

## RESEARCH RESULTS SO FAR

LUIS PEDRO CASTELLANOS MOSCOSO

### 1. INTRODUCTION

The problem of determining whether a given manifold admits a symplectic structure is a classical and hard problem. In the setting of Lie groups, it is natural to ask about the existence of left-invariant structures. A *symplectic Lie group* is a Lie group  $G$  endowed with a left-invariant symplectic form  $\omega$  (that is, a nondegenerate closed 2-form). The study of symplectic Lie groups reduces to the study of *symplectic Lie algebras*  $(\mathfrak{g}, \omega)$ , that is Lie algebras  $\mathfrak{g}$  endowed with nondegenerate closed 2-forms (or equivalently two-cocycles  $\omega \in Z^2(\mathfrak{g})$ ). Still the problem of determining if a given Lie algebra admits a symplectic structure remains difficult in general and the picture seems far from complete. Only some classifications in low dimensions and some special cases in higher dimensions are known.

In [4] we can find a novel method to find nice (e.g., Einstein or Ricci soliton) left-invariant Riemannian metrics. The method is based on the moduli space of left-invariant Riemannian metrics on a Lie group  $G$  (the orbit of space of certain group action). In [5] and [6] the authors adapted the same ideas in the pseudo-Riemannian case successfully. It was natural then, to try to use the same ideas for symplectic Lie groups.

### 2. RESULTS

- (1) Inspired by those previous studies in [3] we developed a similar approach for the study of symplectic Lie groups. We study the moduli space of left-invariant nondegenerate 2-forms on Lie algebras  $\mathfrak{g}$ .
- (2) As a first application of these ideas also in [3] we studied two particular Lie algebras: the Lie algebra of the real hyperbolic space  $\mathfrak{g}_{\mathbb{R}H^{2n}}$ , and the direct sum of the 3-dimensional Heisenberg Lie algebra and the abelian Lie algebra  $\mathfrak{h}^3 \oplus \mathbb{R}^{2n-3}$ . We obtained a classification of symplectic structures on both of them.
- (3) These two Lie algebras belong to a special family of Lie algebras: they are both almost abelian Lie algebras. In [2] we studied a particular family of almost abelian Lie algebras whose adjoint homomorphism is diagonalizable, and obtained a classification of symplectic structures.
- (4) We obtained an improvement on two decomposition theorems of symplectic matrices: the symplectic QR decomposition and the SR decomposition.

### REFERENCES

- [1] Baues, O. and Cortés, V. : *Symplectic Lie groups*. Astérisque **379** (2016).
- [2] Castellanos Moscoso, L. P.: *Left-invariant symplectic structures on diagonal almost abelian Lie groups*. Submitted.
- [3] Castellanos Moscoso, L. P. and Tamaru, H.: *A classification of left-invariant symplectic structures on some Lie groups*. arXiv e-prints, 2020.
- [4] Hashinaga, T., Tamaru, H. and Terada, K.: *Milnor-type theorems for left-invariant Riemannian metrics on Lie groups* J. Math. Soc. Japan **68** (2016), 669-684.
- [5] Kondo, Y., and Tamaru, H.: *A classification of left-invariant Lorentzian metrics on some nilpotent Lie groups*. Tohoku Math. J. To appear.
- [6] Kubo, A., Onda, K., Taketomi, Y., Tamaru, H.: *On the moduli spaces of left-invariant pseudo-Riemannian metrics on Lie groups*. Hiroshima Math. J. **46** (2016), 357-374.

DEPARTMENT OF MATHEMATICS, GRADUATE SCHOOL OF SCIENCE, OSAKA CITY UNIVERSITY, SUGIMOTO,  
SUMIYOSHI-KU, OSAKA CITY, JAPAN 585-8585  
*Email address:* `caste3.1416@gmail.com`