Modular Galois representations, congruences and entanglement

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The theory of congruences of modular forms is a central topic in contemporary number theory, lying at the basis of the proof of Mazur's theorem on torsion in elliptic curves, Fermat's Last Theorem, and Sato-Tate, amongst others. Congruences are a display of the interplay between geometry and arithmetic.

In this talk, I will not only explain how to study and test congruences relations between modular forms, but also how to study isomorphisms of modular Galois representations.

In particular, I will explain how to test efficiently and effectively whether two odd modular Galois representations of the absolute Galois group of the rational numbers are isomorphic and present new optimal bounds on the number of traces to be checked (joint work with Peter Bruin, University of Leiden). I will also briefly discuss new results concerning entanglement of such representations (joint work with Luis Dieulefait, Universitat de Barcelona, and Gabor Wiese, Université du Luxembourg).