Julia Plavnik
Annotated Bibliography
In rough ascending chronological order
MathSciNet reviews accessed May 25, 2022

MR2968637 **Reviewed** Natale, Sonia; Plavnik, Julia Yael On fusion categories with few irreducible degrees. *Algebra Number Theory* 6 (2012), no. 6, 1171–1197. (Reviewer: David A. Jordan) 16T05 (18D10)

We prove some results on the structure of certain classes of integral fusion categories and semisimple Hopf algebras under restrictions on the set of their irreducible degrees.

MR3163515 **Reviewed** Natale, Sonia; Plavnik, Julia Yael Solvability of a class of braided fusion categories. *Appl. Categ. Structures* 22 (2014), no. 1, 229–240. (Reviewer: Alessandro Ardizzoni) 18D10

We show that a weakly integral braided fusion category $\mathcal{C}$ such that every simple object of $\mathcal{C}$ has Frobenius-Perron dimension ≤ 2 is solvable. In addition, we prove that such a fusion category is group-theoretical in the extreme case where the universal grading group of $\mathcal{C}$ is trivial.

MR3270794 **Reviewed** Bruillard, Paul; Galindo, César; Hong, Seung-Moon; Kashina, Yevgenia; Naidu, Deepak; Natale, Sonia; Plavnik, Julia Yael; Rowell, Eric C. Classification of integral modular categories of Frobenius-Perron dimension pq^4 and p^2q^2. *Canad. Math. Bull.* 57 (2014), no. 4, 721–734. (Reviewer: José N. Alonso Álvarez) 18D10

We classify integral modular categories of dimension pq^4 and p^2q^2, where p and q are distinct primes. We show that such categories are always group-theoretical, except for categories of dimension 4q^2 . In these cases there are well-known examples of non-group-theoretical categories, coming from centers of Tambara–Yamagami categories and quantum groups. We show that a non-group-theoretical integral modular category of dimension 4q^2 is either equivalent to one of these well-known examples or is of dimension 36 and is twist-equivalent to fusion categories arising from a certain quantum group.

MR3423950 **Reviewed** Bruillard, Paul; Chang, Liang; Hong, Seung-Moon; Plavnik, Julia Yael; Rowell, Eric C.; Sun, Michael Yuan Low-dimensional representations of the three component loop braid group. *J. Math. Phys.* 56 (2015), no. 11, 111707, 15 pp. (Reviewer: Tetsuya Ito) 20F36 (20G05 57M27)

Motivated by physical and topological applications, we study representations of the group $\mathscr{LB}$_3 of motions of 3 unlinked oriented circles in $\mathbb{R}^3$. Our point of view is to regard the three strand braid group $\mathscr{B}$_3 as a subgroup of $\mathscr{LB}$_3 and study the problem of extending $\mathscr{B}$_3 representations. We introduce the notion of a *standard extension* and

characterize $\mathscr{B}$_3 representations admitting such an extension. In particular we show, using a classification result of Tuba and Wenzl [Pacific J. Math. **197**, 491–510 (2001)], that every irreducible $\mathscr{B}$_3 representation of dimension at most 5 has a (standard) extension. We show that this result is sharp by exhibiting an irreducible 6-dimensional $\mathscr{B}$_3 representation that has no extensions (standard or otherwise). We obtain complete classifications of (1) irreducible 2-dimensional $\mathscr{L}\mathscr{B}$_3 representations, (2) extensions of irreducible 3-dimensional $\mathscr{B}$_3 representations, and (3) irreducible $\mathscr{L}\mathscr{B}$_3 representations whose restriction to $\mathscr{B}$_3 has abelian image.

