Non tame cocycle rigidity above affine unipotent abelian actions on the torus

mercredi 12 juin 2024 11:00 (1 heure)

Cocycle rigidity with tame solutions is a crucial ingredient in KAM theory. We are interested in cocycle rigidity above affine unipotent abelian actions on the torus with Diophantine translation data. We consider *unlocked* actions whose rank one factors are non vanishing translations (the locked actions do not have any kind of stability).

It follows from Katok and Robinson's observations that when one generator of the action is of step less or equal to 2 then cocycle rigidity with tame solutions holds. Moreover, Damjanovic, Fayad and Saprykina proved that in this case *almost* cocycles also have *almost* solutions (with a low regularity control on the error), and from there concluded KAM-rigidity of these actions.

In a joint work with S. Durham, we find examples of affine $\mathbb{Z}^2$-actions on the torus above which smooth cocycle rigidity holds but is not tame. The linear part of the action is generated by unipotent matrices of step 3. Our examples show that KAM-rigidity for higher rank actions by affine unipotent toral actions does not hold in general when no element of the actions is of step less or equal to 2.

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