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Yi Qiu, Caijun Zhou

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Uniform annihilators of local cohomology of extended Rees rings

Yi Qiu Caijun Zhou

*Department of Mathematics, Shanghai Normal University,
Shanghai, 200234, China*

Abstract

The purpose of the paper is to study the annihilators of local cohomology of the extended Rees rings. We will prove that if (A, \mathfrak{m}) is a noetherian local ring with infinite residue field, and a is a uniform local cohomological annihilator of A , then there is an integer n such that $(at)^n$ is a uniform local cohomological annihilator of the extended Rees ring $A[t, t^{-1}I]$ for any \mathfrak{m} -primary ideal I of A .

1 Introduction

Let A be a noetherian ring, I an ideal of A , and t an indeterminate over A . Consider $A[t, t^{-1}]$ as a graded ring in the natural way with $\deg(t) = 1$. The extended Rees ring of A associated to I is the graded subring $R = A[t, t^{-1}I]$ of the ring $A[t, t^{-1}]$. If $I = (a_1, a_2, \dots, a_r)$ then $R[t, t^{-1}I] = R[t, t^{-1}a_1, \dots, t^{-1}a_r]$, so that R is also a noetherian ring. It is known that $\dim(R) = \dim(A) + 1$ [cf. Ma].

Let $\text{gr}_I(A) = \bigoplus_{n \geq 0} I^n / I^{n+1}$ be the associated graded ring of A with respect to I . One can show easily that

$$R/tR \cong \text{gr}_I(A) \quad \text{and} \quad R/(1-t)R \cong A,$$

so that we can regard $\text{gr}_I(A)$ as a deformation of the original ring A , with R as total space of the deformation, in the sense that the values $t = 1$ and 0 correspond to A and $\text{gr}_I(A)$, respectively. Such deformation plays an important role in the theory of algebraic geometry [cf. Fu].

It is well known that if (A, \mathfrak{m}) is a d -dimensional Cohen-Macaulay (abbr. *CM*) local ring and I is an ideal generated by a system of parameters a_1, a_2, \dots, a_d , then the extended Rees ring R is also a *CM* ring [cf. BH], and the result is not valid for all \mathfrak{m} -primary ideals. This means that there is a \mathfrak{m} -primary ideal I and a maximal ideal Q of $A[t, t^{-1}I]$ such that $H_Q^i(A[t, t^{-1}I])$ may be nonzero for some i ($i < \text{ht}(Q)$). In fact, such local cohomology modules are rarely finitely generated. In this paper, we will study the annihilators of these modules.

Recalling that an element $a \in A$ is said to be a uniform local cohomological annihilator of A , if it is not lying in any minimal prime ideal of A , and for any maximal ideal

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