The 7th Seminar on

Commutative Algebra and Related Topics

December 1 & 2, 2010

School of Mathematics, IPM

About IPM and its School of Mathematics

The Institute for Research in Fundamental Sciences (IPM) is an institute affiliated with the Ministry of Science, Research, and Technology. It was founded in 1989 under the name "Institute for Studies in Theoretical Physics and Mathematics" and its initial goal was the advancement of research and innovation in theoretical physics and mathematics. The foundation of the Institute was also accompanied by hopes and expectations that a model would be developed which could serve as a basis for the promotion of the culture of research all across the country.

The Institute started its activities with three research groups in physics and three research groups in mathematics (Combinatorics and Computing, Dynamical Systems, and Mathematical Logic & Theoretical Computer Science). Initially it had few researchers and limited resources, but gradually it managed to expand its manpower in physics and mathematics, and it also attracted scientists from other disciplines. The activities of the Institute thus extended to other fields and in 1997 it acquired its present name. The Institute now consists of 8 schools: Analytic Philosophy Astronomy, Cognitive Sciences, Computer Science, Mathematics, Nano Science, Particles and Accelerator, and Physics. It enjoys an expanding base of infrastructures and facilities (electronic networking, computers, laboratories, a well-equipped and up-to-date library), and has an active presence in the national research activities within the corresponding fields.

The School of Mathematics (formerly called the Section of Mathematics) has been one of the founder schools of IPM. Presently, there are three main research areas at the School: Combinatorics and Computing, Commutative Algebra, and Mathematical Logic. Different research modalities are available at the School of Mathematics: Founding Fellows, Faculty Members, Postdoctal Research Fellows, Senior Associate Researchers, Junior Associate Researchers, Non-Resident Researchers, and Student Researchers in full-time, part-time, and non-resident modes.

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About the Seminar

Commutative algebra series of meetings represents a collaborative effort of Iranian commutative algebraists. 7th seminar on commutative algebra and related topics will be held on December 1-2, 2010 (10-11 Azar 1389), at the School of Mathematics of IPM, Tehran, Iran.

The goal of this session is to bring together many Iranian mathematicians who are working in commutative algebra and related fields to introduce students and young researchers to the current research topics.

Organizers

- **Mohsen Asgharzadeh** (IPM, asgharzadeh@ipm.ir)

- **Mohammad-Taghi Dibaei** (Tarbiat Moallem University & IPM, dibaeimt@ipm.ir)

Speakers

- **Josep Alvarez Montaner**, Universitat Politecnica de Catalunya, Spain
- **Javad Asadollahi**, University of Isfahan and IPM,
- **Abdolnaser Bahlakeh**, Gonbade-Kavous University,
- **Keivan Borna**, Tarbiat Moallem University and IPM,
- **Seadat Ollah Faramarzi**, Payame Noor University, Shahrood,
- **Mohsen Gheibi**, Tarbiat Moallem University,
- **Ali Hajizamani**, Shahre-Kord University,
- **Esmaeil Hosseini**, University of Isfahan and IPM,
- **Maryam Jahangiri**, Damghan University and IPM,
- **Fahimeh Khosh-Ahang**, Ilam University,
- **Amir Mafi**, University of Kurdistan and IPM,
- **Fatemeh Mohammadi**, Islamic Azad University,
- **Reza Naghipour**, University of Tabriz and IPM,
- **Abbas Nasrollah Nejad**, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan,
- **Parviz Sahandi**, University of Tabriz and IPM,
- **Shokrollah Salarian**, University of Isfahan and IPM,
- **Ahmad Yousefian Darani**, University of Mohaghegh Ardabili, Ardabil,
- **Rashid Zaare-Nahandi**, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan.

