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A multi-Frey approach to Fermat equations of signature (5,5,p) and (13,13,p)

The generalized Fermat equation $x^p + y^q = z^r$ is expected to have only trivial primitive integer solutions when $p, q, r \geq 3$. A current approach to this problem is a moduli approach where one attaches to a putative non-trivial primitive solution, a Frey abelian variety. By showing the associated Galois representations are modular, severe constraints on the solutions are obtained. This is the method first pioneered by Wiles' and extended by many mathematicians, including a general program described by Darmon. An important phenomenon that has emerged in recent work is the use of multiple Frey abelian varieties to patch together a complete resolution, not otherwise obtainable by the use of a single Frey abelian variety.

I will report on joint work with Billerey, Dieulefait, and Freitas, where we use a refined application of the multi-Frey method to resolve the equations $x^5 + y^5 = 3z^p$ (for all primes p) and $x^{13} + y^{13} = 3z^p$ (for all primes $p \neq 7$) using modular Frey elliptic curves over totally real fields.