Isfahan School and Conference on Representation Theory of Algebras (ISCRA 2019)

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Representation theory is a central branch of modern mathematics that studies realizations of abstract non-linear structures using classical linear and combinatorial concrete structures like matrices, linear operators and quivers. It is a very active and dynamic area, both heavily influenced by and with important applications to algebra, combinatorics, geometry, topology, analysis, category theory, number theory, mathematical physics and other branches of mathematics and physics.

With origins in the character theory of Gauss and later Frobenius, in its modern form the theory was initiated by Gabriel's work in the early 1970s, and important foundational work in the 70s and 80s was done by Auslander and his school. The connections to Lie-theory and representations of Lie-groups and Lie-algebras, as well as to representations of finite groups, are important.

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In Iran, there are currently several researchers, postdocs and also PhD-students working in this area, partly due to and initiated by the successful School and Conference in 2008 at IPM: <http://www.math.ipm.ac.ir/conferences/2008/CIMPA2008/>. On the other hand, one should note that there are strong connections between representation theory and commutative and non-commutative ring theory, which are the main topics studied by the large Iranian algebraic community.

‘Isfahan School and Conference on Representation Theory of Algebras (ISCRA 2019)’ was held during the period April 7–19, 2019 in the campus of the university of Isfahan, with the aim to introduce the Iranian algebraic community to some of the currently most active research topics of the subject and spreading the techniques and ideas of representation theory to the scientific community of Iran and countries nearby, in particular to young mathematicians and PhD-students. The University has quite a big campus located not far from the city center, in a quiet and convenient area with many facilities. The School part took place April 7–15 and the conference part took place April 16–19.

During the school, nine lecture series covering current trends in Representation Theory of Algebras were presented by nine well-known professors, each of them had four 1-h lectures. There were more than 60 students from Iran attending the activity and almost the same number from 24 countries around the world. The problem-solving sessions were really a success, as participants had enough time to discuss their questions and problems with the lecturers. The school received attention from the Iranian community of mathematics.

The following courses were taught during the School: Grassmannian cluster categories, by Karin Baur (Universität Graz, Austria); Variations on a theme of Auslander-Tachikawa, by Apostolos Beligiannis (University of Ioannina, Greece); Tilting theory and generalizations, by Aslak Bakke Buan (Norwegian University of Science and Technology, Norway); The McKay correspondence and noncommutative desingularizations, by Eleonore Faber (University of Leeds, United Kingdom); Derived categories and homological invariants, by Bernhard Keller (University of Paris, France); An introduction to support theory, by Henning Krause (Bielefeld University, Germany); Gentle algebras: combinatorial and homological aspects, by Pierre-Guy Plamondon (Université de Versailles Saint-Quentin-en-Yvelines, France); Definability in module theory, by Mike Prest (University of Manchester, United Kingdom); and Lattice theory of torsion classes, by Hugh Thomas (Université du Québec à Montréal, Canada).

The school was followed by a conference. The Conference provided an excellent opportunity to bring together researchers interested in the area of ‘Representations of Algebras’ to develop interaction, collaboration and the exchange of ideas. Beside the contributed talks by young mathematicians and recent PhDs, the list of main speakers of the conference included: Hideto Asashiba (Shizuoka University, Shizuoka, Japan); Karin Baur (Universität Graz, Graz, Austria); Silvana Bazzoni (Università di Padova, Padova, Italy); Xiao-Wu Chen (University of Science and Technology of China, Hefei, P.R.China); Erik Darpö (Nagoya University, Nagoya, Japan); Rosanna Laking (Max Planck Institute for Mathematics, Bonn, Germany); Hagen Meltzer (Szczecin University, Szczecin, Poland); Pierre-Guy Plamondon (Université de Versailles Saint-Quentin-en-Yvelines, France); Manuel Saorín (University of Murcia, Murcia, Spain);

Jan Stovicek (Charles University, Prague, Czech Republic); Yu Zhou (Tsinghua University, Beijing, China); and Alexander Zimmermann (Université de Picardie, Amiens, France).

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The scientific committee members of the event were: Lidia Angeleri-Hügel (Università degli Studi di Verona, Italy); Javad Asadollahi (University of Isfahan and IPM-Isfahan, Iran); Aslak Bakke Buan (Norwegian University of Science and Technology (NTNU), Norway); Henning Krause (University of Bielefeld, Germany); Amnon Neeman (Australian National University, Australia) and Mike Prest (University of Manchester, UK).

Ragnar Buchweitz from the University of Toronto, Canada also had accepted to be a member of the scientific committee of the event, but regretfully he passed away on November 11, 2017.

This volume of the Bulletin of the Iranian Mathematical Society is dedicated to IS CRA-2019. There are nine papers, some selected high-quality papers among submissions as well as some invited papers. Seven of them appear in this volume and two of them were already published in another volume. In the following, we review all the nine papers that have been accepted for the special volume.

Cluster structures have been established on numerous algebraic varieties. In the first paper, Karin Baur focused on the Grassmannian variety and explains the cluster structure on it. The tools she uses include dimer models on surfaces, associated algebras, and the study of associated module categories.

In the second paper, in an expository note, Hugh Thomas presents some of the key features of the lattice of torsion classes of a finite-dimensional algebra, focusing in particular on its complete semidistributivity and consequences thereof.

The author of the third paper, Bernhard Keller, recalls the formalism of derived categories and functors and surveys invariance results for the Hochschild (co)homology of differential graded algebras and categories.

The fourth paper is devoted to Hochschild cohomology, monoid objects and monoidal categories. In this paper, Magnus Hellstrøm-Finnssen expands on a category theoretical formulation of Hochschild cohomology for monoid objects in monoidal categories enriched over abelian groups.

In the next paper, Payam Bahiraei develops a method for constructing some model structures on the category of complexes of representations of a quiver with values in an abelian category and shows that the constructed model structures are monoidal.

In the next paper, Yanping Liu studies the relative derived categories with respect to relative Gorenstein projective modules and relative Gorenstein injective modules to unify Gorenstein derived categories and Ding derived categories in a certain sense.

Depth and dimension for triangulated categories were considered by the authors of the last paper of this volume. Li Wang, Zhongkui Liu and Xiaoyan Yang introduced

and studied a new notion of depth of an object in a compactly generated triangulated category with respect to a homogeneous ideal.

As mentioned above, the next two papers do not appear in this volume, but were originally submitted for publication in this special volume.

In the first one, by Carlos E. Parra, Manuel Saorín and Simone Virili, torsion pairs in categories of modules over a preadditive category are studied. Among other results, they present a detailed and self-contained exposition of an extension of the correspondence between (Gabriel filters that are uniquely determined by) idempotent ideals and TTF triples to additive functor categories over small preadditive categories. This paper appeared in Volume 47 of the BIMS, pages 1135–1171 (2021).

The second paper is devoted to study the Cohen-Montgomery duality for pseudo-actions of a group. It is an exposition on 2-equivalences between a 2-category of small k -categories with pseudo G -actions and a 2-category of G -graded small k -categories, where G is a group and k is a commutative ring. It is written by Hideto Asashiba, and appeared in Volume 47 of BIMS, pages 767–842 (2021).

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