Project 5.3. Geometric applications of Elie Cartan's equivalence method.

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WWW of the unit/project: http://www.cft.edu.pl/

Background:
For decades, the main such structure studied in many directions was Riemannian geometry. It turns out that in addition to these well-studied structures there are plenty of other geometries based on concepts other than the concept of distance, which is specific to Euclidean geometry. These geometries bear the common name of Cartan geometry. Some of these geometries find application in alternative gravity theories and other physical theories, but most of them have hitherto existed as mathematical abstraction.

In mathematics, there is a somewhat neglected treatment tool, developed more than a hundred years ago by Elie Cartan, which algorithmically allows (modulo some technical problems; see below) to determine all differential invariants of such geometries and all their homogeneous models. This tool is called - in the determination of invariants - the Cartan equivalence method, and - in the determination of homogeneous models - the Cartan reduction method.

In the project we will refresh and modernize the almost completely forgotten methods of Cartan (the equivalence and reduction methods), and use them, with the help of the latest computers, to solve classic and new problems of local geometry. Even in the case of conformal, projective and CR, and even in the lowest dimensions (respectively 3, 2 and 3) there is still a lot to do!

Aim of the project:
The goal of the project is to use the Cartan equivalence method to determine all invariants and find all homogeneous models for a large class of geometric structures on manifolds. In particular, parabolic geometries will be examined in this respect, with particular emphasis on parabolic geometries whose flat models are homogeneous spaces for real *exceptional* simple Lie groups.

Requirements:
- MSc (or equivalent) degree in physics or mathematics