tensor product algebra

tensor product algebra serves as a fundamental concept in advanced mathematics, particularly in the fields of linear algebra, functional analysis, and quantum mechanics. This algebraic structure is pivotal in understanding how vector spaces can be manipulated and combined, allowing for complex mathematical systems to be expressed in more manageable forms. The tensor product not only unifies various mathematical concepts but also has profound applications in physics, computer science, and engineering. In this article, we will explore the definition and properties of tensor product algebra, delve into its construction and applications, and examine its significance across various fields.

The following sections will guide you through the intricacies of tensor product algebra, covering its foundational aspects and real-world implications.

Understanding Tensor Products

Tensor products are a way of combining two or more vector spaces into a new vector space. The resulting space, known as the tensor product space, captures the interactions between the original spaces. Formally, if V and W are vector spaces over a field F, their tensor product, denoted as $V \otimes W$, is itself a vector space over F. The elements of this space are called tensors.

To fully grasp tensor products, it is essential to understand the notion of bilinearity. A bilinear map is a function that is linear in each of its arguments. The tensor product $V \otimes W$ can be defined as the quotient space of the free vector space generated by the Cartesian product of V and W, where we impose bilinearity. In simpler terms, if (v1, w1) and (v2, w2) are elements of V and W, respectively, the bilinear nature allows us to express the tensor product as:

(v1, w1) ~ (v2, w2) if and only if:

- (v1 + v2, w) ~ (v1, w) + (v2, w) for all w in W
- (v, w1 + w2) ~ (v, w1) + (v, w2) for all v in V
- (cv, w) ~ c(v, w) for all c in F, v in V, and w in W
- (v, cw) ~ c(v, w) for all c in F, v in V, and w in W

This formulation shows how tensors encapsulate the relationships between vectors in different spaces, making tensor product algebra a crucial tool in mathematical analysis.

Properties of Tensor Product Algebra

The properties of tensor product algebra are rich and varied, providing essential insights into its structure and applications. Some of the most notable properties include:

Bilinearity

As previously mentioned, tensor products are inherently bilinear. This means that the operation respects the linear structure of the vector spaces involved, allowing for seamless manipulation of tensors. This bilinearity is fundamental to the construction and application of tensor products in various mathematical contexts.

Associativity

Tensor products exhibit a property known as associativity. If we have three vector spaces V, W, and U, the following holds true:

$(V \otimes W) \otimes U$ is isomorphic to $V \otimes (W \otimes U)$.

This property ensures that the order in which tensor products are taken does not affect the outcome, simplifying calculations and theoretical development.

Commutativity (up to isomorphism)

The tensor product is commutative in nature, meaning that:

$V \otimes W$ is isomorphic to $W \otimes V$.

This property allows for flexibility in the arrangement of vector spaces when working with tensor products, making it easier to apply in various mathematical problems.

Universal Property

The universal property of tensor products states that for any bilinear map $f: V \times W \to X$ (where X is a vector space), there exists a unique linear map $g: V \otimes W \to X$ such that:

$g(v \otimes w) = f(v, w)$ for all v in V and w in W.

This property is crucial in the study of linear transformations and in establishing connections between different vector spaces.

Construction of Tensor Products

The construction of tensor products involves several steps, primarily focusing on creating a suitable vector space that encapsulates the properties of the original spaces. The process typically follows these stages:

Step 1: Free Vector Space

The first step is to form the free vector space generated by the Cartesian product of the two vector spaces. If V and W are vector spaces, their Cartesian product $V \times W$ consists of ordered pairs (v, w) where v is in V and w is in W. The free vector space generated by this set is denoted by $F(V \times W)$.

Step 2: Imposing Relations

Next, we impose the relations that define bilinearity. This involves identifying pairs (v1, w1) and (v2, w2) that should be considered equivalent based on the bilinear properties discussed earlier. The resulting space is the quotient of the free vector space by the subspace generated by these relations.

Step 3: Resulting Tensor Product Space

The final step yields the tensor product space $V \otimes W$, which is a vector space that is defined through the equivalence classes of the pairs in the free vector space. This construction allows for the manipulation of tensors as linear combinations of the basis elements derived from the original vector spaces.

Applications of Tensor Product Algebra

Tensor product algebra finds applications in numerous areas of mathematics and science, showcasing its versatility and importance. Some prominent applications include:

Quantum Mechanics

In quantum mechanics, tensor products are essential for describing the state spaces of composite systems. For instance, if two quantum systems are represented by Hilbert spaces $H1$ and $H2$, the total system is represented by the tensor product space $H1 \otimes H2$. This framework allows physicists to analyze entangled states and the behavior of multi-particle systems.

