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**of analysis»**

**Book of abstracts**



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## LIST OF TOPICS

- Algebraic methods in geometry
- Differential geometry in the large
- Geometry and topology of differentiable manifolds
- General and algebraic topology
- Dynamical systems and their applications
- Geometric problems in mathematical analysis
- Geometric and topological methods in natural sciences
- History and methodology of teaching in mathematics

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НТБ ОНАФТ

# Contractibility of manifolds by means of stochastic flows

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In [2] Xue-Mei Li studied stability of stochastic differential equations and the interplay between the moment stability of a SDE and the topology of the underlying manifold. In particular, she gave sufficient condition on SDE on a manifold  $M$  under which the fundamental group  $\pi_1 M = 0$ . We prove that in fact under essentially weaker conditions the manifold  $M$  is contractible, that is all homotopy groups  $\pi_k M$ ,  $k \geq 1$ , vanish.

Let  $M$  be a smooth connected manifold (i.e. locally Euclidean Hausdorff topological space with countable base) of dimension  $m$  possibly non-compact and having a boundary and  $\mathcal{T} = (\Omega, \mathcal{F}, \mathbf{P})$  be a probability space, so  $\Omega$  is a set,  $\mathcal{F}$  is a  $\sigma$ -algebra of subsets of  $\Omega$ , and  $\mathbf{P}$  is a probability measure on  $\mathcal{F}$ . Let also  $\{\mathcal{F}_t\}_{t \geq 0}$  for some  $a \geq 0$  be a family of  $\sigma$ -algebras in  $\mathcal{F}$  with the following properties:

- each  $\mathcal{F}_t$  contains all null sets of  $\mathcal{F}$ ;
- $\mathcal{F}_s \subseteq \mathcal{F}_t$  for  $s < t$ ;
- $\{\mathcal{F}_t\}_{t \geq 0}$  is right continuous in the sense that  $\mathcal{F}_s = \bigcap_{s < t} \mathcal{F}_t$  for all  $s \geq 0$ .

A map  $\xi : M \times [0, +\infty) \times \Omega \rightarrow M$  will be called a *stochastic deformation* whenever there exists  $N \in \mathcal{F}$  of measure 0 such that for each  $\omega \in \Omega \setminus N$ :

- (a) the map  $\xi_{x,t} : \Omega \rightarrow M$ ,  $\xi_{x,t}(\omega) = \xi(x, t, \omega)$ , is  $\mathcal{F}_t/\mathcal{B}(M)$ -measurable;
- (b) the map  $\xi_\omega : M \times [0, +\infty) \rightarrow M$ ,  $\xi_t(x, t) = \xi(x, t, \omega)$ , is continuous;
- (c)  $\xi(x, 0, \omega) = x$  for all  $x \in M$ .

If in addition to (a) and (b) the map  $\xi$  satisfies “semi-group property”:

- (d)  $\xi_\omega(\xi_\omega(x, s), t) = \xi_\omega(x, s + t)$  for all  $s, t \geq 0$ ,

then  $\xi$  is called an *autonomous stochastic flow*.

Given a stochastic deformation  $\xi$  one can define the following  $\sigma$ -additive probability measures  $\mu_{x,t}$ ,  $(x, t) \in M \times [0, +\infty)$  on  $M$  by

$$\mu_{x,t}(A) := \mathbf{P}\{\omega \in \Omega : \xi(x, t, \omega) \in A\}.$$

**Theorem 1.** *Suppose  $\rho$  is a complete Riemannian metric on  $M$  and  $\xi : M \times [0, +\infty) \times \Omega \rightarrow M$  is a stochastic deformation having the following properties:*

- (i) *the map  $\xi_{t,\omega} : M \rightarrow M$ ,  $\xi_{t,\omega}(x) = \xi(x, t, \omega)$ , is  $C^1$  for all  $t \in [0, +\infty)$  and  $\omega \in \Omega \setminus N$ ;*
- (ii) *for each compact subset  $\mathbf{L}$  of the tangent bundle  $TM$  we have that*

$$\int_0^{+\infty} \sup_{(x,v) \in \mathbf{L}: x \in M, v \in T_x M} \mathbf{E} \|T_x \xi_{t,\omega}(v)\| dt < \infty,$$

where  $\mathbf{E}f = \int_\Omega f d\mathbf{P}$  is a mean value, and the norm is taken with respect to  $\rho$ ;

- (iii) *there exists a point  $z \in M$ , a compact subset  $K \subset M$ ,  $\varepsilon > 0$  and  $N > 0$  such that  $\mu_{z,t}(K) > \varepsilon$  for all  $t > N$ .*

Then  $M$  is contractible.

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