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TRACKING TRENDS & PERFORMANCE IN BASIC RESEARCH

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2008 : August - Fast Breaking Papers : Bernhard Keller & Idun Reiten

FAST BREAKING PAPERS - 2008
August 2008


Bernhard Keller & Idun Reiten talk with *ScienceWatch.com* and answer a few questions about this month's Fast Breaking Paper in the field of Mathematics.


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Article Title: Cluster-tilted algebras are Gorenstein and stably Calabi-Yau

Authors: Keller, B;Reiten, I

Journal: ADVAN MATH

Volume: 211

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(addresses have been truncated)

SW: Why do you think your paper is highly cited?

Our paper is related to cluster algebras, a subject introduced by Sergey Fomin and Andrei Zelevinsky in 2002, and which, in recent years, has witnessed spectacular growth. Inside this subject, our paper has unified the two major existing approaches to categorification: categorification via cluster categories and categorification via stable categories of preprojective algebras.

Cluster categories were first introduced and studied by Buan-Marsh-Reineke-Reiten-Todorov (BMRRT) and in the A_n -case also, by Caldero-Chapoton-Schiffler, and shown to be triangulated by Keller. Many of their important properties were proved by Buan-Marsh-Reiten. Categorification via stable categories is due to Geiss-Leclerc-Schroer.

SW: Does it describe a new discovery, methodology or synthesis of knowledge?

Our paper contains all three:

- 1) A new discovery, namely the discovery of remarkable new homological properties of cluster-tilted algebras: as announced in the title, they turn out to be Gorenstein and stably 3-Calabi-Yau.
- 2) A new methodology, namely the axiomatic method based on triangulated 2-Calabi-Yau categories applied to the investigation of endomorphism algebras of cluster-tilting objects in cluster-categories and in stable categories of preprojective algebras.
- 3) A synthesis of knowledge: the axiomatic framework we set up synthesizes



results obtained previously in different settings and allows us to give unified proofs.

Coauthor
Idun Reiten

SW: How would you summarize the significance of your paper in layman's terms?

Our paper contributes to the study of certain systems, called 2- and 3-Calabi-Yau categories, which are of two and three dimensions, respectively. These categories have turned out to be important in a branch of theoretical physics called string theory, where the elementary particles are modeled by small strings. In this theory, in addition to the four dimensions of classical physics—time plus three spatial dimensions—one has to deal with six real or equivalently three complex dimensions, whose behavior is expected to be controlled by certain 3-Calabi-Yau categories.

SW: How did you become involved in this research and were there any problems along the way?

This research started in informal conversations between the two authors at a conference at the Banff International Research Station (near Calgary, Canada). After the first version of the paper was posted on the *arXive*, Osamu Iyama of the Graduate School of Mathematics, Nagoya University, kindly pointed out to the authors that it contained an error in the part dealing with higher dimensions. This was corrected in the printed version.

Despite the best efforts of the authors, another minor mistake—kindly pointed out to the authors by Xiaowu Chen of the Shanghai Institute for Advanced Studies—unfortunately did make it into the printed version. It has been corrected in the latest version posted on the *arXive*.

SW: Where do you see your research leading in the future?

Our research has already led to a more systematic investigation of 2- and 3-Calabi-Yau categories and to a deeper understanding of the relationship between cluster algebras and these categories. We expect that, in the near future, it will play a role in the solution of outstanding problems like the so-called "periodicity conjecture," which asserts the periodicity of all the solutions to the so-called Y-systems, and in the ongoing investigation of higher cluster categories.

SW: Are there any social or political implications for your research?

The research is in the field of algebra in pure mathematics and, as such, does not have any political implications. From a social perspective, it can be regarded as adding to the totality of human knowledge and understanding by providing us with insights into some of the beauties of pure mathematics.

Professor Bernhard Keller
Université de Paris
Paris, France

Professor Idun Reiten
NTNU
Trondheim, Norway

Related: Aslak Bakke Buan, Robert Marsh, Markus Reineke, [Idun Reiten](#), Gordana Todorov answers a few questions about this month's (October 2007) fast breaking paper in the field of Mathematics.

Keywords: cluster-tiled algebras, categorification, cluster categories, stable categories, Gorenstein, 2- and 3-Calabi-Yau categories, preprojective algebras, theoretical physics, string theory.



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