Data Science and Machine Learning

Tensor products are increasingly used in data science, particularly in the realm of deep learning. Neural networks often utilize tensor algebra to handle multi-dimensional data, enabling efficient computations and transformations. The manipulation of tensors allows for the representation of complex relationships in data, which is vital for training models.

Algebraic Geometry

In algebraic geometry, tensor products are utilized to study vector bundles and sheaf cohomology. The tensor product of line bundles provides a framework to understand the intersection theory and properties of algebraic varieties, facilitating deeper investigations into geometric structures.

Computer Graphics

In computer graphics, tensor products are used to create and manipulate surfaces and shapes. Techniques such as Bézier surfaces and B-splines rely on tensor product representations to achieve smooth curves and surfaces, which are essential in modeling complex objects and animations.

Conclusion

Tensor product algebra stands as a cornerstone of modern mathematics, offering a powerful framework for understanding and manipulating vector spaces. Its properties, such as bilinearity, associativity, and the universal property, provide the foundation for various mathematical applications, from quantum mechanics to data science. As the importance of tensor products continues to grow in multiple disciplines, their rich structures and relationships will undoubtedly remain pivotal in advancing both theoretical and applied mathematics.

Q: What is the definition of a tensor product?

A: The tensor product of two vector spaces V and W, denoted as $V \otimes W$, is a vector space constructed to capture the bilinear relationships between elements of V and W, allowing for the combination of these spaces into a new entity.

Q: How are tensor products used in quantum mechanics?

A: In quantum mechanics, tensor products are used to describe the state spaces of composite systems. The total state of two quantum systems is represented by the tensor product of their individual Hilbert spaces, facilitating the analysis of entangled states and interactions.

Q: What properties make tensor products significant in linear algebra?

A: The significant properties of tensor products include bilinearity, associativity, commutativity (up to isomorphism), and the universal property, all of which allow mathematicians to manipulate and study relationships between vector spaces effectively.

Q: Can tensor products be applied in data science?

A: Yes, tensor products are widely used in data science, particularly in deep learning, where they enable the handling of multi-dimensional data and facilitate the representation of complex relationships within datasets.

Q: How does the construction of a tensor product work?

A: The construction of a tensor product involves forming a free vector space from the Cartesian product of two vector spaces, imposing bilinear relations to create equivalence classes, and defining the resulting tensor product space as a new vector space.

Q: What is the relationship between tensor products and algebraic geometry?

A: In algebraic geometry, tensor products are used to study vector bundles, sheaf cohomology, and intersection theory, providing insights into the properties and structures of algebraic varieties.

Q: Are tensor products commutative?

A: Tensor products are commutative in the sense that $V \otimes W$ is isomorphic to $W \otimes V$, allowing flexibility in the arrangement of vector spaces during calculations and theoretical development.

Q: What role do tensor products play in computer graphics?

A: In computer graphics, tensor products are used in the creation and manipulation of surfaces and shapes, particularly in techniques like Bézier surfaces and B-splines, which are crucial for modeling and animation.

Q: How does the universal property of tensor products facilitate linear mappings?

A: The universal property of tensor products ensures that for any bilinear map from two vector spaces to another vector space, there exists a unique linear map from the tensor product space to the target space, simplifying the study of linear transformations.

Q: What are tensors in the context of tensor product algebra?

A: Tensors are the elements of the tensor product space V ⊗ W, representing the combined effects of vectors from the original spaces V and W through linear combinations and bilinear relationships.

Tensor Product Algebra

tensor product algebra: Abstract Algebra: Tensor Products N.B. Singh, Abstract Algebra: Tensor Products provides a comprehensive exploration of tensor products within the framework of abstract algebra. Beginning with foundational definitions and universal properties, the book progresses to elucidate their applications across diverse algebraic structures such as modules, vector spaces, and rings. Emphasizing clarity and depth, it navigates through advanced topics including categorical perspectives, functorial properties, and their relevance in fields like quantum mechanics and topology. Through numerous examples, and theoretical insights, this book equips readers with the tools to understand and leverage tensor products as powerful algebraic tools, fostering a deeper appreciation for their role in modern mathematics.