MR3448800 **Reviewed** Bruillard, Paul; Galindo, César; Ng, Siu-Hung; Plavnik, Julia Y.; Rowell, Eric C.; Wang, Zhenghan On the classification of weakly integral modular categories. *J. Pure Appl. Algebra* 220 (2016), no. 6, 2364–2388. (Reviewer: David Penneys) 18D10

We classify all modular categories of dimension 4*m*, where *m* is an odd square-free integer, and all ranks 6 and 7 weakly integral modular categories. This completes the classification of weakly integral modular categories through rank 7. Our results imply that all integral modular categories of rank at most 7 are pointed (that is, every simple object has dimension 1). All strictly weakly integral (weakly integral but non-integral) modular categories of ranks 6 and 7 have dimension 4*m*, with *m* an odd square free integer, so their classification is an application of our main result. The classification of rank 7 integral modular categories is facilitated by an analysis of actions on modular categories by two groups: the Galois group of the field generated by the entries of the *S*-matrix and the group of isomorphism classes of invertible simple objects. The interplay of these two actions is of independent interest, and we derive some valuable arithmetic consequences from their actions.

MR3555361 **Reviewed** Cui, Shawn X.; Galindo, César; Plavnik, Julia Yael; Wang, Zhenghan On gauging symmetry of modular categories. *Comm. Math. Phys.* 348 (2016), no. 3, 1043–1064. (Reviewer: Daniel Ion Bulacu) 18D10 (81T60)

Topological order of a topological phase of matter in two spacial dimensions is encoded by a unitary modular (tensor) category (UMC). A group symmetry of the topological phase induces a group symmetry of its corresponding UMC. Gauging is a well-known theoretical tool to promote a global symmetry to a local gauge symmetry. We give a mathematical formulation of gauging in terms of higher category formalism. Roughly, given a UMC with a symmetry group *G*, gauging is a 2-step process: first extend the UMC to a *G*-crossed braided fusion category and then take the equivariantization of the resulting category. Gauging can tell whether or not two enriched topological phases of matter are different, and also provides a way to construct new UMCs out of old ones. We derive a formula for the *H*^4-obstruction, prove some properties of gauging, and carry out gauging for two concrete examples.

MR3606516 **Reviewed** Galindo, César; Plavnik, Julia Yael Tensor functors between Morita duals of fusion categories. *Lett. Math. Phys.* 107 (2017), no. 3, 553–590. (Reviewer: Ehud Meir) 18D10 (20J06 20J15)

Given a fusion category $\mathcal{C}$ and an indecomposable $\mathcal{C}$-module category $\mathcal{M}$, the fusion category $\mathcal{C}$^*_$\mathcal{M}$ of $\mathcal{C}$-module endofunctors of $\mathcal{M}$ is called the (Morita) dual fusion category of $\mathcal{C}$ with respect to $\mathcal{M}$. We describe tensor functors between two arbitrary duals $\mathcal{C}$^∗_$\mathcal{M}$ and $\mathcal{D}$^∗_$\mathcal{N}$ in terms of data associated to $\mathcal{C}$ and $\mathcal{D}$. We apply the results to G-equivariantizations of fusion categories and group-theoretical fusion categories. We describe the orbits of the action of the Brauer–Picard group on the set of module categories and we propose a categorification of the Rosenberg–Zelinsky sequence for fusion categories.

MR3641612 **Reviewed** Bruillard, Paul; Galindo, César; Hagge, Tobias; Ng, Siu-Hung; Plavnik, Julia Yael; Rowell, Eric C.; Wang, Zhenghan Fermionic modular categories and the 16-fold way. *J. Math. Phys.* 58 (2017), no. 4, 041704, 31 pp. (Reviewer: Tim Raeymaekers) 81V35

We study spin and super-modular categories systematically as inspired by fermionic topological phases of matter, which are always fermion parity enriched and modelled by spin topological quantum field theories at low energy. We formulate a 16-fold way conjecture for the minimal modular extensions of super-modular categories to spin modular categories, which is a categorical formulation of gauging the fermion parity. We investigate general properties of super-modular categories such as fermions in twisted Drinfeld doubles, Verlinde formulas for naive quotients, and explicit extensions of $PSU(2)_{4m+2}$ with an eye towards a classification of the low-rank cases.

