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The modularity of non-rigid Calabi-Yau threefolds

Let X be a Calabi–Yau threefold and let $X^\vee$ be its mirror (family) of Calabi–Yau threefolds. Suppose that both X and $X^\vee$ are defined over the rationals. We will consider non-rigid Calabi–Yau threefolds X with small Hodge numbers $h^{1,1}(X)$, or $h^{2,1}(X) > 0$ so that $B_3(X)$ or $B_3(X^\vee)$ are small. Thus, the dimension of the Galois representations associated to X or $X^\vee$ are small.

Our goal is to establish the modularity of X or $X^\vee$. This may be achieved when the Galois representation of the middle cohomology of X or $X^\vee$ decomposes into smaller dimensional ones. We will discuss some examples.