De Rham Cohomology and Ordinary Differential Equations

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We describe an EXPSPACE-algorithm for computing the de Rham cohomology of the complement of an affine hypersurface over the complex numbers. The best previously known algorithm for this problem (cylindrical algebraic decomposition) needs double exponential time. Our algorithm follows the lines of a proof of Monsky for the finite dimensionality of the de Rham cohomology. It reduces the computation of the cohomology to certain systems of ordinary differential equations with Laurent polynomial coefficients. We study the complexity of the solutions of such systems.