# NonCommutative Rings and their Applications, V

**ABSTRACTS**

# NON COMMUTATIVE RINGS
# AND THEIR APPLICATIONS

## 12 ~ 15 Juin 2017, Lens (France)

## Mini-cours

**Frédérique Oggier** (Nanyang Technological University, Singapore)
*An introduction to space-time coding*

**Invited speakers**

**Philippe Langevin** (Université de Toulon, France)
*MacWilliams Extension Theorem for Lee Weight Isometries*

**Christian Lomp** (University of Porto, Portugal)
*Ring theoretical properties of affine cellular algebras*

**Sergio Lopez-Permouth** (University of Athens, Ohio, USA)
*Modules over Infinite Dimensional Algebras*

**Pace Nielsen** (Brigham young University Salt lake city, USA)
*Just how complicated can Euclidean domains get*

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# Algebraic Properties of Division Rings in Terms of Commutators


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**a joint work with**

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**Abstract**

Let $D$ be a division algebra with center $F$ and $K$ a (not necessarily central) subfield of $D$. An element $a \in D$ is called left algebraic (resp. right algebraic) over $K$, if there exists a non-zero left polynomial $a_0 + a_1x + \cdots + a_nx^n$ (resp. right polynomial $a_0 + xa_1 + \cdots + x^na_n$) over $K$ such that $a_0 + a_1a + \cdots + a_na^n = 0$ (resp. $a_0 + aa_1 + \cdots + a^na_n$). Bell et al proved that every division algebra whose elements are left (right) algebraic of bounded degree over a (not necessarily central) subfield must be centrally finite. In this paper we generalize this result and prove that every division algebra whose all multiplicative commutators are left (right) algebraic of bounded degree over a (not necessarily central) subfield must be centrally finite provided that the center of division algebra is infinite. Also, we show that every division algebra whose multiplicative group of commutators is left (right) algebraic of bounded degree over a (not necessarily central) subfield must be centrally finite. Among other results we present similar result regarding additive commutators under certain conditions.



## Keywords

division algebra, commutators, Laurent polynomial identity, maximal subfield, left algebraic.


# References


[1] J. P. Bell, V. Drensky and Y. Sharifi, *Shirshov's theorem and division rings that are left algebraic over a subfield*, J. Pure Appl. Algebra, **217** (2013) 1605–1610.

[2] N. Jacobson, *Structure Theory for Algebraic Algebras of Bounded Degree*, Annals of Math.Second Series, **46** (4) (1945) 695–707.

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# Generalized Hereditary Noetherian Prime Rings

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**a joint work with**

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**Abstract**

In this talk, we will introduce generalized hereditary noetherian prime rings (G-HNP rings for short) which generalizes the class of hereditary noetherian prime (HNP rings for short) rings. We will describe the structure of projective ideals of G-HNP rings and some over rings of G-HNP rings. Examples will be given to illustrate and delimit the theory.

## Keywords

HNP Rings, projective ideals, invertible ideals.

## References

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[2] H. Marubaysahi, A Krull type generalization of HNP rings with enough invertible ideals, Comm. in Algebra 11 (5) (1983), 469-499.

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# C4- and D4-Modules via Perspective Submodules

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[3]*The Ohio State University, Ohio, USA*

**Abstract**

A right $R$-module $M$ is said to be a $C4$-module if for every decomposition $M = A \oplus B$ and every homomorphism $f : A \to B$ with $\ker f \subseteq^{\oplus} A$, then $\mathrm{Im} f \subseteq^{\oplus} B$. A $C4$-module has a natural dual which is called a $D4$-module. In this work, we continue the study of $C4$- and $D4$-modules, providing several new characterizations and results on the subject. Endomorphism rings of $C4$-modules and extensions of right $C4$-rings are also investigated. Decompositions of $C4$-modules with restricted $ACC$ on summands and $D4$-modules with restricted $DCC$ on summands are obtained.

## Keywords

$C4$- and $D4$-modules, $C3$- and $D3$-modules, Perspective submodules.

## References

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# Dual Zariski Topology Of Modules


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**Abstract**

Let $R$ be a commutative ring with identity and $Spec^s(M)$ denote the set all second submodules of an $R$-module $M$. In this talk, we investigate the dual Zariski topology on $Spec^s(M)$, denoted by $\tau^s$, from the point of view of seperation axioms, spectral spaces and combinatorial dimension. We prove that there are some relationships between divisible submodules of $M$ and $T_0$-ness of $(Spec^s(M), \tau^s)$. We investigate when $(Spec^s(M), \tau^s)$ is $T_0$ for injective modules $M$ and weak comultiplication modules $M$. We also give some results concerning $T_1$-ness and $T_2$-ness of $(Spec^s(M), \tau^s)$ for a module $M$ over a Dedekind domain $R$. Furthermore, we study some conditions under which $(Spec^s(M), \tau^s)$ is a spectral space for modules $M$ over some special rings such as Dedekind domains, one-dimensional domains and rings with Noetherin spectrum. Finally, we study on the combinatorial dimension of $(Spec^s(M), \tau^s)$ for a secondful module $M$.



## Keywords

Second submodule, Cotop module, Dual Zariski topology.


# References


[1] J. Y. Abuhlail, A dual Zariski topology for modules, *Topology Appl.* **158** , 457–467, 2011.

[2] H. Ansari-Toroghy and F. Farshadifar, On the dual notion of prime submodules.*Algebra Colloq.* **19 (1)**, 1109-1116, 2012.

