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The Weak Lefschetz Property, almost complete intersections and monomial ideals

Let R be a polynomial ring over a field k with the usual grading. An Artinian graded algebra R/I has the Weak Lefschetz Property (WLP) if multiplication by a general linear form, from any component to the next, has maximal rank. In characteristic zero it's known that monomial complete intersections in any number of variables have WLP, as does every complete intersection in three variables. Migliore and Miró-Roig asked if every *almost complete intersection* has WLP. This was answered negatively, for characteristic zero, by Brenner and Kaid (BK) with a simple monomial example, again in three variables. Both results in three variables were obtained by studying the corresponding syzygy bundles. Here we describe a different approach that does not require characteristic zero, and generalize the BK results in two directions: first, a directly analogous example in any number of variables is shown to fail WLP, regardless of the choice of the field k . Second, we study monomial almost complete intersections, especially in the level case, for three variables. We reduce the WLP question to one of the vanishing of a certain determinant, and as a result the characteristic of the ground field plays a surprising role.

We describe joint work with Rosa Miró-Roig and Uwe Nagel.