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An almost splitting theorem and the topology of the Universe

Cosmic microwave background observations show that the mass density of the Universe is enough to ensure its spatial closure, with about 70% confidence. To reach this conclusion, cosmologists often rely on highly symmetric FLRW or, more generally, Bianchi models, but in fact such a restriction is not necessary. Closure follows much more generally from a Myers-type theorem. This theorem also imposes strong topological constraints on a Universe that exceeds closure density. But there remains a 30% chance that closure density is not reached. In that case, the Universe may still be closed, and we are still able to find restrictions on the allowed topologies. Although cosmologists often consider compact hyperbolic Universes to model this scenario, an almost-splitting theorem of Cheeger-Colding type applies here and suppresses fundamental groups of polynomial growth. This is based on joint work with M Khuri and GJ Galloway.