MAT402, Seminar in Mathematics, 2022 Spring

Physics P129 Monday, Wednesday 4:25-5:45am

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Office: Math Tower 3-116
Office hours: Monday and Wednesday, 1:30pm-2:30pm

Title of the seminar: Geometry and topology of 3-dimensional spaces

Course Brief: Topology is the study of properties of shape that do not change when we bend and stretch while the focus of Geometry is on how to measure the local bending of the spaces. The topology and geometry of surfaces have been discussed in course of MAT 364.

We will extend the idea, learned in MAT 364, to higher dimensional spaces, especially 3-dimensional spaces. For example, models of hyperbolic spaces and spherical 3-dimensional spaces. We will also introduce some topological and geometric invariants which could distinguish two different 3-dimensional spaces.

The study of topology and geometry on 3-dimensional spaces are important in many different applications from various fields, including computer science (for example, machine learning) and computational mathematics (such as optimal transformation).

Course Description: In this seminar, we will explore the field of 3-dimensional spaces and their topological and geometric properties at an undergraduate level while reviewing, reinforcing and extending the idea from MAT364. The main focus of this seminar is on some classical 3-dimensional spaces and describing their topology and geometry. Topics we will cover includes:

- A quick review of surfaces, including properties and classification theorem;
- Examples of 3-dimensional spaces including models of hyperbolic spaces, spherical 3-space and Seifert fiber space;
- Geometry of classical 3-dimensional spaces, including curvatures and geodesics;
- Topological invariants (which could distinguish two different 3-dimensional spaces) including Euler characterization and the fundamental group.

If time permits, we will also discuss the geometric decomposition on 3-dimensional spaces and the classification of 3-dimensional spaces.

I will give a few short lectures on each topic and will assign further material for the students to read and to present in class. Corresponding topics and reading material will be regularly posted on the Blackboard.

Prerequisites: Student need to have completed MAT 364 (Geometry and Topology) or MAT 360 (Geometric structures). Completion of MAT 362 is helpful but not necessary.

Course resources: There is no formal textbook required to this class. Instead, it is required to read, on regular basis, all materials posted in the Blackboard.

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