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*3-manifolds of  $S^1$ -cat 3.*

The study of critical points for a smooth function is of great importance in topology. Lusternik and Schnirelmann introduced what is today called Lusternik-Schnirelman category  $cat(M^n)$  for a manifold  $M^n$ , this is the motivation for the study of category infomation. I study the category properties for 3-manifolds and try to classify manifolds that can be covered by some open sets that satisfy some homotopy properties. Especially, I classify 3-manifolds that can be covered by three solid tori or solid Klein bottles. (Received September 25, 2012)