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The equivalence problem and three-dimensional Szekeres metrics

The problem of determining whether or not two mathematical objects are the same under a change of coordinates has been of interest to mathematicians for several centuries. What was originally of interest to pure mathematicians, the question of equivalence of mathematical objects has become of concern to applied mathematicians, physicists, and most recently computer scientists. Applications of the problem have found themselves in areas such as differential equations, Lagrangian mechanics, general relativity, Lie theory, differential geometry, and many others. In this talk, I will first give an introduction to the equivalence problem, and illustrate some methods used to determine equivalence of objects through the presentation of several digestible examples. I will then discuss the problem in differential geometry concerned with determining equivalence of (pseudo)-Riemannian manifolds, and give an overview of my most recent research where I am concerned with obtaining a local invariant classification of 3-D Szekeres metrics, a class of solutions to Einstein's field equations of general relativity. Time permitting, the aim is to introduce Cartan's method of moving frames, a powerful tool used by both geometers and relativists.