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Automorphisms of Katz-Gabber covers

This is joint work with Ted Chinburg, Bjorn Poonen and Peter Symonds. Let $k$ be an algebraically closed field of characteristic $p > 0$, and let $G$ be a finite group of order divisible by $p$. This talk has to do with the possible isomorphism classes of $G$-sets $T$ which can arise as the ramification locus of a faithful action of $G$ on a smooth projective curve $X$ over $k$. One says this action defines a Katz-Gabber $G$-cover if $X/G$ has genus $0$, $T^G$ is one point, and $G$ acts tamely and transitively on $T - T^G$.

Our goal is to study the automorphism group $\text{Aut}_k(X)$ of $X$ over $k$. This group contains $G$ by virtue of the Katz-Gabber construction.

We consider the case when $X \to X/\text{Aut}_k(X)$ is not a Katz-Gabber cover for the group $\text{Aut}_k(X)$, so that $\text{Aut}_k(X)$ is strictly larger than $G$. We show that then either $X$ belongs to an exceptional family of curves of genus 0 or 1, or the action of $\text{Aut}_k(X)$ on $X$ mixes the tame and totally ramified orbits. The exceptional case in which $X$ has genus 1 is of particular interest because it leads to some new explicit formulas for power series $\sigma(t) = \sum_{i=1}^{\infty} a_i t^i$ which define automorphisms of $k[[t]]$ of order $p^2$ when $p = 2$. 