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[4] M. Behboodi and M. R. Haddadi, Classical Zariski topology of modules and spectral spaces I, *Inter. Electronic J. Alg.* **4**, 104-130, 2008.

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[6] S. Yassemi, The dual notion of prime submodules, *Arch. Math (Brno)* **37**, 273–278, 2001.

# On Generalized Perfect Rings


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**Abstract**

Inspired by the fundamental work of Bass [2] on perfect rings and projective covers, A. Amini, B. Amini, M. Ershad and H. Sharif proposed in [1] to study a class of rings that they named *generalized perfect rings*.

Let $R$ be a ring, and let $F$ and $M$ be right $R$-modules such that $F_R$ is flat. Following [1], a module epimorphism $f\colon F \to M$ is said to be a *$G$-flat cover* of $M$ if $\mathrm{Ker}\,(f)$ is a small submodule of $F$. Still following [1], a ring $R$ is called *right generalized perfect* (right $G$-perfect, for short) if every right $R$-module has a flat cover. A ring $R$ is called *$G$-perfect* if it is both left and right $G$-perfect. It is clear from the definition that right perfect rings are right $G$-perfect rings, and also that von Neumann regular rings are $G$-perfect rings.

A celebrated result by Bican, El Bashir and Enochs [3] shows that any module has a flat cover. The relation between $G$-flat covers and flat covers (if any!) is quite unclear. In the case of perfect rings they coincide, and in the case of von Neumann regular rings flat covers are trivially $G$-flat covers but, in general, the converse is not true [1] (it happens that flat covers are unique up to isomorphism, while $G$-flat covers are not!).

Looking for a characterization of $G$-perfect rings, it was showed in [1] that if $R$ is right $G$-perfect, then the Jacobson radical $J(R)$ is right $T$-nilpotent and, hence, idempotents lift modulo $J(R)$. Moreover, it was also proved that if $R$ is right duo (i.e. all right ideals are two-sided ideals) and right $G$-perfect, then $R/J(R)$ is von Neumann regular. It was claimed that it was reasonable to conjecture that a right $G$-perfect ring is von Neumann regular modulo the Jacobson radical. In this work, we answer this conjecture in the negative by constructing semiprimitive $G$-perfect rings that are not von Neumann regular.

Our examples are built using the following well-known pattern: let $S \hookrightarrow T$ be a ring inclusion, and consider the ring

$$R = \{(x_1, x_2, \ldots, x_n, x, x, \ldots) | n \in \mathbb{N}, x_i \in T, x \in S\} \subseteq T^{\mathbb{N}}.$$

Such a construction appears quite frequently in the literature. Our new input is the study of its category of modules. To do that it is very useful to consider a family of TTF-triples associated to such type of rings that relates the category of modules over $R$ with the categories of $T$-modules and of $S$-modules. We show that if $S$ is right $G$-perfect and $T$ is von Neumann regular, then $R$ is also right $G$-perfect. We also show that if flat covers of $S$-modules are $G$-flat covers, then the same is true for $R$.

## Keywords

Flat covers, Generalized perfect rings

## References

[1] A. Amini, B. Amini, M. Ershad and H. Sharif. *On generalized perfect rings*, Comm. Algebra **35** (2007), 953–963.

[2] H. Bass. *Finitistic dimension and a homological generalization of semi-primary rings*, Trans. Amer. Math. Soc. **95** (1960), 466–488.

[3] L. Bican, R. El Bashir and E. Enochs. *All modules have flat covers*, Bull. London Math. Soc. **33** (2001), no. 4, 385–390.

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# Classical left regular left quotient ring of a ring and its semisimplicity criteria

**V. V. Bavula**

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**Abstract**

Let $R$ be a ring, $\mathcal{C}_R$ and $'\mathcal{C}_R$ be the set of regular and left regular elements of $R$ ($\mathcal{C}_R \subseteq {}'\mathcal{C}_R$). Goldie's Theorem is a semisimplicity criterion for the classical left quotient ring $Q_{l,cl}(R) := \mathcal{C}_R^{-1}R$. Semisimplicity criteria are given for the classical left regular left quotient ring $'Q_{l,cl}(R) := {}'\mathcal{C}_R^{-1}R$. As a corollary, two new semisimplicity criteria for $Q_{l,cl}(R)$ are obtained (in the spirit of Goldie).

## Keywords

Goldie's Theorem, the classical left quotient ring, the classical left regular left quotient ring.

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# On $(f, \sigma, \delta)$-Codes over finite commutative rings

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**Abstract**

Boulagouaz and Leroy (2013) used skew-polynomial rings (a.k.a Ore polynomial rings) to introduce the notion of $(f, \sigma, \delta)$-codes over a finite ring $R$, which generalizes the classical linear cyclic, constacyclic, skew-cyclic, and skew-constacyclic codes over finite fields and rings. However, some work remained to be done to fully compute generating and control matrices of such codes. We settle this issue here by giving recursive formulas that calculate all entries of such matrices. When a code is $(f, \sigma, \delta)^{\perp}$-codes ( That is the case if $R$ is a finite quasi Frobenius ring), $\delta = 0$ and $f(X) = X^n - \lambda$ (so that the code is a classical skew-cyclic one), we use our formulas to explicitly deduce a known control matrix of the code in order to highlight the generalizing side of our computations.