MR3780767 **Reviewed** Plavnik, Julia Yael; Witherspoon, Sarah Tensor products and support varieties for some noncocommutative Hopf algebras. *Algebr. Represent. Theory* 21 (2018), no. 2, 259–276. (Reviewer: Iván Ezequiel Angiono) 16T05 (18D10)

We explore questions of projectivity and tensor products of modules for finite dimensional Hopf algebras. We construct many classes of examples in which tensor powers of nonprojective modules are projective and tensor products of modules in one order are projective but in the other order are not. Our examples are smash coproducts with duals of group algebras, some having algebra and coalgebra structures twisted by cocycles. We apply support variety theory for these Hopf algebras as a tool in our investigations.

MR3876728 **Reviewed** Bruillard, Paul; Plavnik, Julia Yael; Rowell, Eric C. Modular categories of dimension p^3m with m square-free. *Proc. Amer. Math. Soc.* 147 (2019), no. 1, 21–34. (Reviewer: Luz Adriana Mejía Castaño) 18D10 (16T05)

We give a complete classification of modular categories of dimension p^3m where p is prime and m is a square-free integer relatively prime to p. When p is odd, all such categories are pointed. For p=2 one encounters modular categories with the same fusion ring as orthogonal

quantum groups at certain roots of unity, namely SO(2m)_2 We also classify the more general class of modular categories with the same fusion rules as SO(2N)_2 with N odd.

MR4017856 **Reviewed** Edie-Michell, Cain; Jones, Corey; Plavnik, Julia Yael Fusion rules for $\mathbb{Z}/2\mathbb{Z}$ permutation gauging. *J. Math. Phys.* 60 (2019), no. 10, 102302, 15 pp. (Reviewer: Wolfgang Rump) 16D90 (81R50)

In this note, we examine the gauging of the Z/2Z permutation action on the tensor square of a modular tensor category C. When C is unpointed we provide formulas for the fusion rules of the gauged category, which nontrivially involves the modular data of C. Our technique highlights the use of generalized Frobenius-Schur indicators. We discuss several examples related to quantum groups at roots of unity.

MR4109138 **Reviewed** Bruillard, Paul; Galindo, César; Ng, Siu-Hung; Plavnik, Julia Y.; Rowell, Eric C.; Wang, Zhenghan Classification of super-modular categories by rank. *Algebr. Represent. Theory* 23 (2020), no. 3, 795–809. (Reviewer: Costel Gabriel Bontea) 18M20 (16D90 81U20)

We pursue a classification of low-rank super-modular categories parallel to that of modular categories. We classify all super-modular categories up to rank = 6, and spin modular categories up to rank = 11. In particular, we show that, up to fusion rules, there is exactly one non-split super-modular category of rank 2, 4 and 6, namely $PSU(2)_{4k+2}$ for $k = 0,1$ and 2. This classification is facilitated by adapting and extending well-known constraints from modular categories to super-modular categories, such as Verlinde and Frobenius-Schur indicator formulae.

MR4079746 **Pending** Bruillard, Paul; Gustafson, Paul; Plavnik, Julia Yael; Rowell, Eric C. Dimension as a quantum statistic and the classification of metaplectic categories. *Topological phases of matter and quantum computation,* 89–113, Contemp. Math., 747, *Amer. Math. Soc., [Providence], RI,* [2020], ©2020. 18M20 (20J99 81V27)

We discuss several useful interpretations of the categorical dimension of objects in a braided fusion category, as well as some conjectures demonstrating the value of quantum dimension as a quantum statistic for detecting certain behaviors of anyons in topological phases of matter. From this discussion we find that objects in braided fusion categories with integral *squared* dimension have distinctive properties. A large and interesting class of non-integral modular categories such that every simple object has integral squared-dimensions are the metaplectic categories that have the same fusion rules as SO(N)_2 for some N. We describe and complete their classification and enumeration, by recognizing them as ZZ_2-gaugings of cyclic modular categories (i.e. metric groups). We prove that any modular category of dimension 2^km with m square-free and k ≤ 4, satisfying some additional assumptions, is a metaplectic category. This illustrates anew that

dimension can, in some circumstances, determine a surprising amount of the category's structure.

