Syzygies of torsion bundles and the geometry of the level l modular variety over M_g

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In joint work with Chiodo, Eisenbud and Schreyer, we formulate, and in some cases prove, three statements concerning the purity of the resolution of various rings one can attach to a generic curve of genus g and a torsion point of order l in its Jacobian. These statements can be viewed an analogues of Green's Conjecture and we verify them computationally for bounded genus. We then compute the cohomology class of the corresponding non-vanishing locus in the moduli space $R_{g,l}$ of twisted level l curves of genus g and use this to derive results about the birational geometry of $R_{g,l}$. For instance, we prove that $R_{g,3}$ is a variety of general type when g>11. I will also discuss the surprising failure of the Prym-Green Conjecture for genera which are powers of 2.