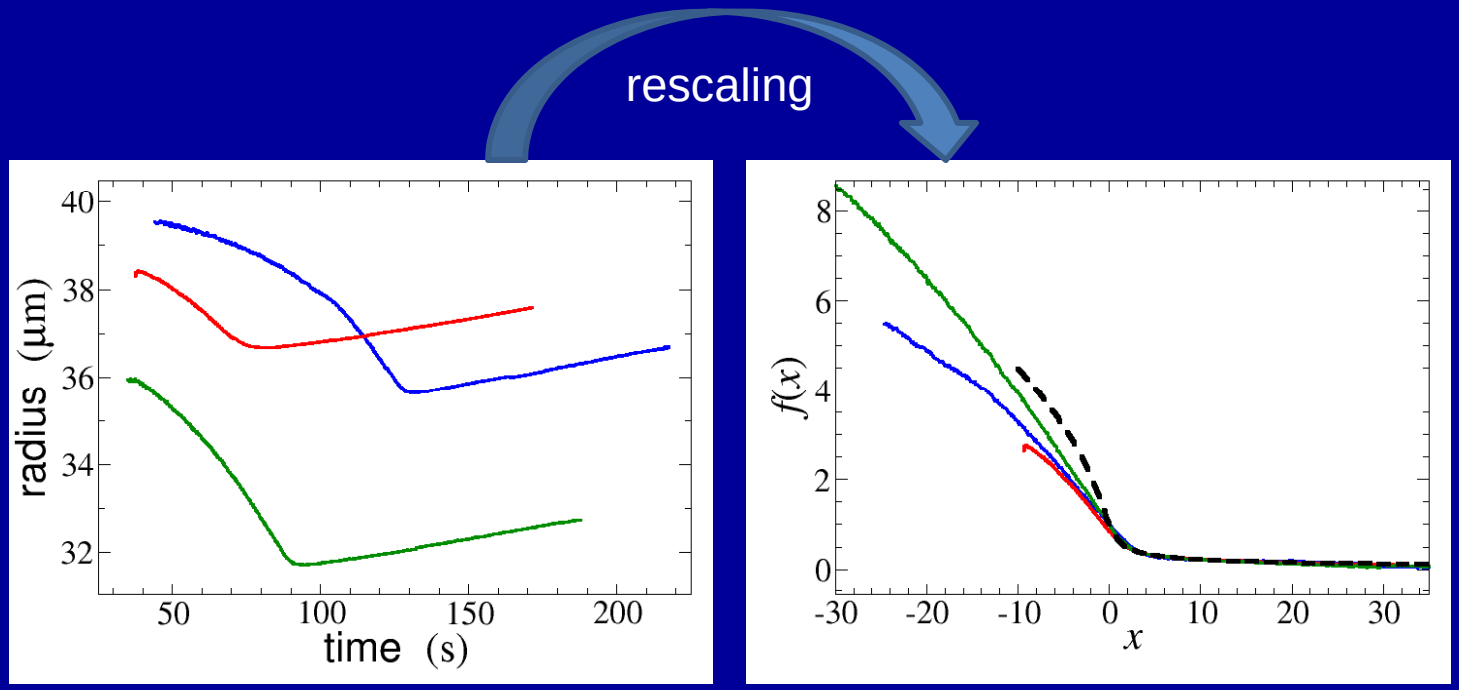
Particle-Encapsulating Vesicles

Haim Diamant, School of Chemistry, Tel Aviv University, Israel

Membrane vesicles (liposomes), encapsulating molecules in solution, are ubiquitous in drug-delivery and cosmetic applications, as well as in key functions of biological cells.

As the number of encapsulated particles is increased (or the outer concentration is decreased), the vesicle swells. In the first stage swelling primarily 'irons' the membrane, making the vesicle approach a spherical shape without a significant change in its area. In the second stage the vesicle continues to swell primarily by stretching, eventually rupturing (osmotic lysis).

The theory developed in this project shows that the transition between the two stages of swelling becomes critical in a certain well-defined limit. Consequently, a high degree of universality can be achieved – the swelling behaviors of different systems can be rescaled into a single universal behavior. (See figure.)



Left: time evolution of the projected radii of three giant unilamellar DMPE lipid vesicles, as molecules of urea permeate in. The projected radius first decreases, as the vesicle approaches a sphere, and subsequently increases, as the sphere stretches. (Data courtesy of P. Peterlin.)
Right: collapse of the rescaled data in the transition region onto the theoretical universal curve (dahed line).