## Keywords

Ore polynomial ring, skew linear code, generic and control matrices, pseudo linear transformation, quasi Frobenius ring. .

# References

[1] D. Boucher, and F. Ulmer *Codes as Modules over Skew Polynomial Rings* Cryptography and Coding Volume 5921 of the series Lecture Notes in Computer Science pp 38-55

[2] D. Boucher, W. Geiselmann, and F. Ulmer *Skew-cylci codes*, Appl. Algebra Eng. Comm. Comp **18** (2007) 379–389.

[3] D. Boucher, P. Solé, and F. Ulmer *Skew constacyclic codes over Galois rings*, Adv. Math. Comm. **2** (2008) 273–292.

[4] M. Boulagouaz and A. Leroy *$(\sigma, \delta)$-codes*, Adv. Math. Comm. **7** (2013) 463–474.

[5] P. Solé and O. Yemen, *Binary quasi-cyclic codes of index 2 and skew polynomial rings*, finite fields and their applications, (2012).

# Solvable Crossed Product Algebras Revisited

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**a joint work with**

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**Abstract**

For any central simple algebra over a field $F$ which contains a maximal subfield $M$ with non-trivial automorphism group $G = \mathrm{Aut}_F(M)$, $G$ is solvable if and only if the algebra contains a finite chain of subalgebras which are generalized cyclic algebras over their centers (field extensions of $F$) satisfying certain conditions. These subalgebras are related to a normal subseries of $G$. A crossed product algebra $F$ is hence solvable if and only if it can be constructed out of such a finite chain of subalgebras. This result was stated for division crossed product algebras by Petit, and overlaps with a similar result by Albert which, however, is not explicitly stated in these terms. In particular, every solvable crossed product division algebra is a generalized cyclic algebra over $F$.

## Keywords

Skew polynomial ring, skew polynomial, solvable crossed product algebra, generalized cyclic algebra, cyclic subalgebra, crossed product subalgebra, admissible group.

## References

[1] A. A. Albert, *Structure of algebras.* Vol. 24, AMS 1939.

[2] C. Brown, PhD Thesis, University of Nottingham, in preparation.

[3] C. Brown, S. Pumplün, *Solvable crossed product algebras revisited.* arXiv preprint arXiv:1702.04605, 2017.

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# Poor modules with no proper poor direct summands

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**a joint work with**

**Rafail Alizade, Sergio R. López-Permouth & Liu Yang**

**Abstract**

Let $R$ be a ring with an identity element. Given right modules $M$ and $N$, $M$ is said to be $N$-injective if for every submodule $K$ of $N$ and every morphism $f : K \to M$ there is a morphism $g : N \to M$ such that $g|_K = f$. The injectivity domain $\mathfrak{In}^{-1}(M)$ of $M$ is defined to be the collection of all modules $N$ such that $M$ is $N$-injective. For any right $R$-module $M$, semisimple right modules are contained in $\mathfrak{In}^{-1}(M)$, and $M$ is injective if and only if $\mathfrak{In}^{-1}(M) =$*Mod-R*. In [1] , a right module $M$ is called *poor* if $\mathfrak{In}^{-1}(M)$ is exactly the class of semisimple right modules. Poor modules exists over arbitrary rings. Direct sum of poor modules is poor, and any module having a poor summand is poor. In this talk we investigate *pauper* modules i.e. poor modules with no poor proper direct summands. In contrast to poor modules, pauper modules do not exist over arbitrary rings. Several classes of rings that admits pauper modules will be investigated. We shall also discuss the structure of pauper modules over Noetherian rings. In particular, we give a complete characterization of pauper abelian groups of torsion-free rank one.

## Keywords

Injective module, poor module, indecomposably poor module.

# References

[1] A. N. Alahmadi, M. Alkan, S. R. López-Permouth, Poor modules: the opposite of injectivity, Glasg. Math. J., 52 A, 2010, pp. 7-17.

[2] R. Alizade, E. Büyükaşık, Poor and pi-poor abelian groups, Comm. Algebra, 45-1, 2017, 420-427.

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[4] N. Er, S. López-Permouth, N. Sökmez, Rings whose modules have maximal or minimal injectivity domains, J. Algebra, 330, 2011, pp. 404-417.

[5] S. López-Permouth, J. Simental, Characterizing rings in terms of the extent of the injectivity and projectivity of their modules, J. Algebra, 362, 2012, 56-69.

# On Generalized Weyl Enveloping Algebras

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**Abstract**

There are two explicit methods for generating ideals of the enveloping algebra of the type $A_1$ semisimple Lie algebra $sl_2$: by highest weight elements relative to the adjoint module structure, introduced by the author, and by homogenous elements relative to the canonical grading of the generalized Weyl algebra, introduced by V. V. Bavula. We give a unitary treatment of these methods in both the classical and quantum type $A_1^n$, that is for all enveloping algebras and quantized enveloping algebras of semisimple Lie algebras that are generalized Weyl algebras.

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# A Generalization of Poor Modules

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**Abstract**

Throughout $R$ is an associative ring with identity and all modules are right and unital unless stated otherwise.

In this work, we define and study impecunious modules. We call an $R$-module $M$ impecunious if the injectivity domain of $M$ is contained in the class of all pure-split $R$-modules, equivalently if whenever $M$ is $N$-injective for an $R$-module $N$, then $N$ is pure-split. Every semisimple module is pure-split and every $N$-injective $R$-module is $N$-pure-injective for an $R$-module $N$ which implies that our definition gives a generalization of both poor modules and pi-poor modules.