tensor product algebra: Introduction to Tensor Products of Banach Spaces Raymond A. Ryan, 2002-01-15 This is the first ever truly introductory text to the theory of tensor products of Banach spaces. Coverage includes a full treatment of the Grothendieck theory of tensor norms, approximation property and the Radon-Nikodym Property, Bochner and Pettis integrals. Each chapter contains worked examples and a set of exercises, and two appendices offer material on summability in Banach spaces and properties of spaces of measures.

tensor product algebra: *Tensor Spaces and Exterior Algebra* Takeo Yokonuma, 1992 This book explains, as clearly as possible, tensors and such related topics as tensor products of vector spaces, tensor algebras, and exterior algebras. You will appreciate Yokonuma's lucid and methodical treatment of the subject. This book is useful in undergraduate and graduate courses in multilinear algebra. Tensor Spaces and Exterior Algebra begins with basic notions associated with tensors. to facilitate understanding of the definitions, Yokonuma often presents two or more different ways of describing one object. Next, the properties and applications of tensors are developed, including the classical definition of tensors and the description of relative tensors. Also discussed are the algebraic foundations of tensor calculus and applications of exterior algebra to determinants and to geometry. This book closes with an examination of algebraic systems with bilinear multiplication. in particular, Yokonuma discusses the theory of replicas of Chevalley and several properties of Lie algebras deduced from them.

tensor product algebra: Tensor Products of C*-Algebras and Operator Spaces Gilles Pisier, 2020-02-27 Based on the author's university lecture courses, this book presents the many facets of one of the most important open problems in operator algebra theory. Central to this book is the proof of the equivalence of the various forms of the problem, including forms involving C*-algebra tensor products and free groups, ultraproducts of von Neumann algebras, and quantum information theory. The reader is guided through a number of results (some of them previously unpublished) revolving around tensor products of C*-algebras and operator spaces, which are reminiscent of Grothendieck's famous Banach space theory work. The detailed style of the book and the inclusion of background information make it easily accessible for beginning researchers, Ph.D. students, and non-specialists alike.

tensor product algebra: Modules and Algebras Robert Wisbauer, 1996-05-15 Module theory over commutative asociative rings is usually extended to noncommutative associative rings by introducing the category of left (or right) modules. An alternative to this procedure is suggested by considering bimodules. A refined module theory for associative rings is used to investigate the bimodule structure of arbitary algebras and group actions on these algebras.

tensor product algebra: Advanced Algebra Anthony W. Knapp, 2007-10-11 Basic Algebra and Advanced Algebra systematically develop concepts and tools in algebra that are vital to every mathematician, whether pure or applied, aspiring or established. Advanced Algebra includes chapters on modern algebra which treat various topics in commutative and noncommutative algebra and provide introductions to the theory of associative algebras, homological algebras, algebraic number theory, and algebraic geometry. Together the two books give the reader a global view of algebra, its role in mathematics as a whole and are suitable as texts in a two-semester advanced undergraduate or first-year graduate sequence in algebra.

tensor product algebra: *Algebra* Serge Lang, 2005-06-21 This book is intended as a basic text for a one year course in algebra at the graduate level or as a useful reference for mathematicians and professionals who use higher-level algebra. This book successfully addresses all of the basic concepts of algebra. For the new edition, the author has added exercises and made numerous corrections to the text. From MathSciNet's review of the first edition: The author has an impressive knack for presenting the important and interesting ideas of algebra in just the right way, and he never gets bogged down in the dry formalism which pervades some parts of algebra.

tensor product algebra: Basic Algebra Paul M. Cohn, 2004-12-01 This is the first volume of a revised edition of P.M. Cohn's classic three-volume text Algebra, widely regarded as one of the most outstanding introductory algebra textbooks. This volume covers the important results of algebra. Readers should have some knowledge of linear algebra, groups and fields, although all the essential facts and definitions are recalled.

tensor product algebra: Theory of Operator Algebras I Masamichi Takesaki, 2012-12-06 Mathematics for infinite dimensional objects is becoming more and more important today both in theory and application. Rings of operators, renamed von Neumann algebras by J. Dixmier, were first introduced by J. von Neumann fifty years ago, 1929, in [254] with his grand aim of giving a sound founda tion to mathematical sciences of infinite nature. J. von Neumann and his collaborator F. J. Murray laid down the foundation for this new field of mathematics, operator algebras, in a series of papers, [240], [241], [242], [257] and [259], during the period of the 1930s and early in the 1940s. In the introduction to this series of investigations, they stated Their solution 1 {to the problems of understanding rings of operators) seems to be essential for the further advance of abstract operator theory in Hilbert space under several aspects. First, the formal calculus with operator-rings leads to them. Second, our attempts to generalize the theory of unitary group-representations essentially beyond their classical frame have always been blocked by the unsolved questions connected with these problems. Third, various aspects of the quantum mechanical formalism suggest strongly the elucidation of this subject. Fourth, the knowledge obtained in these investigations gives an approach to a class of abstract algebras without a finite basis, which seems to differ essentially from all types hitherto investigated. Since then there has appeared a large volume of literature, and a great deal of progress has been achieved by many mathematicians.

