

Qi-Wa, a problem that has plagued Chinese scrolls for millenniums

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Qi-Wa refers to the up curl on the lengths of handscrolls and hanging scrolls, which has troubled Chinese artisans and emperors for as long as the art of painting and calligraphy exists. This warp is unwelcome not only for aesthetic reasons, but its potential damage to the fiber and ink. Although it is generally treated as a part of the cockling and curling due to climate, mounting procedures, and conservation conditions, we emphasize that the intrinsic curvature incurred from the storage is in fact the main cause of Qi-Wa. The Qi-Wa height is determined by experiments to obey scaling relations with the length, width, curvature, and thickness of the scroll, which are supported by Molecular Dynamics Simulation and theoretic derivations. This understanding helps us come up with plausible remedies to mitigate Qi-Wa. All proposals are tested on real mounted paper and in simulations. Due to the general nature of this warp, the scaling relations and recipe on how to mitigate Qi-Wa will benefit not only the major museums in the world that carry oriental collections, but also any field in industries and academics that require bending of a plate or membrane. Examples are the flexible electronic paper and computer screen, area-expanding devices, and even tectonics on the deformation at plate boundaries due to the nonuniform Poisson ratio with depth when under compression.