MR4209971 **Reviewed** Bruillard, Paul; Plavnik, Julia; Rowell, Eric C.; Zhang, Qing On classification of super-modular categories of rank 8. *J. Algebra Appl.* 20 (2021), no. 1, Paper No. 2140017, 36 pp. 18M20 (18E50)

We develop categorical and number-theoretical tools for the classification of super-modular categories. We apply these tools to obtain a partial classification of super-modular categories of rank 8. In particular we find three distinct families of prime categories in rank 8 in contrast to the lower rank cases for which there is only one such family.

MR4287180 **Reviewed** Delaney, Colleen; Galindo, César; Plavnik, Julia; Rowell, Eric C.; Zhang, Qing Braided zesting and its applications. *Comm. Math. Phys.* 386 (2021), no. 1, 1–55. (Reviewer: Xiao-Kan Guo) 18M20 (18M15)

We give a rigorous development of the construction of new braided fusion categories from a given category known as zesting. This method has been used in the past to provide categorifications of new fusion rule algebras, modular data, and minimal modular extensions of super-modular categories. Here we provide a complete obstruction theory and parameterization approach to the construction and illustrate its utility with several examples.

MR4219963 **Reviewed** Bergh, Petter Andreas; Plavnik, Julia Yael; Witherspoon, Sarah Support varieties for finite tensor categories: complexity, realization, and connectedness. *J. Pure Appl. Algebra* 225 (2021), no. 9, Paper No. 106705, 21 pp. (Reviewer: Ehud Meir) 16E40 (16T05 18M05)

We advance support variety theory for finite tensor categories. First we show that the dimension of the support variety of an object equals the rate of growth of a minimal projective resolution as measured by the Frobenius-Perron dimension. Then we show that every conical subvariety of the support variety of the unit object may be realized as the support variety of an object. Finally, we show that the support variety of an indecomposable object is connected.

Extension Theory for Braided-Enriched Fusion Categories
Corey Jones, Scott Morrison, David Penneys, Julia Plavnik
International Mathematics Research Notices, rnab133, https://doi.org/10.1093/imrn/rnab133
Published: 02 July 2021

For a braided fusion category V, a V-fusion category is a fusion category C equipped with a braided monoidal functor F : V → Z(C). Given a fixed V-fusion category (C, F) and a fixed G-graded extension C ⊆ D as an ordinary fusion category, we characterize the enrichments tilde(F) : V → Z(D) of D that are compatible with the enrichment of C. We show that G-crossed

extensions of a braided fusion category C are G-extensions of the canonical enrichment of C over itself. As an application, we parameterize the set of G-crossed braidings on a fixed G-graded fusion category in terms of certain subcategories of its center, extending Nikshych's classification of the braidings on a fusion category.

MR4378088 **Pending** Negron, Cris; Plavnik, Julia Cohomology of finite tensor categories: duality and Drinfeld centers. *Trans. Amer. Math. Soc.* 375 (2022), no. 3, 2069–2112. 18G15 (16T99)

We consider the finite generation property for cohomology of a finite tensor category C, which requires that the self-extension algebra of the unit Ext^•_C (1, 1) is a finitely generated algebra and that, for each object V in C , the graded extension group Ext^•_C (1, V) is a finitely generated module over the aforementioned algebra. We prove that this cohomological finiteness property is preserved under duality (with respect to exact module categories) and taking the Drinfeld center, under suitable restrictions on C . For example, the stated result holds when C is a braided tensor category of odd Frobenius-Perron dimension. By applying our general results, we obtain a number of new examples of finite tensor categories with finitely generated cohomology. In characteristic 0, we show that dynamical quantum groups at roots of unity have finitely generated cohomology. We also provide a new class of examples in finite characteristic which are constructed via infinitesimal group schemes.