tensor product algebra: Fundamentals of the Theory of Operator Algebras. V2 , 1986-06-10 Fundamentals of the Theory of Operator Algebras. V2

tensor product algebra: Tensor Products of Principal Series Representations F. L. Williams, 2006-11-15

tensor product algebra: Banach Algebras and the General Theory of *-Algebras: Volume 1, Algebras and Banach Algebras Theodore W. Palmer, 1994-03-25 This is the first volume of a two volume set that provides a modern account of basic Banach algebra theory including all known results on general Banach *-algebras. This account emphasizes the role of *-algebraic structure and explores the algebraic results that underlie the theory of Banach algebras and *-algebras. The first volume, which contains previously unpublished results, is an independent, self-contained reference on Banach algebra theory. Each topic is treated in the maximum interesting generality within the framework of some class of complex algebras rather than topological algebras. Proofs are presented in complete detail at a level accessible to graduate students. The book contains a wealth of historical comments, background material, examples, particularly in noncommutative harmonic analysis, and an extensive bibliography. Volume II is forthcoming.

tensor product algebra: Tensor Products of C*-algebras Alain Guichardet, 1969

tensor product algebra: Symmetries, Lie Algebras and Representations Jürgen Fuchs, Christoph Schweigert, 2003-10-07 This book gives an introduction to Lie algebras and their representations. Lie algebras have many applications in mathematics and physics, and any physicist or applied mathematician must nowadays be well acquainted with them.

tensor product algebra: *A Course in Commutative Banach Algebras* Eberhard Kaniuth, 2008-12-16 Banach algebras are Banach spaces equipped with a continuous multipli- tion. In roughterms,there arethree types ofthem:algebrasofboundedlinear operators on Banach spaces with composition and the operator norm, al- bras consisting of bounded continuous functions on topological spaces with pointwise product and the uniform norm, and algebrasof integrable functions on locally compact groups with convolution as multiplication. These all play a key role in modern analysis. Much of operator theory is best approached from a Banach algebra point of view and many questions in complex analysis (such as approximation by polynomials or rational functions in speci?c - mains) are best understood within the framework of Banach algebras. Also, the study of a locally compact Abelian group is closely related to the study 1 of the group algebra L (G). There exist a rich literature and excellent texts on each single class of Banach algebras, notably on uniform algebras and on operator algebras. This work is intended as a textbook which provides a thorough introduction to the theory of commutative Banach algebras and stresses the applications to commutative harmonic analysis while also touching on uniform algebras. In this sense and purpose the book resembles Larsen's classical text [75] which shares many themes and has been a valuable resource. However, for advanced graduate students and researchers I have covered several topics which have not been published in books before, including some journal articles.

tensor product algebra: Tensor Products and Regularity Properties of Cuntz Semigroups Ramon Antoine, Francesc Perera, Hannes Thiel, 2018

tensor product algebra: C. Saunders MacLane, 1995-02-15 In presenting this treatment of homological algebra, it is a pleasure to acknowledge the help and encouragement which I have had from all sides. Homological algebra arose from many sources in algebra and topology. Decisive examples came from the study of group extensions and their factor sets, a subject I learned in joint work with OTTO SCHIL LING. A further development of homological ideas, with a view to their topological applications, came in my long collaboration with SAMUEL ElLENBERG; to both collaborators, especial thanks. For many years the Air Force Office of Scientific Research supported my research projects on various subjects now summarized here; it is a pleasure to acknowledge their lively understanding of basic science. Both REINHOLD BAER and JOSEF SCHMID read and commented on my entire manuscript; their advice has led to many improvements. ANDERS KOCK and JACQUES RIGUET have read the entire galley proof and caught many slips and obscurities. Among the others whose sug gestions have served me well, I note FRANK ADAMS, LOUIS AUSLANDER, WILFRED COCKCROFT, ALBRECHT DOLD, GEOFFREY HORROCKS, FRIED RICH KASCH, JOHANN LEICHT, ARUNAS LIULEVICIUS, JOHN MOORE, DIE TER PUPPE, JOSEPH YAO, and a number of my current students at the University of Chicago - not to m~ntion the auditors of my lectures at Chicago, Heidelberg, Bonn, Frankfurt, and Aarhus. My wife, DOROTHY, has cheerfully typed more versions of more chapters than she would like to count. Messrs.