Schedule of talks

	December 1 Wednesday	December 2 Thursday
8:30-9:00	**Registration**	
9:00-9:50	**J. Asadollahi** A Nice Generalization of Submodule Categories is Almost Frobenius	**J. Alvarez Montaner** Some Examples and Applications of Cartier Algebras
10:00-10:50	**Rashid Zaare-Nahandi** Barycentric Subdivision of a Simplicial Complex	**A. Nasrollah Nejad** The Gradient Aluffi Algebra
11:00-11:30	**Coffee Break**	**Coffee Break**
11:30-12:00	**P. Sahandi** Semistar Normal Pairs And Related Characterizations Of P*Mds	**R. Naghipour** Quintasymptotic Sequences over an Ideal
12:00-12:30	**M. Jahangiri** Boundedness of Cohomology	**K. Borna** How To Compute The Associated Primes and Regularity of Monomial Ideals
12:30-14:00	**Lunch**	**Lunch**
14:00-14:30	**S. Salarian** On the Adjoint Functors on the Homotopy Categories	**A. Yousefian Darani** On Weakly 2-Absorbing Ideals Of Commutative Rings
14:30-15:00	**A. Bahlekeh** Cofibrant and Gorenstein Projective Modules	**S. Faramarzi** Balanced 3-Polytopes
15:00-15:30	**F. Khosh-Ahang** Some Generalizations Of Bass Formula	**Coffee Break**
15:30-16:00	**Coffee Break**	**F. Mohammadi** Foxby Equivalence, Local Duality And Gorenstein Homological Dimensions
16:00-16:30	**A. Hajizamani** Periodic Flat Resolutions and Periodicity in Group (co)homology	**M. Gheibi** Linkage of Modules over Cohen-Macaulay Rings
16:30-17:00	**A. Mafi** On The Finiteness Dimension Of Local Cohomology Module	
17:00-17:30	**E. Hosseini** Model Category Structure Induced By Complete Cotorsion Pairs	

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Some Examples and Applications of Cartier Algebras

Josep Alvarez Montaner
Universitat Politecnica de Catalunya
Barcelona, Spain

The recent development in the study of Cartier algebras has given a new approach to the description of generalized test ideals in non regular rings. In this talk we will first recall the notion of Frobenius and Cartier algebras associated to an R-module and then we will give a full description for the case of Stanley-Reisner rings. This description allow us to study the discreteness of the set of F-jumping numbers of the corresponding generalized test ideals.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

A Nice Generalization of Submodule Categories is Almost Frobenius

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In this lecture we consider the category of mono-representations of a certain two flag quiver and show that it is almost Frobenius. This category, in fact, provides a very nice generalization of the notion of submodule categories.

This is a joint 'work in progress' with H. Lenzing.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Cofibrant and Gorenstein Projective Modules

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Benson introduced the cofibrant modules for his study of $\mathbb{Z}\Gamma$-modules of type FP_∞ when Γ is in the class LH$\mathcal{F}$. For any group Γ, a $\mathbb{Z}\Gamma$-module M is said to be cofibrant if $M \otimes B(\Gamma, \mathbb{Z})$ with diagonal Γ-action is a projective $\mathbb{Z}\Gamma$-module, where $B(\Gamma, \mathbb{Z})$ is the set of bounded functions from Γ to $\mathbb{Z}$. A $\mathbb{Z}\Gamma$-module A is said to be of type FP_∞ if A admits a projective resolution by finitely generated projective modules. The class H$\mathcal{F}$ was defined by Kropholler as the smallest class of groups that contains the class of finite groups and whenever a group Γ admits a finite-dimensional contractible Γ-CW-complex with stabilizers in H$\mathcal{F}$, then Γ is in H$\mathcal{F}$. Denote by LH$\mathcal{F}$ the class of groups Γ such that every finitely generated subgroup of Γ is in H$\mathcal{F}$.

On the other hand, Asadollahi, Bahlekeh and Salarian studied Gorenstein projective modules in the category of $\mathbb{Z}\Gamma$-modules. It is easy to see that every cofibrant $\mathbb{Z}\Gamma$-module is Gorenstein projective. We believe that in essence the two notions, cofibrant and Gorenstein projective, are the same. Here, we obtain some results pointing to this direction. These results is based on a joint work with O. Talelli and F. Dembegioti.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

How to Compute the Associated Primes and Regularity of Monomial Ideals

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Generally speaking there is no guaranty for having the implication "$\mathfrak{p} \in \operatorname{ass}_S I \Longrightarrow \mathfrak{p} \in \operatorname{ass}_S I^n$ for all $n \geq 1$." In this talk we show that for a monomial ideal I of a polynomial ring S over a field K, if $\mathfrak{p} \in \operatorname{ass}_S I$ and $\operatorname{ht} \mathfrak{p} = \lambda(I)$, where $\lambda(I)$ is the number of indeterminates appear in generators of I, then $\mathfrak{p} \in \operatorname{ass}_S I^n$ for all $n \geq 1$.

