

# Smooth Manifolds, Vector fields, Flows, Lie derivative

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## 1 Manifold

We shall first define topological manifold and then provide them with a smooth structure to form smooth manifold. An  $n$ -dimensional topological manifold is a topological space that is locally modeled by  $\mathbb{R}^n$ .

**Definition 1.1** (Topological manifold). Let  $n \in \mathbb{N}$ . A topological  $n$ -manifold,  $M$ , is a **second countable, Hausdorff** topological space such that every point  $p \in M$  has a neighbourhood  $N \ni p$  and a homeomorphism  $\varphi : N \rightarrow U$  where  $U \subset \mathbb{R}^n$  is an open set.

A topological manifold