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## **The rate of change of width under flows**

I will discuss a geometric invariant, that we call the width, of a manifold and first show how it can be realized as the sum of areas of minimal 2-spheres. When  $M$  is a homotopy 3-sphere, the width is loosely speaking the area of the smallest 2-sphere needed to “pull over”  $M$ . Second, we will estimate the rate of change of width under various geometric flows, including flows by mean curvature and Ricci curvature, to prove sharp estimates for extinction times. This is joint work with Toby Colding.