In the second part of this talk, we find the regularity of monomial ideals that satisfy some conditions on their primary representation. More precisely, let I be a monomial ideal of S. Then $I = \cap_{i=1}^{k} Q_i$, where each Q_j is generated by pure powers of the variables. Thus Q_j is a $\mathfrak{p}_j$-primary ideal, where $\mathfrak{p}_j = (x_{i_1}, \cdots, x_{i_c})$ for some positive integer c. One now can note that $\operatorname{ht}(Q_j) = \operatorname{ht}(x_{i_1}, \cdots, x_{i_c}) = c$ and indeed $c \leq \lambda(I)$. Hence $\operatorname{ht}(\mathfrak{p}) \leq \lambda(I)$ for all $\mathfrak{p} \in \operatorname{ass}_S I$. It now makes perfect sense to see whenever the equality holds in fact. We say that I satisfies the *maximal height condition* for $\operatorname{ass}_S I$ (*MHC* for short), if there exists a prime ideal $\mathfrak{p} \in \operatorname{ass}_S I$ with $\operatorname{ht}(\mathfrak{p}) = \lambda(I)$. We show that if I satisfies the MHC, then $\operatorname{reg}(I) = m(I) = \max\{|Q_j| - \operatorname{ht}(Q_j) \mid j = 1, \ldots, k\}$. That is, regularity of such ideals is given by $\max\{|Q| - ht(Q)\}$, where Q appears in the irredundant pure primary representaion of I.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Balanced 3-Polytopes

Seadat Ollah Faramarzi
Payame Noor University
Shahrood, Iran

In this lecture we give a list of all possibly occurring E-equivalence classes of three-dimensional balanced and Col-divisible polytopes. Also we compute all balanced polytopes which are not Col-divisible.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Linkage of Modules over Cohen-Macaulay Rings

Mohsen Gheibi
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Inspired by the works in linkage theory of ideals, the concept of sliding depth of extension modules is defined to prove the Cohen-Macaulyness of linked module if the base ring is merely Cohen-Macaulay. Some relations between this new condition and other module-theory conditions such as G-dimension and sequentially Cohen-Macaulay are established. By the way several already known theorems in linkage theory are improved or recovered by new approaches.

This is a joint work with M.T. Dibaei, S.H. Hassanzadeh, and A. Sadeghi.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Periodic Flat Resolutions and Periodicity in Group (Co)homology

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Using the notion of flat covers and proper flat resolutions, we study modules with periodic flat resolutions. It follows that equivalently, we may study modules with periodic homology. We specialize our results to the category of modules over integral group ring $\mathbb{Z}\Gamma$, where Γ is an arbitrary group. Among other results, we show that if a group Γ is in a certain class of groups then Γ has periodic homology of period q after some steps with the periodicity isomorphisms of homology groups induced by the cap product with an element in $H^q(\Gamma, C)$, where C is the cotorsion envelope of the trivial Γ-module $\mathbb{Z}$, if and only if it has periodic cohomology of period q after some steps with the periodicity isomorphisms of cohomology groups induced by the cup product with an element in $H^q(\Gamma, \mathbb{Z})$.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Model Category Structure Induced by Complete Cotorsion Pairs

Esmaeil Hosseini
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Let X be a noetherian scheme and Flat(X) be the class of all flat quasi-coherent $\mathcal{O}_X$-modules. We show that the complete cotorsion pair (Flat(X), Flat(X)$^{\perp}$) induces a complete cotorsion pair in the category $\mathcal{C}$ of chain complexes of quasi-coherent $\mathcal{O}_X$-modules. This in turn provides a model category structure on $\mathcal{C}$.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Boundedness of Cohomology

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Let $d \in \mathbb{N}$ and let $\mathcal{D}^d$ denote the class of all pairs (R, M) in which $R = \bigoplus_{n \in \mathbb{N}_0} R_n$ is a Noetherian homogeneous ring with Artinian base ring R_0 and such that M is a finitely generated graded R-module of dimension $\leq d$. For such a pair (R, M) let $d^i_M(n)$ denotes the (finite)-R_0 length of the n-th graded component of the i-th R_+- transform module $D^i_{R_+}(M)$.