tensor product algebra: Topological Algebras A. Mallios, 2011-08-18 This volume is addressed to those who wish to apply the methods and results of the theory of topological algebras to a variety of disciplines, even though confronted by particular or less general forms. It may also be of interest to those who wish, from an entirely theoretical point of view, to see how far one can go beyond the classical framework of Banach algebras while still retaining substantial results.The need for such an extension of the standard theory of normed algebras has been apparent since the early days of the theory of topological algebras, most notably the locally convex ones. It is worth noticing that the previous demand was due not only to theoretical reasons, but also to potential concrete applications of the new discipline.

tensor product algebra: Continuous Tensor Products and Arveson's Spectral C^*-Algebras Joachim Zacharias, 2000 This book is intended for graduate students and research mathematicians interested in operator algebras

tensor product algebra: Algebra I N. Bourbaki, 1998-08-03 This softcover reprint of the 1974 English translation of the first three chapters of Bourbaki’s Algebre gives a thorough exposition of the fundamentals of general, linear, and multilinear algebra. The first chapter introduces the basic objects, such as groups and rings. The second chapter studies the properties of modules and linear maps, and the third chapter discusses algebras, especially tensor algebras.

Related to tensor product algebra

What Is a Tensor? The mathematical point of view. - Physics Forums A tensor itself is a linear combination of let’s say generic tensors of the form . In the case of one doesn’t speak of tensors, but of vectors instead, although strictly speaking they

An Introduction to Tensors - Mathematics Stack Exchange In mathematics, tensors are one of the first objects encountered which cannot be fully understood without their accompanying universal mapping property. Before talking about tensors, one

What, Exactly, Is a Tensor? - Mathematics Stack Exchange Every tensor is associated with a linear map that produces a scalar. For instance, a vector can be identified with a map that takes in another vector (in the presence of an inner product) and

Are there any differences between tensors and multidimensional Tensor : Multidimensional array :: Linear transformation : Matrix. The short of it is, tensors and multidimensional arrays are different types of object; the first is a type of function,

What even is a tensor? - Mathematics Stack Exchange I'm an electrical engineer, and thus don't often interact with the types of mathematics that involve tensors. But when I try to get a deeper understanding of certain

How would you explain a tensor to a computer scientist? A tensor extends the notion of a matrix analogous to how a vector extends the notion of a scalar and a matrix extends the notion of a vector. A tensor can have any number

What are the Differences Between a Matrix and a Tensor? What is the difference between a matrix and a tensor? Or, what makes a tensor, a tensor? I know that a matrix is a table of values, right? But, a tensor?

terminology - What is the history of the term "tensor"? tensor - In new latin tensor means "that which stretches". The mathematical object is so named because an early application of tensors was the study of materials stretching under tension

Why is a linear transformation a $ (1,1)$ tensor? Note that it's typical to define tensor to mean a multilinear map that is a function of vectors only in the same vector space, or of covectors in the associated dual space, or some

What is a Rank 3 Tensor and Why Does It Matter? - Physics Forums A rank 3 tensor inputs three generalized vectors (i.e. either a vector or their dual vector), and spits out a scalar. One can also think of it as inputting 2 generalized vectors (or a

What Is a Tensor? The mathematical point of view. - Physics Forums A tensor itself is a

linear combination of let’s say generic tensors of the form . In the case of one doesn’t speak of tensors, but of vectors instead, although strictly speaking they

An Introduction to Tensors - Mathematics Stack Exchange In mathematics, tensors are one of the first objects encountered which cannot be fully understood without their accompanying universal mapping property. Before talking about tensors, one

What, Exactly, Is a Tensor? - Mathematics Stack Exchange Every tensor is associated with a linear map that produces a scalar. For instance, a vector can be identified with a map that takes in another vector (in the presence of an inner product) and

Are there any differences between tensors and multidimensional Tensor : Multidimensional array :: Linear transformation : Matrix. The short of it is, tensors and multidimensional arrays are different types of object; the first is a type of function,

What even is a tensor? - Mathematics Stack Exchange I'm an electrical engineer, and thus don't often interact with the types of mathematics that involve tensors. But when I try to get a deeper understanding of certain

