**HOMEWORK SET 5**  
**SPRING 2020**

**INSTRUCTOR: YI LIU**

*Due Thursday April 30, 2020.*

1. For any hyperbolic 3–manifold $M$ of finite volume, show that there are finitely many conjugacy classes of subgroups of $\pi_1(M)$ isomorphic to $\mathbb{Z} \times \mathbb{Z}$.

2. For any value $V > 0$, show that there are at most finitely many hyperbolic 3–manifolds which are mutually non-isomorphic and which all have volume $V$.

3. For any integer $n > 0$, construct $n$ hyperbolic 3–manifolds which all have the same volume but which are mutually non-homeomorphic.