Among other results concerning impecunious modules, we show that a ring $R$ is right pure-semisimple if and only if every $R$-module is impecunious.

## Keywords

Poor module, pure-injectively poor module, impecunious module, pure-split module.

## References


[1] A. N. Alahmadi, M. Alkan, and S. López-Permouth, Poor modules: the opposite of injectivity. *Glasg. Math. J.*, **52(A)** (2010), 7–17.

[2] R. Alizade and E. Büyükaşık. Poor and pi-poor abelian groups. *Communications in Algebra*, **45(1)** (2017), 420–427.

[3] N. Er, S. López-Permouth, and N. Sökmez. Rings whose modules have maximal or minimal injectivity domains. *J. Algebra*, **330** (2011), 404–417.

[4] A. Harmanci, S. R. López-Permouth, and B. Ungor. On the pure-injectivity profile of a ring. *Comm. Algebra*, **43(11)** (2015), 4984–5002.


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# On the polynomial representation of the Principal matrix $p$-th root


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**Abstract**

The computation of matrix $p$-th roots is involved in various applications of mathematics, such as systems theory, finance and health care. Given a matrix $A \in M_d(\mathbb{C})$, a matrix $X$ is a $p$-th root of $A$ if

$$X^p = A.$$

When $A$ has no eigenvalues on $\mathbb{R}^-$ (the closed negative real axis) there exists a unique matrix $X$ such that $X^p = A$ and the eigenvalues of $X$ lie in the segment $\{z;\ -\pi/p < arg(z) < \pi/p\}$ (see [2]), where $arg(z)$ symbolizes the argument of $z$. In this case the matrix $X$ is the so-called principal $p$th root of the matrix $A$, and it is denoted as $X = A^{1/p}$. Besides, the matrix function $f(A) = A^{1/p}$ is a primary matrix function (see [2] and [3, Ch. 6]), where $f$ is the complex function $f(z) = z^{1/p}$ defined on its principal branch.

Several works have been carried out on the calculation of matrix $p$-th roots, using specifically numerical methods. In this research we are particularly interested in the polynomial representation of the principal matrix $p$-th root, of non-singular matrices, using some fundamental properties of matrix functions and generalized Fibonacci sequences.



## Keywords

Principal Matrix $p$th root, Matrix function, Generalized Fibonacci Sequence, Binet formula.

## References

[1] F. R. Gantmacher, "Theory of Matrices", Chelsea, New York, Vol. I, (1960).

[2] N. J. Higham, "Functions of Matrices: Theory and Computation", Society for Industrial and Applied Mathematics, Philadelphia, PA, USA, (2008).

[3] R. A. Horn and C. R. Johnson, "Topics in Matrix Analysis", Cambridge Univ. Press, Cambridge, UK, (1994).

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# On images of linear maps with skew derivations

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**Abstract**

Motivated by the Skolem-Noether theorem, in [1] given a nonzero derivation $\delta$ of a simple GPI-ring $R$ we characterize linear differential maps $\phi\colon x \mapsto \sum_j a_j \delta^j(x)$ for $x \in R$, where $Q$ is Martindale symmetric ring of quotients of $R$ and $a_j$'s are finitely many elements in $Q$, such that $\phi(R) \subseteq [R, R]$. These results also are described and proved in terms of polynomials in $Q[t; \delta]$, the Ore extension of $Q$ by the derivation $\delta$. In this talk, our aim is to generalize the results in [1] to the skew case. We use a more general notion introduced in [4] for quasi-algebraic skew derivations which is suitable for our purpose in this work.

## Keywords

Simple GPI-ring, $\sigma$-derivation, Martindale symmetric ring of quotients, quasi-algebraic, associated polynomial.

## References

[1] M. P. Eroğlu and T.-K. Lee, *The images of polynomials of derivations,* Comm. Algebra, **45** (10) (2017), 4550-4556.

[2] V.K. Kharchenko, *Differential identities of prime rings*, Algebra i Logika **17** (1978), 220-238. (Engl. Transl., Algebra and Logic **17** (1978), 154-168.)

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# Modules with chain conditions up to isomorphism

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**Abstract**

The content of the first of the two papers in the references will be presented. The second paper will be presented by my coauthor. We have studied modules with chain conditions up to isomorphism, in the following sense. Let $R$ be a ring and $M$ be a right $R$-module. We say that $M$ is *isoartinian* if, for every descending chain $M \geq M_1 \geq M_2 \geq \dots$ of submodules of $M$, there exists an index $n \geq 1$ such that $M_n$ is isomorphic to $M_i$ for every $i \geq n$. Dually, we say that $M$ is *isonoetherian* if, for every ascending chain $M_1 \leq M_2 \leq \dots$ of submodules of $M$, there exists an index $n \geq 1$ such that $M_n \cong M_i$ for every $i \geq n$. Similarly, we say that $M$ is *isosimple* if it is non-zero and every non-zero submodule of $M$ is isomorphic to $M$. We study these three classes of modules, determining a number of their properties. The results we obtain give a good description of these modules and often have a surprising analogy with the "classical" case of artinian, noetherian and simple modules. For instance, we prove that any isoartinian module contains an essential submodule that is a direct sum of isosimple modules. The endomorphism ring of an isosimple module $M_R$ is a right Ore domain $E$, whose principal right ideals form a noetherian modular lattice with respect to inclusion. We say that a ring $R$ is *right isoartinian* if the right module $R_R$ is isoartianian. Several results will be presented.

