

### Some familiar topics in Geometry

A student can do a research project in any of the areas listed below. The list below is not exhaustive; students may contact relevant faculty members based on their interests. This may involve lectures in the second year, or a reading course with discussion, as advised by the faculty members.

#### **Riemannian Geometry**

Review of Differential Geometry and Differential Manifold: Manifolds and examples, smooth maps, tangent vectors and the tangent bundle, push-forward. Tensor fields, tensor product. Lie derivative. Partition of unity, orientation, Riemannian metric, Cartan's formula. Definition of Riemannian manifolds and examples. Connections and covariant derivatives of vector fields and other tensors. Levi-Civita connection, parallel transport : The fundamental theorem of Riemannian geometry. Geodesics, exponential map, curvature and examples. Geodesic completeness, Hopf-Rinow Theorem. Riemannian and sectional curvature. Manifolds with constant curvature, sphere, geometry of hyperbolic space, classification.

#### Textbooks:

1. John M. Lee, *Riemannian Manifolds: An Introduction to Curvature*. Springer.
2. M. do Carmo, *Riemannian Geometry*, Springer.
2. W. M. Boothby, *An Introduction to Differentiable Manifolds and Riemannian Geometry*, Academic Press.
4. S. Kumaresan, *Riemannian Geometry-Concepts, Examples and Techniques*, Techno World.