245.9	245.9	245.9	221.5	118.6	118.6	149.1
Minimum radius of any domain tracked in this expt. run (microns)	1.13	1.15	1.24	2.23	1.09	1.95	2.43	2.18	3.74
Maximum radius of any domain tracked in this expt. run (microns)	15.11	10.09	20.06	16.71	13.10	15.06	13.83	11.65	19.00
Min domain radius/vesicle radius	0.03	0.03	0.01	0.02	0.01	0.02	0.04	0.04	0.05
Max domain radius/vesicle radius	0.35	0.23	0.16	0.14	0.11	0.14	0.23	0.20	0.25
Bulk fluid surrounding vesicle	water	water	water	water	water	water	water	water	water
Final temp. after quench (˚C)	39.05	37.86	38.99	36.9	37.97	37.98	44.07	43.89	44.05
Average area fraction	0.23	0.08	0.16	0.17	0.16	0.19	0.20	0.14	0.22
Area fraction standard deviation	0.01	0.01	0.03	0.02	0.02	0.03	0.02	0.02	0.03
Minimum area fraction throughout experimental run	0.21	0.05	0.12	0.13	0.13	0.15	0.15	0.10	0.18
Maximum area fraction throughout experimental run	0.26	0.13	0.24	0.20	0.20	0.26	0.26	0.17	0.28

Experimental Run #	10	11	12	13	14	15	16	17
Vesicle diameter (microns)	149.1	88.5	88.5	88.5	130.3	130.3	130.3	100.6
Minimum radius of any domain tracked in this expt. run (microns)	1.20	1.03	1.23	1.24	1.1	2.0	2.3	2.2
Maximum radius of any domain tracked in this expt. run (microns)	20.16	7.39	11.95	11.10	8.3	8.6	9.4	7.4
Min domain radius/vesicle radius	0.02	0.02	0.03	0.03	0.02	0.03	0.04	0.04
Max domain radius/vesicle radius	0.27	0.17	0.27	0.25	0.13	0.13	0.14	0.15
Bulk fluid surrounding vesicle	water	water	water	water	water	water	water	water
Final temp. after quench (˚C)	42.09	38.98	40.96	36.94	40.03	38.07	36.08	42.99
Average area fraction	0.25	0.20	0.14	0.25	0.12	0.17	0.18	0.12
Area fraction standard deviation	0.03	0.02	0.03	0.04	0.02	0.02	0.01	0.01
Minimum area fraction throughout experimental run	0.19	0.14	0.09	0.19	0.09	0.12	0.16	0.10
Maximum area fraction throughout experimental run	0.29	0.24	0.21	0.35	0.17	0.22	0.22	0.15

Table S1 (Continued): Experimental Values

Area fraction $\phi < 0.3$, Bulk Solution = Dextran

Experimental Run #	18	19	20	21	22	23	24	25	26
Vesicle diameter (microns)	83.0	83.0	106.7	85.1	217.3	129.9	129.9	107.1	111.2
Minimum radius of any domain tracked in this expt. run (microns)	0.9	0.8	1.2	0.9	1.3	1.1	0.9	1.3	1.8
Maximum radius of any domain tracked in this expt. run (microns)	7.6	9.8	6.3	7.7	12.1	6.8	12.2	10.8	10.2
Min domain radius/vesicle radius	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.03
Max domain radius/vesicle radius	0.18	0.24	0.12	0.18	0.11	0.10	0.19	0.20	0.18
Bulk fluid surrounding vesicle	dextran	dextran	dextran	dextran	dextran	dextran	dextran	dextran	dextran
Final temp. after quench (˚C)	37.99	36.96	33.96	35.99	39.01	36.06	42.99	42.05	42.04
Average area fraction	0.09	0.11	0.07	0.09	0.11	0.09	0.18	0.12	0.11
Area fraction standard deviation	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02
Minimum area fraction throughout experimental run	0.04	0.08	0.05	0.06	0.08	0.06	0.13	0.10	0.08
Maximum area fraction throughout experimental run	0.14	0.15	0.12	0.12	0.13	0.12	0.22	0.14	0.15

Area fraction $0.3 < \phi < 0.7$, Late time

Experimental Run #	1	2	3	4	5	6	7	8
Vesicle diameter (microns)	104.8	130.0	112.8	102.2	100.6	100.6	92.8	92.8
Minimum radius of any domain tracked in this expt. run (microns)	0.5	1.4	0.8	2.8	2.3	2.4	0.8	0.4
Maximum radius of any domain tracked in this expt. run (microns)	12.8	4.3	14.8	10.9	6.3	5.5	4.5	3.7
Min domain radius/vesicle radius	0.01	0.02	0.01	0.05	0.05	0.05	0.02	0.01
Max domain radius/vesicle radius	0.24	0.07	0.26	0.21	0.13	0.11	0.10	0.08
Bulk fluid surrounding vesicle	water	water	water	water	water	water	dextran	dextran
Initial area fraction (average first 2 seconds, when small domains)	0.42	0.50	0.41	0.38	0.38	0.32	0.36	0.42
Temperature	29.99	29.96	28.92	24.00	28.76	27.66	16.96	

Experimental Run #	9	10
Vesicle diameter (microns)	92.8	82.2
Minimum radius of any domain tracked in this expt. run (microns)	0.6	1.2
Maximum radius of any domain tracked in this expt. run (microns)	4.1	4.1
Min domain radius/vesicle radius	0.01	0.03
Max domain radius/vesicle radius	0.09	0.10
Bulk fluid surrounding vesicle	dextran	dextran
Initial area fraction (average first 2 seconds, when small domains)	0.44	0.60
Temperature	14.99	20.02

Movie S1:
Coarsening of liquid domains within a giant unilamellar vesicle. Membrane domains consisting of lipids in a liquid-ordered phase diffuse and merge within a background membrane consisting of lipids in a liquid-disordered phase. The vesicle is 90.2 microns in diameter, and only the top slice is in focus in these images. Frames are separated by 30 seconds, and the entire frame is 92.2 microns on each side. The movie contains 100 frames and is in .avi file format.

Supporting References:

1. Veatch, S. L., P. Cicuta, P. Sengupta, A. Honerkamp-Smith, D. Holowka, and B. Baird. 2008. Critical fluctuations in plasma membrane vesicles. ACS Chem. Biol. 3:287-293.