## Keywords

Chain conditions.

## References


[1] A. Facchini and Z. Nazemian: *Modules with chain conditions up to isomorphism,* J. Algebra 453 (2016), 578–601.

[2] A. Facchini and Z. Nazemian: *Artinian dimension and isoradical of modules,* accepted for publication in J. Algebra (2017).


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# Skew cyclic codes: Hamming distance and decoding algorithms


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**Abstract**

Cyclic structures on convolutional codes were first considered in [9]. From a pure mathematical perspective, these cyclic convolutional codes are understood as left ideals of an Ore extension of a finite algebra. This idea has been developed, for example, in [10], [2], [8], [6]. In [3], an alternative way to endow convolutional codes with cyclic structures is proposed. Thus, skew cyclic convolutional codes are understood as left ideals of a suitable factor ring of a skew polynomial ring with coefficients in the rational function field of a finite field. The proposal to build skew cyclic block codes by using skew polynomials with coefficients in a finite field was started in [1]. By a careful choice of the non-commutative roots of the generator polynomial, skew Reed-Solomon convolutional codes were constructed and studied in [4], and they were proved to be MDS, with the help of the theory developed in [7]. Also, a Sugiyama like decoding algorithm, based on a noncommutative version of the "key equation", is proposed. Indeed, these ideas work over an abstract field, so that they can be successfully applied also to skew RS block codes. This is made explicit in [5], where a noncommutative version of Peterson-Gorenstein–Zierler decoding algorithm is designed. The aim of this talk is to describe some of these ideas and constructions.



## Keywords

Skew polynomial ring, skew RS code, skew convolutional code, MDS code, decoding algorithm.

## References


[1] D. Boucher, W. Geiselmann, and F. Ulmer: *Skew-cyclic codes,* Appl. Algebr. Eng. Commun., **18** (2007) 379–389.

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# Injective Hulls of Simple Modules Over Nilpotent Lie Color Algebras

**Can Hatipoglu**

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**Abstract**

Using cocycle twists for associative graded algebras, we characterize finite dimensional nilpotent Lie color algebras $L$ graded by arbitrary abelian groups whose enveloping algebras $U(L)$ have the property that the injective hulls of simple right $U(L)$-modules are locally Artinian.

## Keywords

Lie color algebras, graded algebras, enveloping algebras.

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# Nondistributive rings

**Małgorzata E. Hryniewicka**

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**Abstract**

Referring to a graduate course in Abstract Algebra, by a ring we mean a set $R$ of no fewer than two elements, together with two binary operations called the addition and multiplication, in which (1) $R$ is an abelian group with respect to the addition, (2) $R$ is a semigroup with unit with respect to the multiplication, (3) $(r+s)t = rt+st$ and $r(s+t) = rs+rt$ for any $r, s, t \in R$. A nearring $N$ is a generalization of a ring, namely the addition needs not be abelian and only the right distributive law is required, additionally the left distributive law is replaced by $n0 = 0$ for every $n \in N$. The last postulate means that we require a nearring to be zerosymmetric. The talk is intended as a discussion on sets $N$ satisfying the nearring axioms except the right distributive law, which we replace by $0n$ for every $n \in N$.

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# On radicals of graded ring constructions

**Emil Ilić-Georgijević**

*University of Sarajevo, Bosnia and Herzegovina*

**Abstract**

In this talk by a graded ring we mean a ring which is a direct sum of a family of its additive subgroups such that the product of homogeneous elements is again homogeneous. We extend already known construction of the graded polynomial ring over a graded ring to other graded ring constructions and observe their radicals with emphasis on the incidence ring of group automata over a graded ring.

## Keywords

Graded rings, semigroup rings, incidence rings of group automata, radical.

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# Rings and modules characterized by opposites of Absolute Purity


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**a joint work with**

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**Abstract**

The purpose of this talk is to mention the study of an alternative perspective on the analysis of the absolute purity of a module. Our study follows a pattern which has been somewhat established in previous studies so called test module for injectivity by subinjectivity (t.i.b.s.) and indigent modules(see [1], [2]).

Given a right $R$-module $M$ and a left $R$-module $N$, the module $M$ is said to be absolutely $N$-pure if $M \otimes N \to K \otimes N$ is monic for each extension $K$ of $M$. For a right module $M$, *the subpurity domain of* $M$ is defined to be the collection of all left modules $N$ such that $M$ is absolutely $N$-pure (see [3]). $M$ is absolutely pure if and only if its subpurity domain consists of the entire class $R - MOD$. As an opposite to absolute purity, a module $M$ is called *sp-poor* if its subpurity domain is as small as possible, namely, consisting of exactly the flat left modules. Rings all of whose modules are sp-poor are shown to be precisely the von Neumann regular rings.

For a right Noetherian ring $R$ we prove that every simple right $R$-module is sp-poor or absolutely pure if and only if $R$ is a right $V$-ring or $R \cong A \times B$, where $A$ is right Artinian with a unique non-injective simple right $R$-module and $Soc(A_A)$ is homogeneous and $B$ is semisimple. We also prove necessary conditions for a right Noetherian ring whose (cyclic, finitely generated) right modules are sp-poor or absolutely pure.

