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Higher dimensional manifolds with S^1-category two

A subset U of a closed topological n-manifold M is S^1-contractible (in M) if there exist maps $f\colon U \longrightarrow S^1$, $\alpha\colon S^1 \longrightarrow M$ such that the inclusion of U into M is homotopic to αf.

M has S^1-category $\leq k$ if it can be covered by k open subsets which are S^1-contractible.

Previously we have determined, for $n \leq 3$, the n-manifolds with S^1-category 2.

Theorem 1 *If $n > 3$ and M^n has S^1-category 2 then M^n is an n-sphere or an S^{n-1}-bundle over S^1.*

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