We are looking for subcategories of $\mathcal{D}^d$, say $\mathcal{C}$, for which the set of cohomology tables $\{d_M := (d^i_M(n))_{(i,n) \in \mathbb{N} \times \mathbb{Z}} | (R, M) \in \mathcal{C}\}$ is finite.

This is a joint work with M. Brodmann and C. H. Linh.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Some Generalizations of Bass Formula

Fahimeh Khosh-Ahang
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In this talk, by comparing the Krull dimension, Gorenstein injective dimension and injective dimension of a module, we establish some generalizations of the Bass formula.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

On the Finiteness Dimension of Local Cohomology Modules

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Let R be a commutative Noetherian ring, $\mathfrak{a}$ an ideal of R, and M a non-zero finitely generated R-module. Let t be a non-negative integer. It is shown that $\dim \operatorname{Supp} H^i_{\mathfrak{a}}(M) \leq 1$ for all $i < t$ if and only if there exists an ideal $\mathfrak{b}$ of R such that $\dim R/\mathfrak{b} \leq 1$ and $H^i_{\mathfrak{a}}(M) \cong H^i_{\mathfrak{b}}(M)$ for all $i < t$. Moreover, we prove that $\dim \operatorname{Supp} H^i_{\mathfrak{a}}(M) \leq \dim M - i$ for all i.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Foxby Equivalence, Local Duality and Gorenstein Homological Dimensions

Fatemeh Mohammadi
Islamic Azad University
Tehran, Iran

Let $(R, \mathfrak{m})$ be a local ring and $(-)^\vee$ denote the Matlis duality functor. We investigate the relationship between Foxby equivalence and local duality through generalized local cohomology. Assume that R possesses a normalized dualizing complex D and X and Y are two homologically bounded complexes of R-modules with finitely generated homology modules. If Gorenstein projective dimension of X and injective dimension Y are finite, then we show that

$$\mathbf{R}\Gamma_{\mathfrak{m}}(\mathbf{R}\operatorname{Hom}_R(X,Y)) \simeq (\mathbf{R}\operatorname{Hom}_R(Y, D \otimes^{\mathbf{L}}_R X))^\vee.$$

Also, we prove that if Gorenstein injective dimension of Y and projective dimension of X are finite, then

$$\mathbf{R}\Gamma_{\mathfrak{m}}(\mathbf{R}\operatorname{Hom}_R(X,Y)) \simeq (\mathbf{R}\operatorname{Hom}_R(\mathbf{R}\operatorname{Hom}_R(D,Y), X))^\vee.$$

We present several other duality results. As applications, we establish Grothendieck's non-vanishing Theorem in the context of generalized local cohomology modules and we give some insight to two questions raised by Christensen, Foxby and Holm.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Quintasymptotic Sequences over an Ideal

Reza Naghipour
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Let I be an ideal in a Noetherian ring R. A prime ideal $\mathfrak{p}$ is called a *quintasymptotic prime ideal* of I if there exists $\mathfrak{q} \in \operatorname{mAss} R^*_\mathfrak{p}$ such that $\operatorname{Rad}(IR^*_\mathfrak{p} + \mathfrak{q}) = \mathfrak{p}R^*_\mathfrak{p}$, where $R^*_\mathfrak{p}$ denotes the $\mathfrak{p}R_\mathfrak{p}$-adic completion of $R_\mathfrak{p}$. The set of *quintasymptotic primes* of I is denoted by $\overline{Q}^*(I)$. The purpose of this talk is to introduce the concept of the quintasymptotic sequence over I, and is to show that if R is local, then the lengths of all maximal quintasymptotic sequences over I are the same, and equal to:

$$\begin{aligned} qacorade\, I &= \min\{\dim(R^*/IR^* + \mathfrak{q}) \,|\, \mathfrak{q} \in \operatorname{mAss} R^*\} \\ &= \min\{\dim R^*/\mathfrak{q} - ht(IR^* + \mathfrak{q}/\mathfrak{q}) \,|\, \mathfrak{q} \in \operatorname{mAss} R^*\}. \end{aligned}$$

