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**VI International Meeting on Lorentzian Geometry  
Granada (Spain), September 6-9, 2011  
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**Invited talk:**

**How to reconstruct a metric by its unparameterized geodesics**

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We discuss whether it is possible to reconstruct a metric by its unparameterized geodesics, and how to do it effectively. We explain why this problem is interesting for general relativity. We show how to understand whether all curves from a sufficiently big family are unparameterized geodesics of a certain affine connection, and how to reconstruct algorithmically a generic 4-dimensional metric by its unparameterized geodesics. The algorithm works most effectively if the metric is Ricci-flat. We also prove that almost every metric does not allow nontrivial geodesic equivalence, and construct all pairs of 4-dimensional geodesically equivalent metrics of Lorenz signature. If the time allows, I will also explain how this theory helped to solve two problems explicitly formulated by Sophus Lie in 1882, and the semi-Riemannian two-dimensional version of the projective Lichnerowicz-Obata conjecture.

The new results of the talk are based on the papers  
arXiv:1010.4699, arXiv:1002.3934, arXiv:0806.3169, arXiv:0802.2344,  
arXiv:0705.3592 joint with Bryant, Bolsinov, Kiosak, Manno, Pucacco