A domain $R$ is Prüfer if and only if each finitely generated ideal is sp-poor. Finally, we give a characterization of sp-poor modules over commutative hereditary Noetherian rings. It is proved that an $R$-module $N$ is sp-poor if and only if $Hom(N/Z(N), S) \neq 0$ for each singular simple $R$-module $S$, where $Z(N)$ is the singular submodule of $N$.



## Keywords

Absolutely pure modules, Injective modules, Flat modules.

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# On strongly $\pi$-extending modules

**Yeliz Kara**

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**a joint work with**

**Adnan Tercan**

*Hacettepe University, Ankara, Turkey*

**Abstract**

A module $M$ is called $\pi$-extending provided that every projection invariant submodule of $M$ (i.e., a submodule which is invariant under all idempotent endomorphisms of $M$) is essential in a direct summand. We focus on strongly $\pi$-extending modules which is a proper subclass of $\pi$-extending modules. We obtain that strongly $\pi$-extending modules behave better than $\pi$-extending modules in some special module theoric cases.

**Keywords** Extending modules, projection invariant, $\pi$-extending module.

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# Quasi-Euclidean Rings and Modules

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**a joint work with**

**André Leroy 1[1],**

[1] *Univeristé d'Artois, Lens, France*

**Abstract**

We relate the notion of quasi-Euclidean rings with other ring theoretical notions such as stable range, von Neumann regularity, unit regularity and also Bézout and K-Hermite rings. We introduce the notion of quasi-Euclidean modules and give some of their properties. It is natural to introduce the notion of quasi-Euclidean modules since it is expected to have more functorial properties (e.g. the submodule and the quotient module of a Q.E module is Q.E) and, of course, generalizes the notion of quasi-Euclidean rings.

**Keywords** Quasi-Euclidean rings, Stable range, von Neumann regularity, Unit regularity, Bézout ring, K-Hermite ring

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# A Perspective On Amalgamated Rings Via Symmetricity

**H. Kose**

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**a joint work with**

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[2]*Bilkent University, Ankara, Turkey*
[3]*Hacettepe University, Ankara, Turkey*

**Abstract**

In this work, we deal with some versions of reversibility and symmetricity on amalgamated rings along an ideal.

### Keywords

Reversible ring, weakly reversible ring, symmetric ring, GWS ring, amalgamated ring along an ideal.

This work was supported by the Ahi Evran University Scientific Research Projects Coordination Unit. Project Number: FEF. A4. 16. 001

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# MacWilliams Extension Theorem for Lee Weight Isometries

**Philippe Langevin**

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**a joint work with**

**S. Dyshko[1] & J. Wood[2]**

[1] *Toulon University, La Garde, France*
[2] *Western Michigan University, Chicago, USA*

**Abstract**

The MacWilliams extension Theorem claims that any isometry of a code in an Hamming space extends to an isometry of the ambiant space. It is well known that the extension poperty holds in various situation, typically, for the codes over finite Frobenius rings equiped of the Hamming distance. In the two last years, we proved the extension property holds for the codes over the modular rings equiped of the Lee metric. In my talk, I will give two proofs in the case of prime fields. The first proof [4] uses classical results of the theory of Dirichlet $L$-functions and it can be adapted to the case of a primary module. The second proof due to Sergey Dyshko [3] involves tricks from Harmonic analysis and it works for of a composite module.

### Keywords

MacWilliams extension theorem, Isometry, Lee Weight, $L$-function, Harmonic analysis. .

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# Ring theoretical properties of affine cellular algebras

**Christian Lomp**

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**a joint work with**

**P. Carvalho[1] & S. Koenig[2]& A. Shalile[3]**

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[3]*University of Stuttgart, Germany*

**Abstract**

As a generalisation of Graham and Lehrers cellular algebras, affine cellular algebras have been introduced by Koenig and Xi in order to treat affine versions of diagram algebras like affine Hecke algebras of type $A$ and affine TemperleyLieb algebras in a unifying fashion. Since then several classes of

algebras, like the Khovanov-Lauda- Rouquier algebras or Kleshchevs graded quasihereditary algebras have been shown to be affine cellular. In this talk we will exhibit some ring theoretical properties of affine cellular algebras. In particular we will show that any affine cellular algebra $A$ satisfies a polynomial identity, from which it follows, in case $A$ is an affine $k$-algebra over a field $k$, that simple modules are finite dimensional. Furthermore, we show that A can be embedded into its asymptotic algebra if the occurring commutative affine k-algebras $B_j$ are reduced and the determinants of the swich matrices are non-zero divisors. As a consequence we show that the Gelfand-Kirillov dimension of $A$ is less or equal to the largest Krull dimension of the algebras $B_j$ and that equality hold in case all affine cell ideals are idempotent or if the Krull dimension of the algebras $B_j$ is less or equal to 1. Special emphasis is given to the question when an affine cell ideal is idempotent, generated by an idempotent or finitely generated.

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# Modules over Infinite Dimensional Algebras

**Sergio R. Lopez-Permouth**

*Ohio University, Athens, USA*

**a joint work with**

## L. AI-Essa[1] & N. Muthana[2]

[1] *University of Damman, Damman, Saudi Arabia*
[2] *King Abdullaziz University, Jeddah, Saudi Arabia*

**Keywords** Amenable bases, congeniality of bases, proper congeniality, simple.

**Abstract**

Let $A$ be an infinite dimensional $K$- algebra, where $K$ is a field and let $B$ be a basis for $A$. In this talk we explore a property of the basis $B$ that guarantees that $K^B$ (the direct product of copies indexed by $B$ of the field $K$) can be made into an $A$-module in a natural way. We call bases satisfying that property "amenable" and we show that not all amenable bases yield isomorphic $A$-modules. Then we consider a relation (which we name congeniality) that guarantees that two different bases yield isomorphic $A$-module structures on $K^B$. We will look at several examples in the familiar setting of the algebra $K[x]$ of polynomials with coefficients in $K$ and will introduce several general interesting questions in that context. Finally, if time allows, we will mention some results regarding these notions from a topological perspective.