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

The Gradient Aluffi Algebra

Abbas Nasrollah Nejad
Institute for Advanced Studies in Basic Sciences (IASBS)
Zanjan, Iran

Paolo Aluffi in a striking paper that shows, in the case of a hypersurface, how to define a so-called *characteristic cycle* in parallel to the well-known *conormal cycle* in intersection theory. In order to do so, Aluffi introduces an intermediate algebra between a symmetric algebra of an ideal and the corresponding Rees algebra (blowup). Of course, algebraists have long been considering such intermediations in a variety of setups, but what comes as a striking fact is that one of these has such a basic and immediate impact in a celebrated difficult area of algebraic geometry.

Aluffi has dubbed his construction a *quasi-symmetric* algebra. Since there are many homomorphic images of the symmetric algebra that could equally benefit from this terminology, A.Nasrollah Nejad and A.Simis called it an *Aluffi algebra*.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Semistar Normal Pairs and P⋆MDs

Parviz Sahandi
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Given an overring extension of domains $D \subseteq T$, we introduce the semistar-theoretic analogues of D being integrally closed in T, (D, T) being a normal pair, $D \subseteq T$ being a residually algebraic extension and (D, T) being a residually algebraic pair. Our main result generalizes Davis' characterization of normal pairs (D, T) as (overring) extensions $D \subseteq T$ for which each intermediate ring is D-flat, while also generalizing some celebrated characterizations of Prüfer domains and several results of Ayache-Jabbalah on residually algebraic pairs. This work also involves extending the connections between the semistar-theoretic notions of primitivity and INC-pair that were given by Chang and Fontana. Applications include several characterizations of P⋆MDs.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

On the Adjoint Functors on the Homotopy Categories

Shokrollah Salarian
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In this talk, we will discuss the existence of some special adjoints on the homotopy category of flats as well as projectives and also injectives. We also will present some applications of these adjoints.

ON Weakly 2-Absorbing Ideals of Commutative Rings

Ahmad Yousefian Darani
University of Mohaghegh Ardabili
Ardabil, Iran

In this talk, we study weakly 2-absorbing ideals of a commutative ring with identity as a generalization of weakly prime ideals. Badawi introduced the concept of 2-absorbing ideals, which are a generalization of prime ideals, where a proper ideal I of a commutative ring R is called a 2-*absorbing ideal of* R if whenever $a, b, c \in R$ and $abc \in I$, then either $ab \in I$ or $ac \in I$ or $bc \in I$. Recall also that a proper ideal I of a commutative ring R is said to be a *weakly prime ideal of* R if whenever $a, b \in R$ and $0 \neq ab \in I$, then either $a \in I$ or $b \in I$. We define a proper ideal of a commutative ring R to be a *weakly 2-absorbing ideal of* R if whenever $a, b, c \in R$ and $0 \neq abc \in I$, then either $ab \in I$ or $ac \in I$ or $bc \in I$. For example, every proper ideal of a quasi-local ring (R, M) with $M^3 = \{0\}$ is a weakly 2-absorbing ideal of R. We provide many basic properties of weakly 2-absorbing ideals. We also give a characterization for commutative rings with the property that all proper ideals are weakly 2-absorbing ideals.

The 7th Seminar on Commutative Algebra and Related Topics,
December 1 & 2, 2010, IPM, Tehran

Barycentric Subdivision of a Simplicial Complex

Rashid Zaare-Nahandi
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In this talk we show that a simplicial complex can be determined uniquely up to isomorphism by its barycentric subdivision or comparability graph. It is summarized several algebraic, combinatorial and topological invariants of simplicial complexes. As a consequence, it is shown that checking Cohen-Macauleyness of all simplicial complexes, is equal to checking Cohen-Macaulayness of all graphs with uniquely transitively orientable complement.

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