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A generalization of the Strong Castelnuovo Lemma

We consider a set X of distinct points in the n-dimensional projective space over an algebraically closed field k. Let A denote the coordinate ring of X, and let $a_i(X) = \dim_k[\mathrm{Tor}_i^R(A, k)]_{i+1}$. Green's Strong Castelnuovo Lemma (SCL) shows that if the points are in general position, then $a_{n-1}(X) \neq 0$ (that is, there are linear syzygies up to order $n-1$) if and only if the points are on a rational normal curve. Cavaliere, Rossi and Valla conjectured that if the points are not necessarily in general position the possible extension of the SCL should be the following: $a_{n-1}(X) \neq 0$ if and only if either the points are on a rational normal curve or in the union of two linear subspaces whose dimensions add up to n. In this work we prove the conjecture.