How would you explain a tensor to a computer scientist? A tensor extends the notion of a matrix analogous to how a vector extends the notion of a scalar and a matrix extends the notion of a vector. A tensor can have any number

What are the Differences Between a Matrix and a Tensor? What is the difference between a matrix and a tensor? Or, what makes a tensor, a tensor? I know that a matrix is a table of values, right? But, a tensor?

terminology - What is the history of the term "tensor"? tensor - In new latin tensor means "that which stretches". The mathematical object is so named because an early application of tensors was the study of materials stretching under tension

Why is a linear transformation a $ (1,1)$ tensor? Note that it's typical to define tensor to mean a multilinear map that is a function of vectors only in the same vector space, or of covectors in the associated dual space, or some

What is a Rank 3 Tensor and Why Does It Matter? - Physics Forums A rank 3 tensor inputs three generalized vectors (i.e. either a vector or their dual vector), and spits out a scalar. One can also think of it as inputting 2 generalized vectors (or a

What Is a Tensor? The mathematical point of view. - Physics Forums A tensor itself is a linear combination of let’s say generic tensors of the form . In the case of one doesn’t speak of tensors, but of vectors instead, although strictly speaking they

An Introduction to Tensors - Mathematics Stack Exchange In mathematics, tensors are one of the first objects encountered which cannot be fully understood without their accompanying universal mapping property. Before talking about tensors, one

What, Exactly, Is a Tensor? - Mathematics Stack Exchange Every tensor is associated with a linear map that produces a scalar. For instance, a vector can be identified with a map that takes in another vector (in the presence of an inner product) and

Are there any differences between tensors and multidimensional Tensor : Multidimensional array :: Linear transformation : Matrix. The short of it is, tensors and multidimensional arrays are different types of object; the first is a type of function,

What even is a tensor? - Mathematics Stack Exchange I'm an electrical engineer, and thus don't often interact with the types of mathematics that involve tensors. But when I try to get a deeper understanding of certain

How would you explain a tensor to a computer scientist? A tensor extends the notion of a matrix analogous to how a vector extends the notion of a scalar and a matrix extends the notion of a vector. A tensor can have any number

What are the Differences Between a Matrix and a Tensor? What is the difference between a matrix and a tensor? Or, what makes a tensor, a tensor? I know that a matrix is a table of values, right? But, a tensor?

terminology - What is the history of the term "tensor"? tensor - In new latin tensor means "that

which stretches". The mathematical object is so named because an early application of tensors was the study of materials stretching under tension

Why is a linear transformation a $ (1,1)$ tensor? Note that it's typical to define tensor to mean a multilinear map that is a function of vectors only in the same vector space, or of covectors in the associated dual space, or some

What is a Rank 3 Tensor and Why Does It Matter? - Physics Forums A rank 3 tensor inputs three generalized vectors (i.e. either a vector or their dual vector), and spits out a scalar. One can also think of it as inputting 2 generalized vectors (or a

Related to tensor product algebra

EXACT SEQUENCES FOR MIXED COPRODUCT/TENSOR-PRODUCT RING CONSTRUCTIONS (JSTOR Daily6y) To a commutative ring K, and a family of K-algebras indexed by the vertex set of a graph, we associate a K-algebra obtained by a mixture of coproduct and tensor product constructions. For this, and

EXACT SEQUENCES FOR MIXED COPRODUCT/TENSOR-PRODUCT RING CONSTRUCTIONS (JSTOR Daily6y) To a commutative ring K, and a family of K-algebras indexed by the vertex set of a graph, we associate a K-algebra obtained by a mixture of coproduct and tensor product constructions. For this, and

C*-Algebras: Tensor Products, Approximation & Classification (uni2y) Since Elliotts classification of approximately finite C*-algebras it is well known that there are strong ties between classification theory and approximation theory for C*-algebras. The full depth of

C*-Algebras: Tensor Products, Approximation & Classification (uni2y) Since Elliotts classification of approximately finite C*-algebras it is well known that there are strong ties between classification theory and approximation theory for C*-algebras. The full depth of

New tensor network-based approach could advance simulation of quantum many-body systems (9don MSN) The quantum many body problem has been at the heart of much of theoretical and experimental physics over the past few decades

New tensor network-based approach could advance simulation of quantum many-body systems (9don MSN) The quantum many body problem has been at the heart of much of theoretical and experimental physics over the past few decades

Back to Home: http://www.speargroupllc.com