# Isoradical of modules and modules generated by isosimple modules

**Z. Nazemian**

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**a joint work with**

**A. Facchini**[1]

[1] *Padova University, Padova, Italy*

**Abstract**

A module $M$ is called *isosimple* if it is non-zero and every non-zero submodule of $M$ is isomorphic to $M$. For a ring $R$, the *right isoradical* I-rad $(R_R)$ of a ring $R$ is defined to be the intersection of the annihilators of all isosimple right $R$-modules. Unlike Jacobson radical, which is the intersection of the annihilators of simple right modules, isoradical of a ring is not left/right symmetric. We generalize the concept of isoradical from rings to modules and using that we study modules generated by isosimple modules. Special cases of such modules are when a module is a sum or a direct sum of isosimple modules. A module that is a sum of isosimple modules is not necessarily a direct sum of isosimple modules, but if a module $M$ is a sum of pairwise non-isomorphic isosimple modules, then the sum is direct. A ring that is generated by isosimple right modules must be a semiprime right noetherian ring. It is shown that a ring $R$ is generated by isosimple right modules if and only if it is a sum of isosimple right ideals, if and only if $R$ is a finite direct product of prime right noetherian rings that are sums of isosimple right ideals. We do not know whether such a ring is a direct sum of isosimple right ideals.

## Keywords

Isoradical of modules.

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# Euclidean domains – why they are both easier and harder than you'd think

**Pace P. Nielsen**

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**a joint work with**

[1] **Chris Conidis**

,[2] Vandy Tombs

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[2] Brigham Young University, Provo, UT, USA

**Abstract**

Every Euclidean domain has a minimal norm. By allowing transfinite values, we show that Euclidean domains can have arbitrary indecomposable ordinal length to their minimal norm, and no other ordinal types are possible. We also construct a Euclidean domain with no multiplicative integer valued norm. (This work is joint with Chris Conidis and Vandy Tombs.)

## Keywords

Euclidean domain, transfinite norm.

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# Introduction to Space-Time Coding

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**Abstract**

Space-time coding is a form of coding theory which addresses the design of matrices with complex coefficients. It is motivated by a communication scenario appearing in the context of wireless communication. Techniques from non-commutative algebras have been successfully used to design good space-time codes.

The course will present an introduction to space-time coding. From an application view point, it will give some background to explain where space-time coding comes from, and what are some of the parameters relevant from a "practical" view point. From a coding theory view point, code designs will be given, and connections with classical coding theory (both over finite fields and over finite rings) will be made. From a mathematical view point, we will introduce techniques from algebraic number theory, central simple algebras, and lattice theory.

## Keywords

space-time coding, coding for wireless communications, number fields, lattices, division algebras


## References


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[4] "On skew polynomial codes and lattices from quotients of cyclic division algebras", by Ducoat and Oggier


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# Neat Homomorphisms over Dedekind Domains


**S. Ozdemir**

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**a joint work with**

**E. Mermut**

*Dokuz Eylul University, Izmir, Turkey*



**Abstract**

The study of neat homomorphisms, due to [1] and [2], originated with a generalization of neat subgroups and torsion free covers of modules. One characterization of neat homomorphisms given in [2] is as follows. A homomorphism $f : M \to N$ of modules is neat in the sense of Enochs (we call *E-neat* homomorphism) if and only if there are no proper extensions of $f$ in the injective envelope of $M$. In [3], Zöschinger gave some characterizations of E-neat homomorphisms for abelian groups. Considering one of these characterizations, we define Z-neat homomorphisms in general for modules over arbitrary rings. We call a homomorphism $f : M \to N$ of modules *Z-neat* if $\operatorname{Im} f$ is closed in $N$ and $\ker f \subseteq \operatorname{Rad} M$. In this presentation, we prove that E-neat homomorphisms and Z-neat homomorphisms coincide over Dedekind domains.



## Keywords

Neat homomorphisms, Dedekind domains.

## References

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# Semisimple Hopf actions and factorization through group actions

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**a joint work with**

**Christian Lomp**

*University of Porto, Porto, Portugal*

**Abstract**

Let $H$ be a Hopf algebra over a field $F$ acting on an algebra $A$. Let $I \subseteq \mathrm{Ann}_H(A)$ be a Hopf ideal of $H$, then one says that the action of $H$ on $A$ *factors through* the quotient Hopf algebra $H/I$. If there exists $I \subseteq \mathrm{Ann}_H(A)$ such that $H/I \cong F[G]$, for some group $G$, we say that the action of $H$ on $A$ *factors through a group action*. In 2014, Etingof and Walton have shown that any semisimple Hopf action on a commutative domain factors through a group action [2]. Also in 2014, using their previous result, Cuadra, Etingof and Walton showed that any action of a semisimple Hopf algebra $H$ on the $n$th Weyl algebra $A = A_n(F)$, with $\mathrm{char}(F) = 0$, factors through a group action [1].

