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Three Dimensional Manifolds All of Whose Geodesics Are Closed

The existence of closed geodesics and the geometry of manifolds all of whose geodesics are closed are among the classical problems in geometry. One famous problem is the Berger Conjecture, which states that, on a simply connected manifold all of whose geodesics are closed, the geodesics have the same least period. I will give an introduction to the topic and mention known results. I will explain a possible approach via Morse Theory on the free loop space, and present some results on the Morse Theory in dimension three, where the conjecture is still open. If time permits, I will sketch a proof of the main theorem, which states that the energy function is perfect for S^1 -equivariant Morse Theory with rational coefficients for the cohomology.