Magnetic structure and observed width of coronal loops

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Previous studies have found that coronal loops have a nearly uniform thickness, which seems to disagree with the characteristic expansion of active region magnetic fields. This is one of the most intriguing enigmas in solar physics. We here report on the first comprehensive one-to-one comparison of observed loops with corresponding magnetic flux tubes obtained from cotemporal magnetic field extrapolation models. We use EUV images from TRACE, magnetograms from the MDI instrument on SOHO, and linear force-free field extrapolations. For each loop, we find the particular value of the force-free parameter (alpha) that best matches the observed loop axis and then construct flux tubes using different assumed cross sections at one footpoint (circle and ellipses with different orientations). We find that the flux tubes expand with height by typically twice as much as the corresponding loops. We also find that many flux tubes are much wider at one footpoint than the other, whereas the corresponding loops are far more symmetric. It is clear that the actual coronal magnetic field is more complex than the models we have considered. We suggest that the observed symmetry of loops is related to the tangling of elemental magnetic flux strands produced by photospheric convection.