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Matrix Factorizations for Complete Intersections

Hilbert introduced the approach to describe the structure of modules by free resolutions. Hilbert's Syzygy Theorem shows that minimal free resolutions over a polynomial ring are finite. By a result of Serre, it follows that most minimal free resolutions over quotient rings are infinite. We will discuss the structure of such resolutions. The concept of matrix factorization was introduced by Eisenbud 35 year ago, and it describes completely the asymptotic structure of minimal free resolutions over a hypersurface. Matrix factorizations have applications in many fields of mathematics: for the study of cluster algebras, Cohen-Macaulay modules, knot theory, moduli of curves, quiver and group representations, and singularity theory. Starting with Kapustin and Li, physicists discovered amazing connections with string theory. In a joint work with Eisenbud, we introduce the concept of matrix factorization for complete intersection rings and show that it suffices to describe the asymptotic structure of minimal free resolutions over complete intersections.