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Abstract: We revisit the universal behavior of crystalline membranes at and below the crumpling transition, which pertains to the mechanical properties of important soft and hard matter materials, such as the cytoskeleton of red blood cells or graphene. Specifically, we perform large-scale Monte Carlo simulations of a triangulated two-dimensional phantom network which is freely fluctuating in three-dimensional space. We obtain a continuous crumpling transition characterized by critical exponents which we estimate accurately through the use of finite-size techniques. By controlling the scaling corrections, we additionally compute with high accuracy the asymptotic value of the Poisson ratio in the flat phase, thus characterizing the auxetic properties of these systems. We obtain agreement with the value which is universally expected for polymerized membranes of fixed connectivity.