In this talk we will briefly present a generalization of Cuadra, Etingof and Walton's result. Namely, that any action of a semisimple Hopf algebra $H$ on an iterated Ore extension of derivation type in characteristic zero factors through a group action [3]. We also present a work in progress on semisimple Hopf algebra actions on the quantum polynomial algebras which do not factor through a group actions.

This talk is all based on my upcoming Ph.D. Thesis under the supervision of Christian Lomp.

## Keywords

Semisimple Hopf Algebras, Hopf actions, Factorization.

## References

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# On Dual Automorphism Modules

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**a joint work with**

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**Abstract**

Let $M$ and $N$ be two right $R$-modules. We call $M$ dual automorphism $N$-invariant if whenever $K_1$ is a small submodule of $M$ and $K_2$ is a small submodule of $N$, then any epimorphism $p : M/K_1 \to N/K_2$ with small kernel lifts to a homomorphism $\varphi : M \to N$. Let $\pi_1 : P_1 \to M$ and $\pi_2 : P_2 \to N$ be projective covers. We prove that $M$ is dual automorphism $N$-invariant if and only if $\sigma(Ker(\pi_1)) \leq Ker(\pi_2)$ for any isomorphism $\sigma : P_1 \to P_2$. We call $M$ an s-ADS-module if for every decomposition $M = S \oplus T$ of $M$ and every supplement $T'$ of $S$ with $T' + T = M$ and $(T \cap T') \ll M$, we have $M = S \oplus T'$. It is shown that an amply supplemented $R$-module $M$ is s-ADS if and only if for each decomposition $M = A \oplus B$, $A$ and $B$ are relatively dual automorphism invariant.

**Keywords** Dual automorphism-invariant module, pseudo-projective module, ADS-modules

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# Generalization of CS Condition

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**a joint work with**

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*Anhui University of Technology, Ma'anshan, China*

**Abstract**

Let $R$ be an associative ring with identity. An $R$-module $M$ is called an NCS module if $\mathcal{C}(M) \cap \mathcal{S}(M) = \{0\}$, where $\mathcal{C}(M)$ and $\mathcal{S}(M)$ denote the set of all closed submodules and the set of all small submodules of $M$ respectively. It is clear that the NCS condition is a generalization of the well-known CS condition. Properties of the NCS conditions of modules and rings are explored in this article. In the end, it is proved that a ring $R$ is right $\Sigma$-CS if and only if $R$ is right perfect and right countably $\Sigma$-NCS. Recall that a ring $R$ is called right $\Sigma$-CS if every direct sum of copies of $R_R$ is a CS module. And a ring $R$ is called right countably $\Sigma$-NCS if every direct sum of countable copies of $R_R$ is an NCS module.

## Keywords

NCS modules, NCS rings, CS rings, $\Sigma$-CS rings, countably $\Sigma$-NCS rings.

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# On Modules over a G-set

## Mehmet UC

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**a joint work with**

## Mustafa ALKAN

*Akdeniz University, Antalya-Turkey*

**Abstract**

Let $R$ be a commutative ring with unity, $M$ a module over $R$ and let $S$ be a $G-$set for a finite group $G$. We denote a set $MS$ to be the set of elements expressed as the formal finite sum of the form $\sum_{s\in S} m_s s$ where $m_s \in M$. The set $MS$ is a module over the group ring $RG$ under addition and scalar multiplication similar to the $RG$–module $MG$. $(MS)_{RG}$ generalizes the notion of $RG$–module $MG$ defined by Kosan, Lee and Zhou in [6]. In this paper, we establish some properties of $(MS)_{RG}$. In particular, we describe a method for decomposing a given $RG$–module $MS$ as a direct sum of $RG$–submodules. In addition, we prove the semisimplicity problem of $(MS)_{RG}$ with regard to the properties of $M_R, S$ and $G$.

### Keywords

Group rings, Group modules.

## References

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# Skew Reed Muller Codes

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**a joint work with**

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**Abstract**

In this talk, we will generalize the classical Reed Mueller codes using iterated skew polynomial rings instead of classical commutative polynomial rings.

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# The maximum dimension of a Lie nilpotent subalgebra of $M_n(F)$ of index $m$

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**Abstract**

In this talk we will present the following result: if $F$ is any field and $R$ any $F$-subalgebra of the algebra $M_n(F)$ of $n \times n$ matrices over $F$ with Lie nilpotence index $m$, then

$$\dim_F R \leq M(m+1, n)$$

where $M(m+1,n)$ is the maximum of $\frac{1}{2}\left[n^2 - \sum_{i=1}^{m+1} k_i^2\right] + 1$ subject to the constraint $\sum_{i=1}^{m+1} k_i = n$ and $k_1, k_2, \ldots, k_{m+1}$ nonnegative integers. The case $m = 1$ reduces to a classical theorem of Schur (1905), later generalized by Jacobson (1944) to all fields, which asserts that if $F$ is an algebraically closed field of characteristic zero, and $R$ is any commutative $F$-subalgebra of $M_n(F)$, then $\dim_F R \leq \left\lfloor \frac{n^2}{4} \right\rfloor + 1$. Examples constructed from block upper triangular matrices show that the upper bound of $M(m+1,n)$ cannot be lowered for any choice of $m$ and $n$.

## Keywords

Lie nilpotent, matrix algebra, Lie algebra, commutative subalgebra, dimension

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**All lectures will take place in room S25**

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