On odd-dimensional modular tensor categories, with A. Czenky.
To appear Algebra & Number Theory (2021)

We study odd-dimensional modular tensor categories and maximally non-self dual (MNSD) modular tensor categories of low rank. We give lower bounds for the ranks of modular tensor categories in terms of the rank of the adjoint subcategory and the order of the group of invertible objects. As an application of these results, we prove that MNSD modular tensor categories of ranks 13 and 15 are pointed. In addition, we show that MNSD tensor categories of ranks 17, 19, 21 and 23 are either pointed or perfect.

Completion for braided enriched monoidal categories, with S. Morrison and D. Penneys.
Preprint: arXiv:1809.09782 (2018).

Monoidal categories enriched in a braided monoidal category V are classified by braided oplax monoidal functors from V to the Drinfeld centers of ordinary monoidal categories. In this article, we prove that this classifying functor is strongly monoidal if and only if the original V-monoidal category is tensored over V. We then define a completion operation which produces a tensored V-monoidal category overline(C) from an arbitrary V-monoidal category C, and we determine many equivalent conditions which imply C and overline(C) are V-monoidally equivalent. Since being tensored is a property of the underlying V-category of a V-monoidal category, we begin by studying the equivalence between (tensored) V-categories and oplax (strong) V-module

categories respectively. We then define the completion operation for V-categories, and adapt these results to the V-monoidal setting.

Algebraic structures in group-theoretical fusion categories, with Y. Morales, M. Müller, A. Ros Camacho, A. Tabiri, and C. Walton.
Preprint: arXiv:2001.03837 (2020).

It was shown by Ostrik (2003) and Natale (2017) that a collection of twisted group algebras in a pointed fusion category serve as explicit Morita equivalence class representatives of indecomposable, separable algebras in such categories. We generalize this result by constructing explicit Morita equivalence class representatives of indecomposable, separable algebras in group-theoretical fusion categories. This is achieved by providing the 'free functor' Φ from a pointed fusion category to a group-theoretical fusion category with a monoidal structure. Our algebras of interest are then constructed as the image of twisted group algebras under Φ. We also show that twisted group algebras admit the structure of Frobenius algebras in a pointed fusion category, and we establish a Frobenius monoidal structure on Φ as well. As a consequence, our algebras are Frobenius algebras in a group-theoretical fusion category, and like twisted group algebras in the pointed case, they also enjoy several good algebraic properties.

Zesting produces modular isotopes and explains their topological invariants, with C. Delaney and S. Kim.
Preprint: arXiv:2107.11374 (2021).

We observe that the ribbon zesting construction can produce modular isotopes - different modular fusion categories with the same modular data. By analyzing how Reshetikhin-Turaev link invariants transform under zesting we are able to explain the phenomenology of topological invariants beyond the modular data for the Mignard-Schauenburg modular isotopes like the W-matrix and Borromean tensor B. This gives a perspective on how one might rigorously use topological invariants to characterize and classify topological orders of topological phases of matter in light of modular data not being a complete invariant.

Modular tensor categories, subcategories, and Galois orbits, with A. Schopieray, Z. Yu, and Q. Zhang.
Preprint: arXiv:2111.05228 (2021).

We establish a set of general results to study how the Galois action on modular tensor categories interacts with fusion subcategories. This includes a characterization of fusion subcategories of modular tensor categories which are closed under the Galois action, and a classification of modular tensor categories which factor as a product of pointed and transitive categories in terms of pseudoinvertible objects. As an application, we classify modular tensor categories with two Galois orbits of simple objects and a nontrivial grading group.