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Algebraic geometry, theory of singularities, and convex geometry

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I will review some results which relate these areas of mathematics.
Newton polyhedra connect algebraic geometry and the theory of singularities to the geometry of convex polyhedra. This connection is useful in both direc- tions. On the one hand, explicit answers are given to problems of algebra and the theory of singularities in terms of the geometry of polyhedra. On the other hand, algebraic theorems of general character (like the Hirzebruch–Riemann–Roch theorem) give significant information about the geometry of polyhedra. In this way one obtains, for example, a multidimensional generalization of the classical one-dimensional Euler–Mclaurin formula. Combinatorics related to the Newton polyhedra theory allows to prove that in hyperbolic space of high dimension there do not exist discrete groups generated by reflections with fundamental polyhedron of finite volume (it was a longstanding conjecture).
The theory of Newton–Okounkov bodies relates algebra, singularities and geom- etry outside the framework of toric geometry. This relationship is useful in many directions. For algebraic geometry it provides elementary proofs of intersection- theoretic analogues of the geometric Alexandrov–Fenchel inequalities and far-reach- ing generalizations of the Fujita approximation theorem. The local version of the theory provides a new proof of the famous Teissier's inequalities for the multiplici- ties of primary ideals in a local ring. In geometry it suggests a transparent analog of Alexandrov–Fenchel inequality for coconvex bodies.

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