Topology and the Universe

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In recent decades, astronomical observations have led to a broad, if incomplete, consensus description of the Universe: its evolution is determined by the relative proportions of a handful of substances ('usual' matter like atoms, stars and galaxies; a hidden, but gravitationally attractive dark matter; the poorly understood and unfortunately named dark energy) all of which are changing in concert under the influence of physical laws. In the region of the Universe visible to astronomers, great cosmological structures are observed---dense clusters in which the majority of galaxies form; vast and apparently empty voids; and a tangle of filaments that has been coined 'the cosmic web'.

In this talk, I explore the role topology plays in defining our understanding of the Universe. After reviewing the relationship between geometry and dynamics that characterises the modern Big Bang theory, I discuss two topics of interest to topologists: i) the classification of cosmological structures as a means of understanding both the physics of the very early Universe and the evolution and formation of galaxies; ii) the theory and measurements of the global topology of the Universe. As modern cosmology remains somewhat under-informed by topological ideas, I expect there is much to be gained from interaction between these fields.